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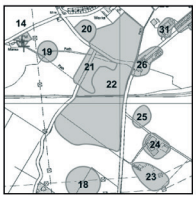





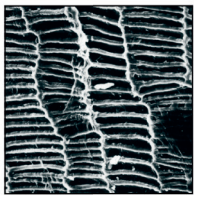


A12 CHELMSFORD TO A120, JUNCTION 23–25, ESSEX

GEOPHYSICAL SURVEY REPORT

commissioned by Jacobs UK Ltd
on behalf of Costain Ltd

January 2021

HEADLAND ARCHAEOLOGY

REGISTERED ORGANISATION CIfA

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January 2021

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

PROJECT INFO:

HA Project Code **ATCE20** / NGR **TL 87544 18974 to TL 91517 23480** / Parish **Feering All Saints, Messing All Saints, Inworth All Saints, Easthorpe: St Mary the Virgin, Marks Tay** / Local Authority **Essex County Council** / OASIS Ref. **headland5-412144**

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HEADLAND ARCHAEOLOGY

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REGISTERED ORGANISATION CIfA

PROJECT SUMMARY

Headland Archaeology (UK) Ltd undertook a geophysical (magnetometer) survey of 140 hectares on land between junctions 23 and 25 within the A12 Chelmsford to A120 Proposed Scheme (PS), to inform an archaeological assessment of the proposed road. The survey has successfully evaluated the geophysical survey areas within the Proposed Scheme except in a small number of areas where ground conditions were deemed unsuitable for survey. Anomalies of either likely, or possible, archaeological potential have been identified. Of high archaeological potential are a series of enclosures containing a ring ditch immediately south of the old Roman Road at area GP/13f, a discrete curvilinear enclosure of possible archaeological origin in GP/13a, small rectilinear enclosures on the edge of the Proposed Scheme in GP/13k and GP/13h and curvilinear and possible pit-like anomalies in GP/22e, GP/03h and GP/03g. 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, land drains, trackways, backfilled pits and fences. Numerous linear anomalies, corresponding with field boundaries marked on historic Ordnance Survey maps, have also been identified throughout the survey areas. Several irregularly shaped low magnitude anomalies have been detected which are probably due to natural or geological causes. Overall, most of the PS contains no anomalies of any archaeological potential and therefore the PS is assessed as having low to moderate archaeological potential, although locally high in the vicinity of the clearly defined areas of archaeological activity.

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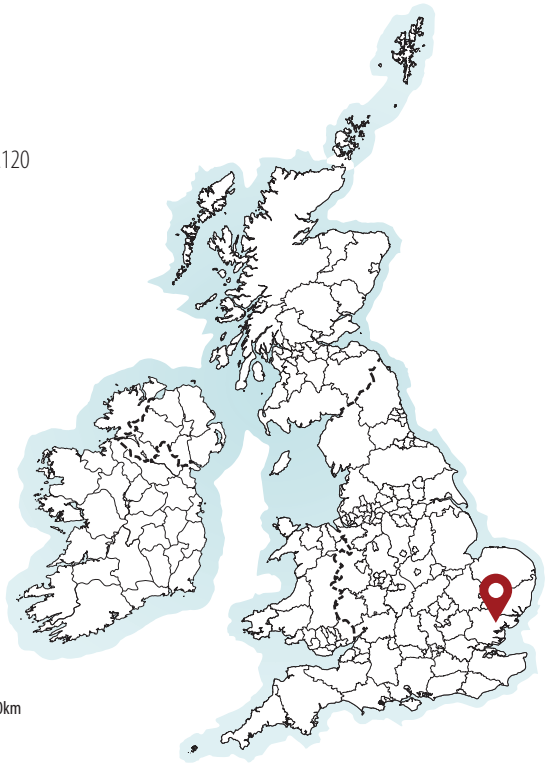
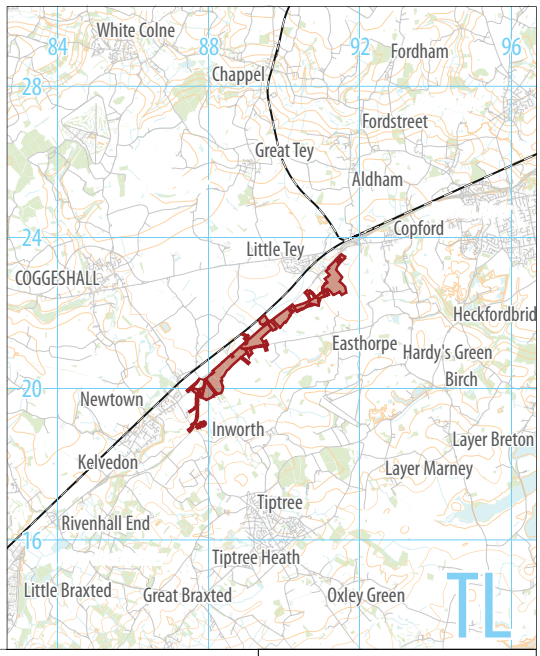
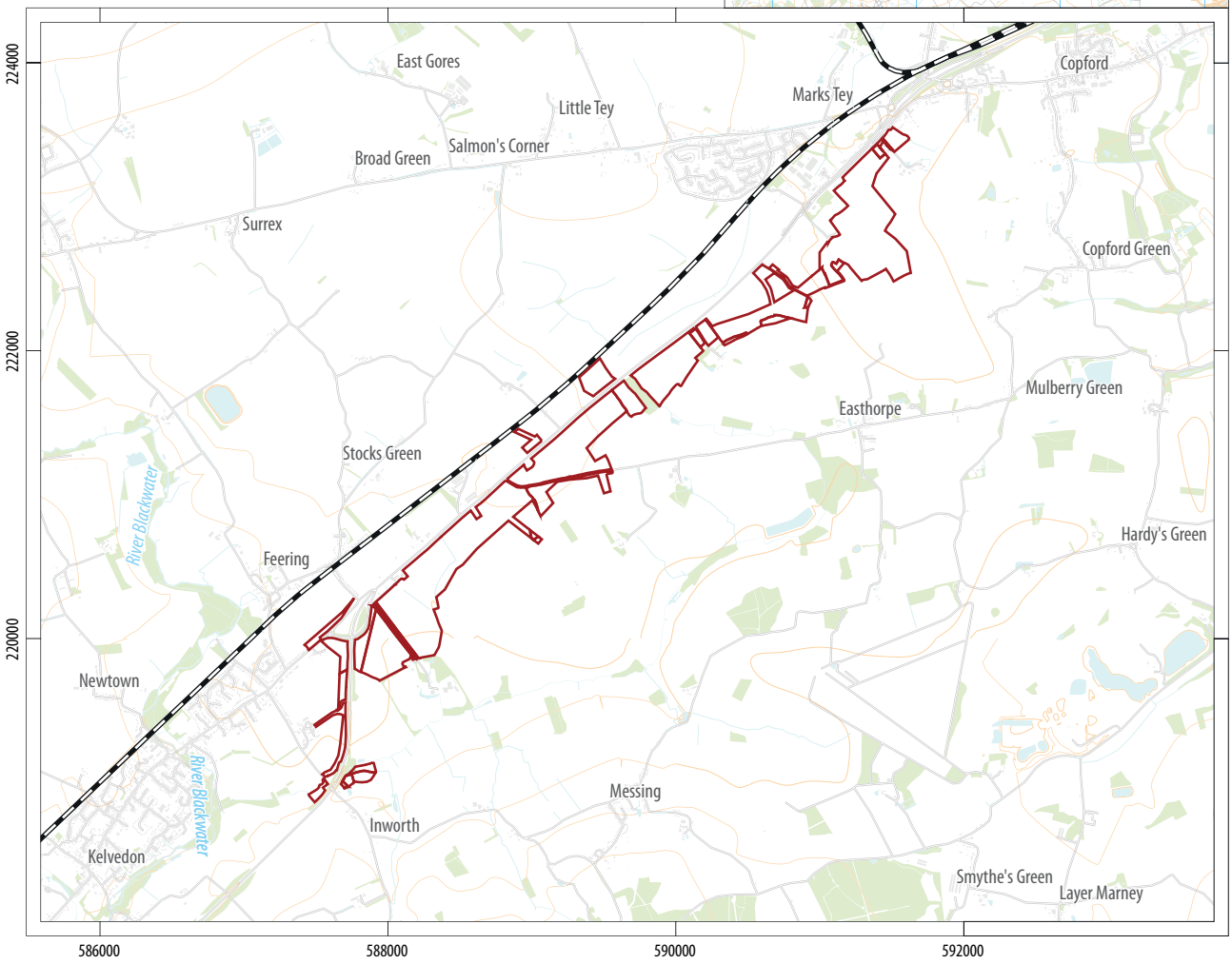
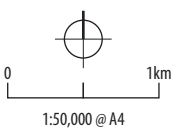
A12 Chelmsford to A120
Junctions 23 to 25
Essex









geophysical survey area

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ILLUS 1 Site location (1:50,000)

A12 CHELMSFORD TO A120, JUNCTION 23–25, 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 Junction 23 to Junction 25 within the A12 Chelmsford to A120 Proposed Scheme (PS). Ten survey areas, as numbered in Table 1, totalling 140 hectares, were surveyed along this corridor (Illus 1).

The results of the survey will inform future archaeological strategy at the site. The survey was undertaken 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) and Early Works Order (Jacobs 2020), with guidance within the National Planning Policy Framework (MHCLG 2019) and in line with current best practice (Chartered Institute for Archaeologists 2014, Europae Archaeologia Consilium 2016). The 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 September 2nd 2020 and October 14th 2020.

1.1 SITE LOCATION, TOPOGRAPHY AND LAND-USE

This section of the PS starts at Junction 23 (Kelvedon South Interchange) to the south-west of Kelvedon, extending to Junction 25 (Marks Tey), excluding any areas already surveyed during the Phase 1 geophysical survey.

The PS lies within the county of Essex and passes through the local planning authority areas of Chelmsford, Braintree, and Maldon. The Great Eastern Main Line runs parallel with the A12 for the whole length of the PS.

This section of the PS covered by this report passes through predominantly open countryside comprising large open arable fields and Grade 2 (very good) agricultural land. Other than Kelvedon to the west there are no towns located on this section of the route. The PS starts north of the village of Inworth and passes the nearest villages of Stocks Green, Feering and Easthorpe located either side of the A12.

Close to the western end of the PS, south of Witham and Kelvedon, lies the Blackwater Valley. The Blackwater Valley has large areas of floodplain associated with the River Blackwater which flows close to the PS through Kelvedon and immediately west of the Feering village.

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

1.2 GEOLOGY AND SOILS

All the area considered 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 deposits with a significant majority of the PS covered by Diamicton of the Lowestoft Formation. The very western part of the PS considered in this phase of work close to Kelvedon and Feering, has mixed superficial deposits of River Terrace Sand and Gravel and Head Clay, Silt Sand and Gravel deposits (NERC 2018). 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 9 Association, characterised as lime-rich loams and clays with impeded drainage. At the western end of the PS areas GP/29, 38, 47 and 48 have soils in the Soilscape 8 Association, characterised as slightly acid loamy and clayey soils with impeded drainage and GP/22 is characterised in the Soilscape 6 Association as freely draining slightly acid loamy soils (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 numerous archaeological remains recorded for the area within the Essex Historic Environment Record suggesting that there is a high potential for the presence of unknown archaeological remains throughout the PS.

The Cultural Heritage Desk Based Assessment (Jacobs 2018) shows that much of the Historic Landscape Type for this phase of the PS is recorded as post-1950 boundary loss. It also details the Palaeolithic potential of the PS as generally deemed to be low with one small area of moderate to very high potential identified at the western end in fields adjacent the A12 located between Kelvedon and Inworth. Neighbouring the PS to the east at Marks Tey is an area deemed very high in Palaeolithic potential. Here important information about the environment and landscape during the Palaeolithic has been recovered from well preserved lake deposits.

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.

3.1 MAGNETOMETER SURVEY

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

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

MLGrad601 and MultiGrad601 (Geomar Software Inc.) software was used to collect and export the data. Terrasurveyor V3.0.36.0 (DWConsulting) software was used to process and present the data.

3.2 REPORTING

A set of general site location plans with greyscale data and interpretations are shown in Illus 3–6 at a scale of 1:10,000. 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 7 to Illus 36 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 display and interpret the data to best effect. The interpretations are based on the experience and knowledge of management and reporting staff.

4 RESULTS AND DISCUSSION

Ground conditions were very good throughout the PS contributing to a high standard of data collection. A few areas were either not surveyed or were partly surveyed for a variety of reasons. These areas are displayed 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

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)
GP/48	TL 87544 18974	0.2	A modern pumping station of low value is listed in this area. Superficial geology comprises Diamicton.
GP/29	TL 87724 19014	0.3	Nearby post-medieval findspots are deemed of negligible value. Superficial geology comprises Diamicton.
GP/38	TL 87808 19031	0.97	Nearby post-medieval findspots are deemed of negligible value. Superficial geology comprises Diamicton and River Terrace Sand and Gravel.
GP/47	TL 87900 19107	0.83	A modern pumping station of low value is listed in this area. Superficial geology comprises Diamicton and River Terrace Sand and Gravel.
GP/22	TL 87689 19622	6.29	A cropmark of a rectangular enclosure (48301 MEX1041346) is identified at the southern end of GP/22c. Cropmarks detailing a double-ditch trackway, ring ditch with internal pit feature (8806 MEX28267) are in located the same field as GP22/e. Post-medieval findspots are deemed of negligible value in GP/22d. A modern pumping station of low value is listed at the southern end of field GP/22a. Superficial geology comprises River Terrace Sand and Gravel and Head Clay, Silt Sand and Gravel deposits.
GP/31	TL 88052 19857	4.1	No known archaeological remains with the PS. Bordering the PS to the south are grounds of Grade II listed Prested Hall which dates to the medieval period. Fragmentary remains of a moat are deemed of moderate value and cropmarks of former garden features and field boundaries of low value. Superficial geology comprises Diamicton and Head Clay, Silt Sand and Gravel deposits.
GP/13	TL 88936 21114	76.45	Cropmarks of two ring ditches (8804 MEX28260) are recorded in GP/13f, one is recorded as a pond on OS Maps. No known archaeological remains are identified for areas GP/13a-e and i-p. The 1888 OS Map shows a barn no longer extant in the south east corner of GP/13k and a further small structure surrounded by water no longer present off Gypsy Lane in GP/13i. The 1888 OS Map also shows a former field boundary in GP/13n. Superficial geology comprises Diamicton.
GP/14	TL 89435 21831	4.51	Cropmarks of field and woodland boundaries (named as "Domsey Grove") (14249 MEX39040) appear on OS Map of 1888 and 1946 vertical photography in GP/14c. No known archaeological remains in GP/14a-b. Superficial geology comprises Diamicton.
GP/12	TL 90213 22137	1.38	No known archaeological remains in GP/12a. Immediately south lay two Grade II listed post-medieval buildings (1225564 and 1238923). Superficial geology comprises Diamicton.
GP/03	TL 91203 22770	44.85	No known archaeological remains are identified for all areas in GP/03. Adjacent to GP/03h is a Grade II listed medieval/ post-medieval building, Doggets Hammer Farm (1266767). In the adjacent field between the A12 and GP/03h several Roman and Iron Age archaeological findspots deemed of negligible value are recorded. Outside the PS south of GP/03k are several heritage asset records for various aspects of the Grade II* listed Medieval Barn (1224577) belonging to Marks Tey Hall (11721 MEX34124). The 1888 OS Map shows former field boundaries in GP/03g-h. Superficial geology comprises Diamicton.

depth and composition of the topsoil and the superficial deposits from which they derive. Against this background a number of anomalies have been identified. A general classification of anomalies based on their response type is possible with the most common responses outlined below. 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 introduced into the topsoil as a result of manuring or tipping/infilling. There is no obvious clustering to these ferrous anomalies in any of the survey areas 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 widespread across the PS and 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. Several higher magnitude linear anomalies throughout the PS form the characteristic patterns of modern land drains and have been interpreted accordingly with clear examples in parts of GP/13, GP/03 and GP/14c (Illus 13–15, 19–27 and 34–36).

TABLE 2 Summary of findings by Geophysical Survey Area

GEOPHYSICAL SURVEY AREA AND SECTOR NO	SUMMARY OF FINDINGS
GP/22a-c, 29, 38, 47, 48 Sector 1 Illus 7–9	Strong Areas suitable for survey in GP/48a and GP/29, 47b were significantly reduced due to pig sheds and overgrown areas respectively and the areas which were surveyable have only detected modern ferrous interference, likely as a result of their proximity to the A12. Ferrous disturbances are also seen in GP22a/b and GP/38. An isolated linear anomaly (D1) in the southern part of GP/22c may relate to a cropmark of a rectangular enclosure. A magnetically weaker and broader trend anomaly in the north of GP/22c is likely of geological origin.
GP/13a, 31a-b, 22d-e Sector 2 Illus 10–12	Significant parts of GP/31 were overgrown and tree covered and unsuitable for survey. A very faint linear anomaly traversing GP/31b is a historic field boundary visible on the 1875 and 1881 OS Maps which is not recorded from 1897 onwards. Parts of GP/22d-e are covered by areas of ferrous disturbance adjacent to the A12 and other field boundaries. A modern service pipe crosses the northern part of GP/22d. A cluster of small, increased magnitude anomalies (P1) in the eastern part of GP/22e are distinct from the magnetic background and other isolated anomalies interpreted as geological in origin. An archaeological origin remains possible with cropmarks detailing a double-ditch trackway, ring ditch with internal pit feature located immediately to the north in the same field.
GP/13a-e Sector 3 Illus 13–15	In the south-east corner of GP/13a a weakly magnetic curvilinear anomaly containing a cluster of pit-like anomalies (D2) may be of archaeological origin. No previous archaeological remains are recorded for this area. A group of connected high magnitude linear anomalies close to the centre of GP/13a are interpreted as land drains. Further clear examples of land drains are present in GP/13c and e. Two broad, weakly magnetic anomalies in the northern part of GP/13b may well represent flooding incursions or palaeochannels. Further similar geological effects are more prominent in fields GP/13c and GP/13e with the addition of an area random high magnitude responses (HD1) likely corresponding to a geological Head deposit known in this area (NERC 2018). Field GP/13d was largely bird cover and unsuitable for survey but a short section of a historic field boundary visible on the 1888 OS Map has been detected. A weakly magnetic linear anomaly running approximately east-west across GP/13a is likely a trackway linking field entrances at the corners of the field. Ferrous disturbance is recorded along the length of the western boundary of GP/13a-b likely due to a buried service and alongside the A12 in fields GP/13c and GP/13e.
GP/13e-f Sector 4 Illus 16–18	A ring ditch (RD1) approximately 22.5m in diameter and likely associated enclosure ditches (E1 and E2) is present in the central part of GP/13f. This is possibly one of the two ring ditches recorded in the HER for this field. The more ephemeral weakly magnetic linear anomalies close by may also have an archaeological origin though linear anomaly (FB1) which bisects the ring ditch is know from early OS Maps. A concentrated cluster of high magnitude and some ferrous anomalies (IP1) are evident in the eastern part of GP/13f. These anomalies can be identified as a pond recorded on successive early OS Maps. The HER records a second ring ditch in this location as being marked by a pond on OS maps (Jacobs 2018), however there is no suggestion in the geophysics this anomaly has an archaeological origin and is an infilled pond fed by a short section of land drain visible as a strongly magnetic linear anomaly terminating at a former field boundary. In the south-east corner of GP/13f weakly magnetic linear anomalies forming a right angle (D3) may be of archaeological origin associated with a former building recorded on the 1st Edition OS Map in this location off Gypsy Lane. The structure is no longer recorded on OS Maps after 1975. Broad, weakly magnetic anomalies in the western and eastern parts of GP/13f (PC1) are of geological origin and may well represent flooding incursions or palaeochannels. Ferrous interference is largely confined to the field boundaries adjacent the A12 and pylon bases on the boundary of the PS.

GEOPHYSICAL SURVEY AREA AND SECTOR NO	SUMMARY OF FINDINGS
GP/13h-k Sector 5 Illus 19–21	Ferrous and non-ferrous magnetic disturbance in GP/13i (DB1) marks the location of former building recorded on the 1st Edition OS Map off Gypsy Lane. Historic OS Mapping shows a water filled area adjacent this structure and the magnetic responses are likely from the infilling of ponds marked on the historic mapping. In GP/13i linear high magnitude anomalies are former field boundaries with lower magnitude anomalies likely the result of modern cultivation. Short linear anomalies surrounding isolated pit-like anomalies in the south-east corner of GP/13k (E3) likely mark a small enclosure possibly associated with a structure 'New Barn' first recorded on the 1888 OS Map. GP/13k contains a complex network of field drains some of which respect no longer extant field boundaries suggesting multiple phases of drainage. No suitable areas were available in GP/13h or GP/13g due to thick hedges and a quinoa crop was present in GP/13j.
GP/13k-l, 14a-b Sector 6 Illus 22–24	Findings are limited to hight magnitude linear anomalies indicative of land drains and former field boundaries in GP/14a-b. More land drains are evident in GP/14c but also the boundary of 'Domsey Grove' (FB2) from the 1888 OS Map shows as a lower magnitude anomaly in the north-east corner of the PS. Ferrous disturbance is spread across the southern boundary of GP/13l likely reflecting tipping/infilling for a modern track and at field boundaries adjacent the A12.
GP/13l-n, 14c Sector 7 Illus 25–27	Isolated areas of ferrous disturbance in GP/13l likely reflect the fields current use as a dirt racing track with the anomalies representing areas of tipping/infilling. A modern service (SP1) extends into this field in the north-east corner. Findings in GP/13m are limited to a former field boundary, broad curvilinear anomalies geological in nature and ferrous interference alongside the A12. Area GP/13n contains a significant number of faint linear anomalies that form irregular patterns indicative of periglacial effects (PG1). Further geological anomalies in the form of broad, curvilinear responses (PC2) representing flooding events or palaeochannels are also present, possibly reflecting their location next to Domsey Brook.
GP/03a-b, 12a, 13p-o Sector 8 Illus 28–30	Findings in GP/12a are limited to a strongly magnetic land drain or service pipe. Linear anomalies running north-south in GP/03a (FB3 and FB4) represent former field boundaries and broader linear and curvilinear anomalies are likely geological in origin. A strongly magnetic service (SP2) is present in GP/03a and b and likely belongs to the same pipe. Ferrous interference is present in GP/03a on the western boundary and GP/03b adjacent to the A12 and farm buildings in the north-east corner. Parallel faint linear trends indicative of cultivation effects are recorded in GP/13p.
GP/03b-g,m Sector 9 Illus 31–33	A strongly magnetic and possibly discontinuous curving land drain is recorded in the eastern part of GP/03b. A variety of responses are detected in GP/03e. Curvilinear anomaly (TR1) and an associated isolated area of ferrous response (IP2) can be tied to a trackway and infilled pond from the 1st Edition OS Map. Linear and curvilinear anomalies with a high magnitude response associated with the infilled pond are likely land drains. Close to the infilled pond and adjacent to the field boundary is a short curvilinear anomaly (D4) which may be of geological/natural or archaeological origin. Parallel weakly magnetic trends orientated parallel to the current field boundaries are interpreted as cultivation effects. In the western part of GP/03h a small cluster of anomalies with elevated magnetic readings against the background (P2) could be described as pit-like and may be of archaeological potential with one stronger anomaly suggestive of burning (B1). With little context and the lack of more distinctive anomalies it is possible these anomalies may be natural/geological in origin. The nearest recorded heritage assets are a series of Roman and Iron Age archaeological findspots c 250m west adjacent the A12 deemed of negligible value. In the south-west corner of GP/03g a cluster of slightly enhanced magnetic anomalies (P3) against the background maybe be of archaeological or natural/geological origin. With no previously known recorded assets or other anomalies within the data to provide context interpretation of these anomalies remains difficult. Ferrous interference from a large pylon affects much of the data from GP/03f. Slightly enhanced curvilinear anomalies may be geological in origin.
GP/03g-l Sector 10 Illus 34–36	The two adjacent large fields, GP/03g and GP/03h both have faint polygonal anomalies typical of periglacial effects. Amongst these anomalies in GP/03h are a cluster of curvilinear anomalies of increased magnitude (E4) with possible associated pit-like anomalies. Difficult to differentiate from the surrounding periglacial effects these anomalies may be of archaeological origin. These anomalies provide similar responses to others seen in this part of GP/03h (Illus 31-33) and may all be associated. A further cluster of enhanced anomalies (E5) is evident to the north-west of E4, these anomalies are thought to be archaeological in origin, possibly locating a small enclosure of a field system Regular linear anomalies in GP/03h can be traced to historic field boundaries visible on the 1887 OS Map which would have once divided the field into four irregular shaped parcels. Multiple isolated and interconnected linear anomalies typical of land drains are present in in fields GP/03g-l. Other faint parallel linear anomalies characteristic of modern agricultural ploughing are visible in GP/03h. Ferrous disturbances are concentrated along the side of the A12 and around the northern boundaries with a strongly magnetic modern service bisecting field GP/03k. No anomalies which could be associated with the Grade II* Listed medieval barn south of GP/03k have been detected.

4.3 GEOLOGICAL ANOMALIES

Low magnitude irregular anomalies, sub-linear and curvilinear, occur in many areas of the PS. Some of the broad, weakly magnetic anomalies are probably associated with palaeochannels and other fluvial events with examples in areas GP/13c (Illus 13–15), GP/13f (Illus 16–18) and GP/13m-n (Illus 25–27). Periglacial effects can also be seen across large parts of the eastern end of the PS most prominently in Sectors 9 and 10 (Illus 31–36) but also Sector 7 (Illus 25–27).

4.4 POSSIBLE ARCHAEOLOGICAL ANOMALIES

Eight high magnitude anomalies or clusters of anomalies (relative to the magnetic background) have been identified throughout the PS as having possible archaeological potential. Of high archaeological potential are a series of enclosures containing a ring ditch immediately south of the old Roman Road at area GP/13f (Illus 16–18), a discrete curvilinear enclosure of possible archaeological origin in GP/13a (Illus 13–15), small rectilinear enclosures on the edge of the PS in GP/13h and GP/13k (Illus 16–21) and curvilinear and possible pit-like anomalies in GP/22e, GP/03h and GP/03g (Illus 31–36). An isolated weakly magnetic linear anomaly in GP/22c may be of archaeological origin, though the small survey area provides little wider context to aid interpretation. A possible archaeological interpretation has been provided based on the nature of response and recorded cropmark in this location (Illus 7–9).

5 CONCLUSION

The survey has successfully evaluated the geophysical survey areas within the Proposed Scheme except for small areas where ground conditions were unsuitable for survey. Eight anomalies or clusters of anomalies with either likely or possible archaeological potential have been identified. Of high archaeological potential are a series of enclosures containing a ring ditch immediately south of the old Roman Road at area GP/13f, a discrete curvilinear enclosure of possible archaeological origin in GP/13a, small rectilinear enclosures on the edge of the Proposed Scheme in GP/13k and GP/13h and curvilinear and possible pit-like anomalies in GP/22e, GP/03h and GP/03g. 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, land drains, trackways, backfilled pits and fences. 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 particularly in larger fields in the eastern half of the scheme. Irregularly shaped linear and sub-linear low magnitude anomalies are visible in the eastern half of the PS and represent periglacial effects. Similarly weak but broader curvilinear anomalies present across the PS denote palaeochannels and other fluvial events. Generally the geological background has proved receptive to magnetic prospection with the detection of a broad range of anomalies both natural and anthropogenic in origin.

The results of the geophysical survey support the findings detailed in the Cultural Desk Based Assessment (Jacobs 2018) for this phase of the PS. This highlighted a high potential for the presence of unknown buried archaeological remains despite few heritage assets being recorded within the boundaries of the PS. 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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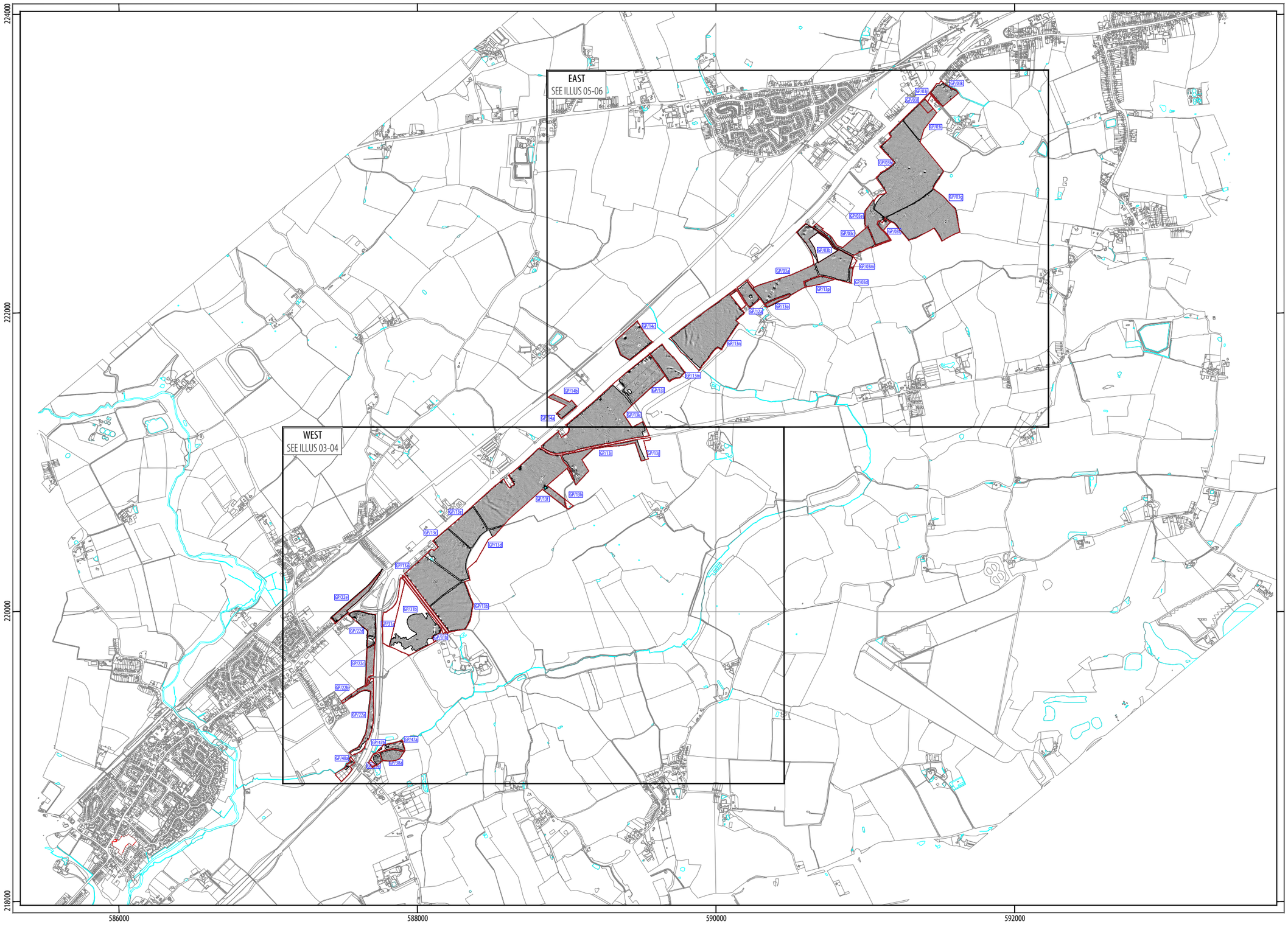
Jacobs 2019 ***A12 Chelmsford to A120 Invitation to tender volume 2: Archaeological geophysical survey written scheme of investigation***

Jacobs 2020 ***A12 Chelmsford to A120 Archaeological Geophysical Survey Specification Phase 2 Early Works Order***



geophysical survey area

nT
-1.0
2.0

0
500m
1:25,000 @ A3

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Junctions 23 to 25
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ILLUS 2 Overview of greyscale magnetometer data

SECTOR 4
SEE ILLUS 16-18

SECTOR 5
SEE ILLUS 19-21

SECTOR 2
SEE ILLUS 10-12

SECTOR 3
SEE ILLUS 13-15

SECTOR 1
SEE ILLUS 7-9

GP/13a
GP/13b
GP/13c
GP/13d
GP/13e
GP/13f
GP/13h
GP/13i
GP/13j
GP/22a
GP/22b
GP/22c
GP/22d
GP/22e
GP/31a
GP/31b
GP/38a
GP/47a
GP/47b
GP/48a

220000

588000

590000

geophysical survey area

nT
-1.0 2.0

0 200m
1:10,000 @ A3

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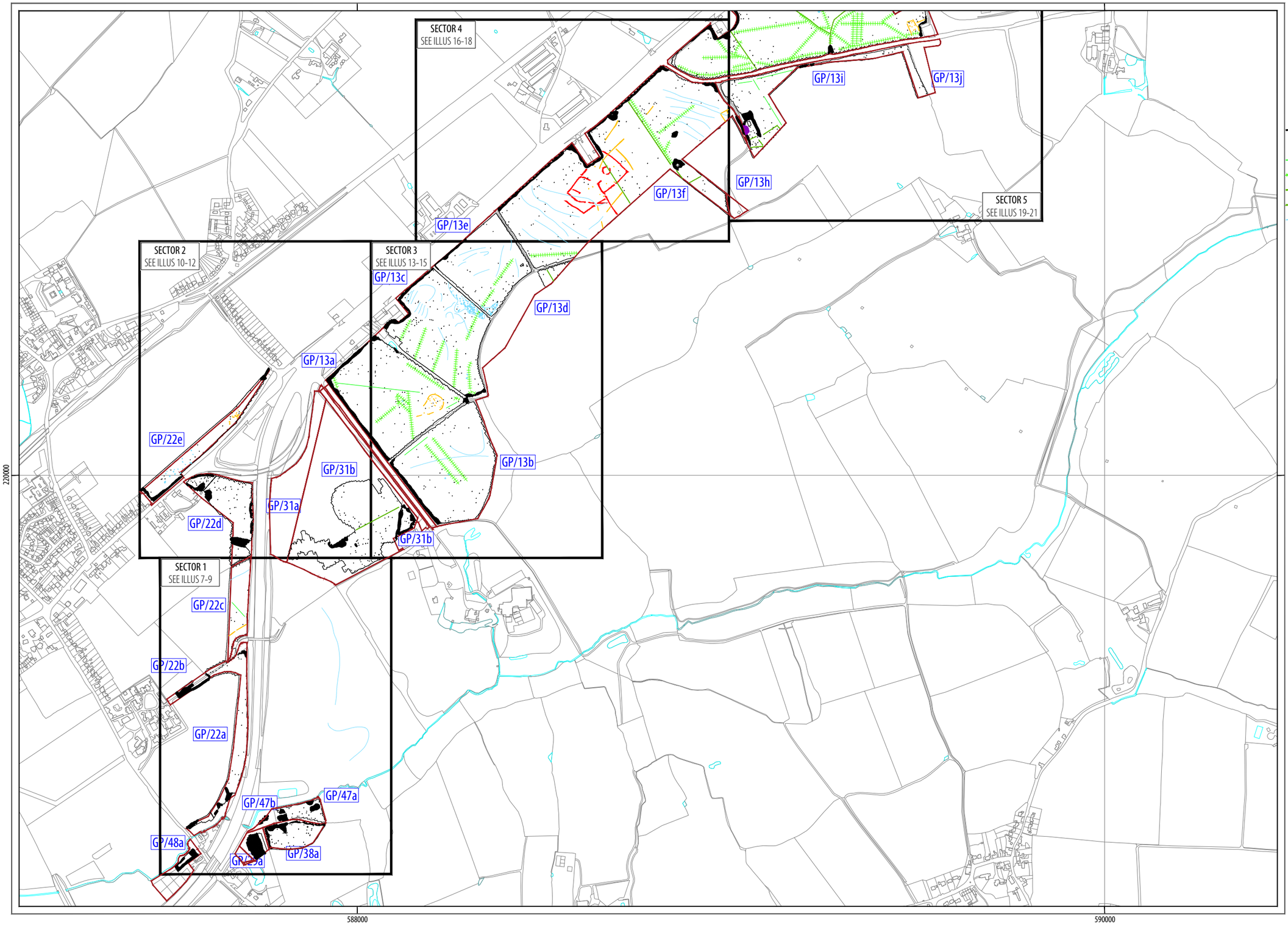
ILLUS 3 Overall greyscale plot of magnetometer data; West



geophysical survey area

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

0 200m
1:10,000 @ A3

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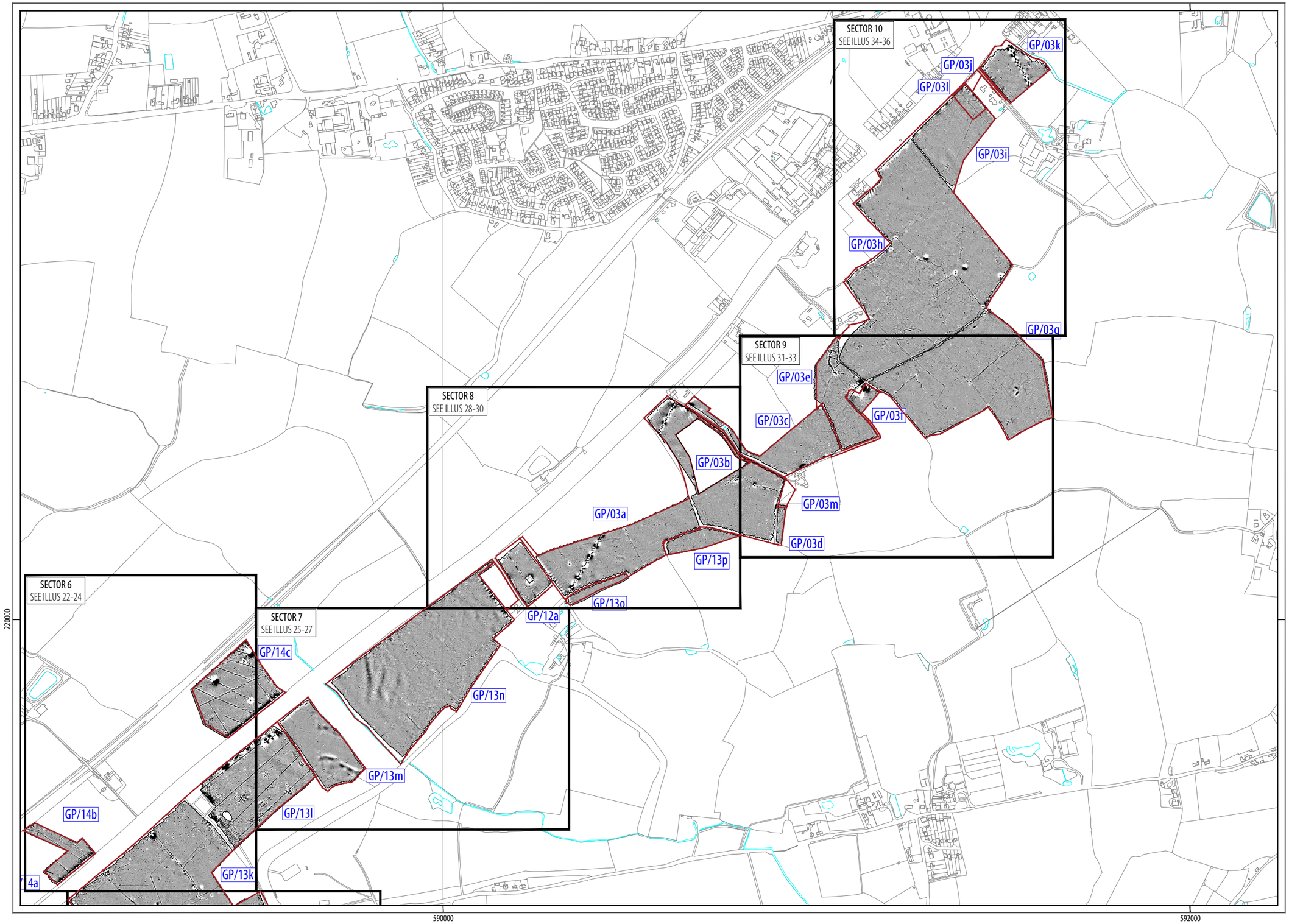
ILLUS 4 Overall interpretation of magnetometer data; West



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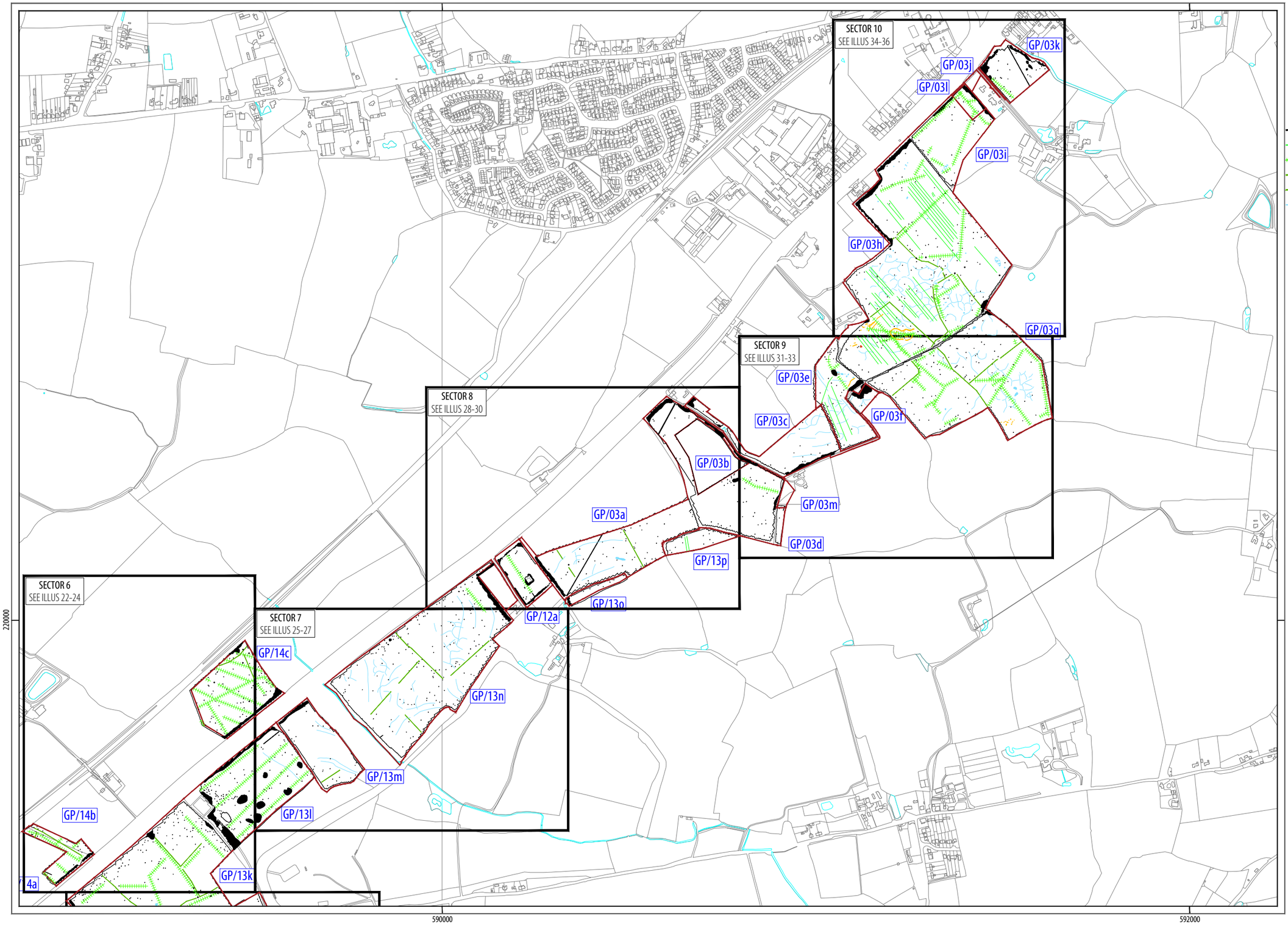
ILLUS 5 Overall greyscale plot of magnetometer data; East



geophysical survey area

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

0 200m
1:10,000 @ A3

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ILLUS 6 Overall interpretation plot of magnetometer data; East

nT
-1.0
2.0

0
50m
1:2,500 @ A3

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ILLUS 7 Processed greyscale magnetometer data; Sector 1

GP/22c
GP/31a
GP/22b
GP/22a
GP/47b
GP/47a
GP/38a
GP/29a
GP/48a
219500
219000
587500
588000

25.0nT/cm

0 50m

1:2,500 @ A3

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ILLUS 8 XY trace plot of minimally processed magnetometer data; Sector 1

GP/31a
GP/22c
D1
GP/22b
GP/22a
GP/47a
GP/47b
GP/38a
GP/29a
GP/48a

219500
219000
587500
588000

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

TYPE OF ANOMALY	INTERPRETATION
linear trend	geological variation
magnetic enhancement	archaeology?

ABBREVIATIONS	
D	ditch

0 50m
1:2,500 @ A3

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ILLUS 9 Interpretation of magnetometer data; Sector 1

220500

220000

587500

588000

GP/22e

GP/22d

GP/13a

GP/31b

nT

-1.0

2.0

0

50m

1:2,500 @ A3

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ILLUS 10 Processed greyscale magnetometer data; Sector 2

220500

220000

587500

588000

GP/13a

GP/22e

GP/22d

GP/31b

25.0nT/cm

0 50m

1:2,500 @ A3

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ILLUS 11 XY trace plot of minimally processed magnetometer data; Sector 2

220500

220000

587500

588000

P1

GP/22e

GP/22d

GP/13a

GP/31b

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
magnetic enhancement	geology
magnetic enhancement	archaeology?

ABBREVIATIONS

P pit

0 50m

1:2,500 @ A3

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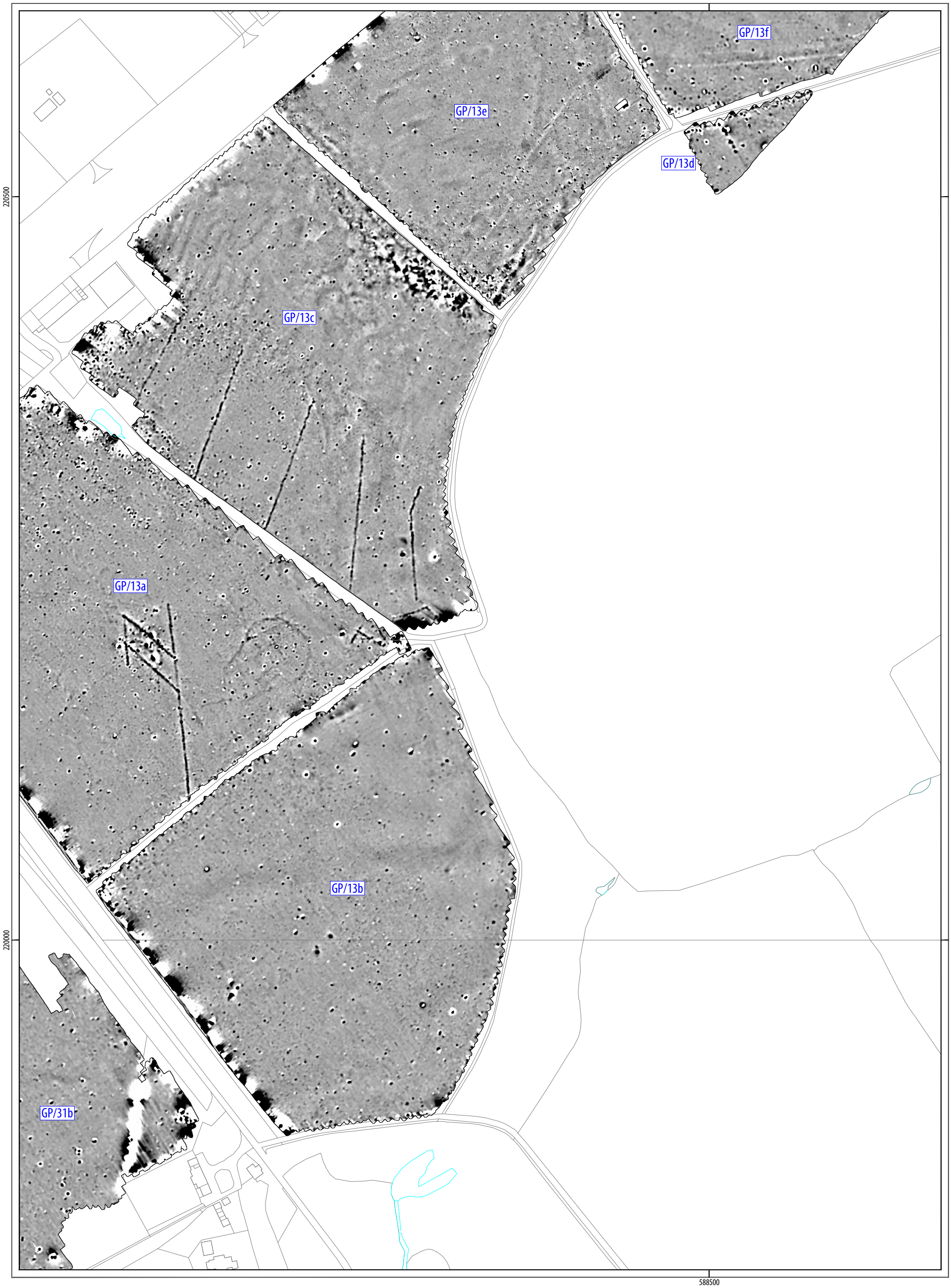
ILLUS 12 Interpretation of magnetometer data; Sector 2



nT
-1.0
2.0

0
50m
1:2,500 @ A3

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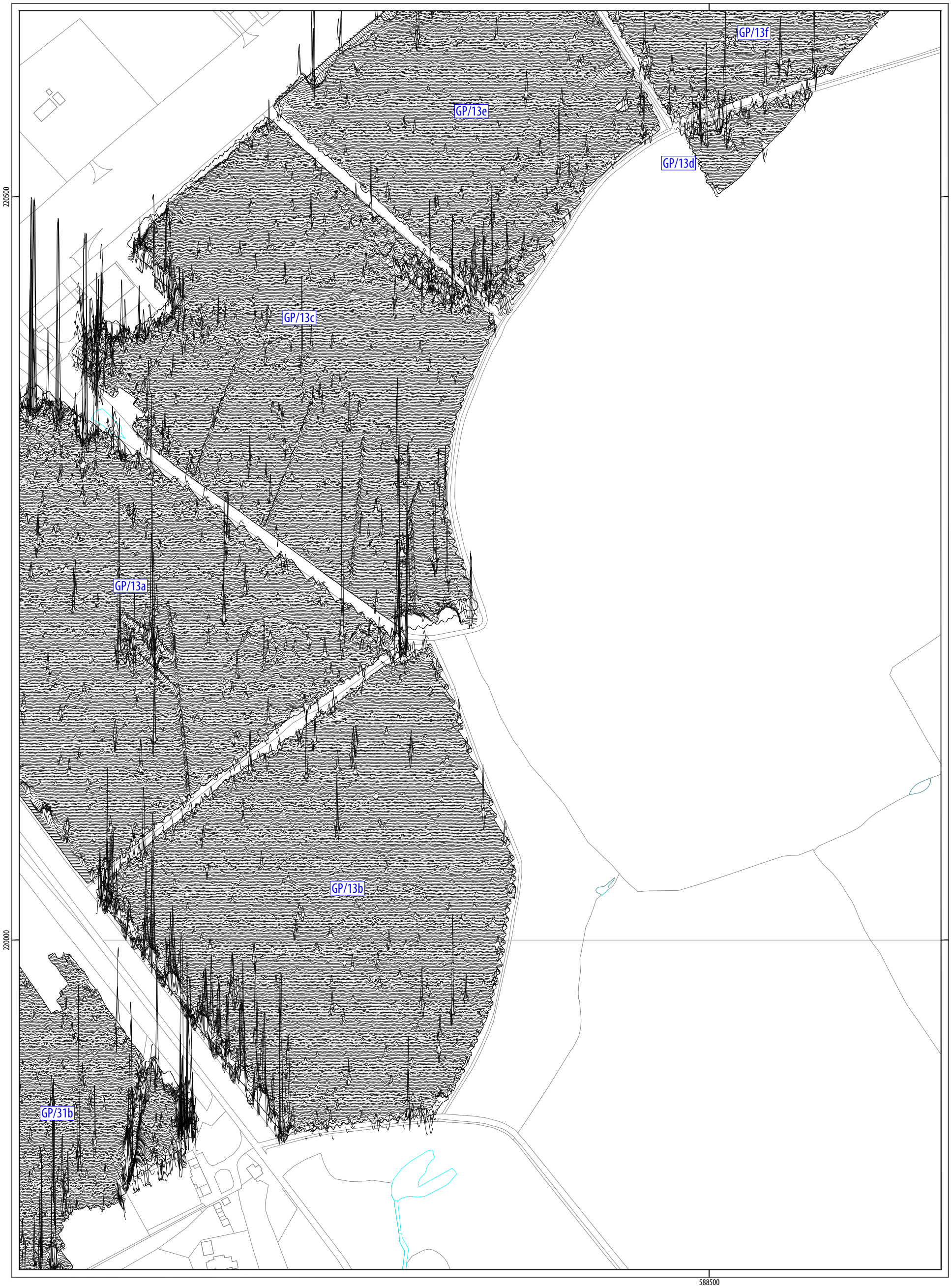
ILLUS 13 Processed greyscale magnetometer data; Sector 3



25.0nT/cm

0 50m

1:2,500 @ A3

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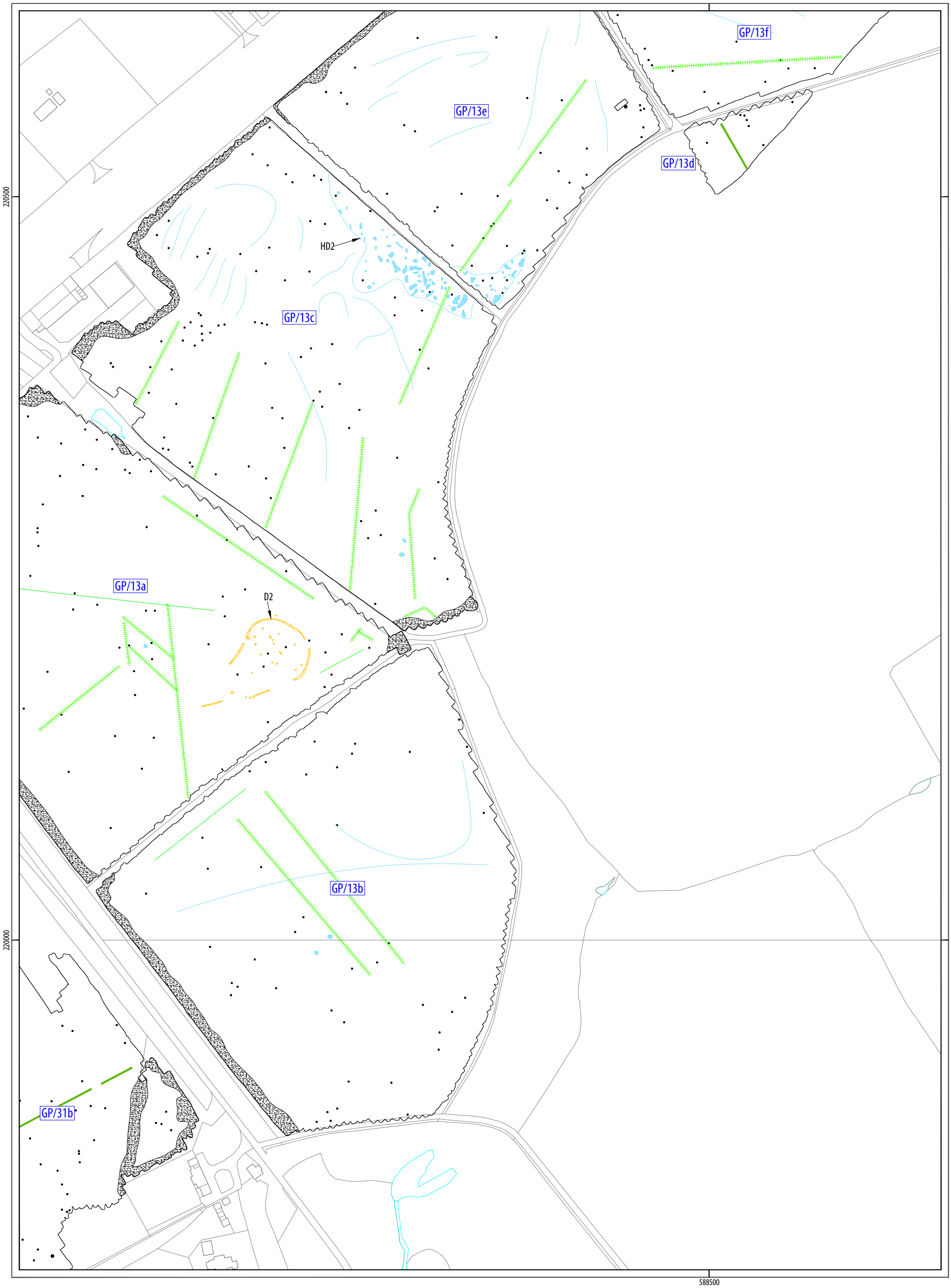
ILLUS 14 XY trace plot of minimally processed magnetometer data; Sector 3



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

TYPE OF ANOMALY	INTERPRETATION
magnetic enhancement	geology
magnetic enhancement	archaeology?

ABBREVIATIONS	
D	ditch
HD	head deposit

0 50m
1:2,500 @ A3

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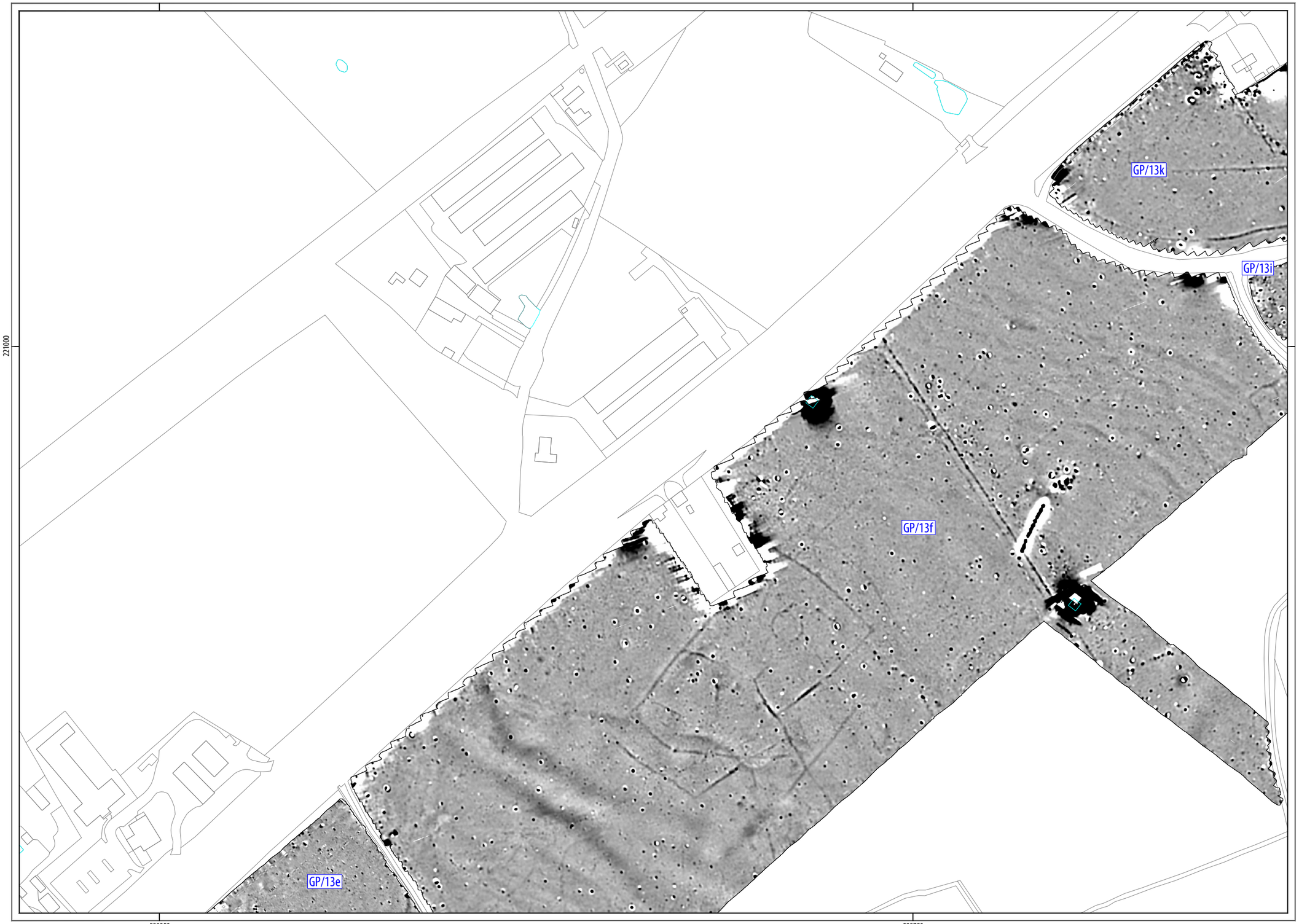
ILLUS 15 Interpretation of magnetometer data; Sector 3



nT
-1.0
2.0

0
50m
1:2,500 @ A3

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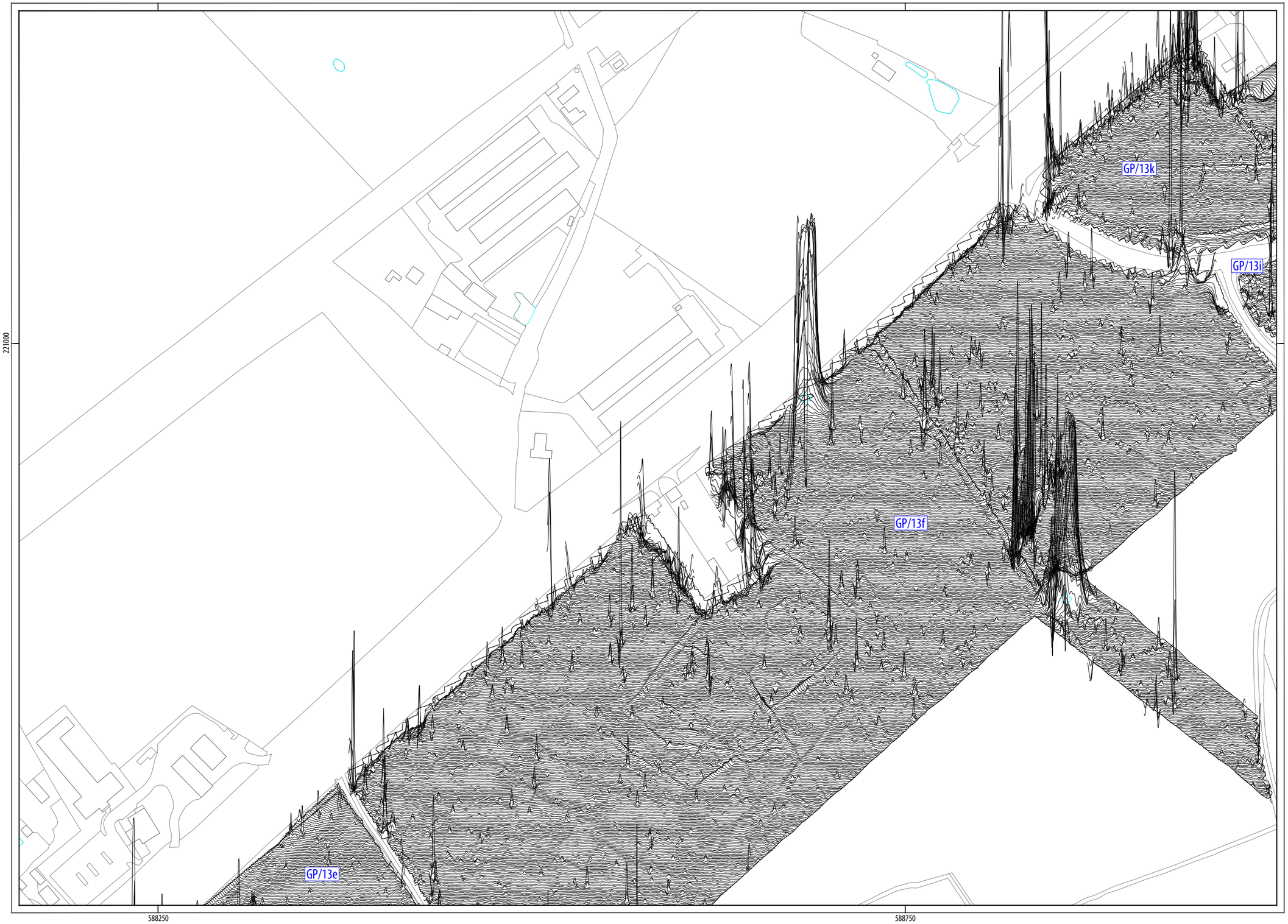
ILLUS 16 Processed greyscale magnetometer data; Sector 4



25.0nT/cm

0 50m

1:2,500 @ A3

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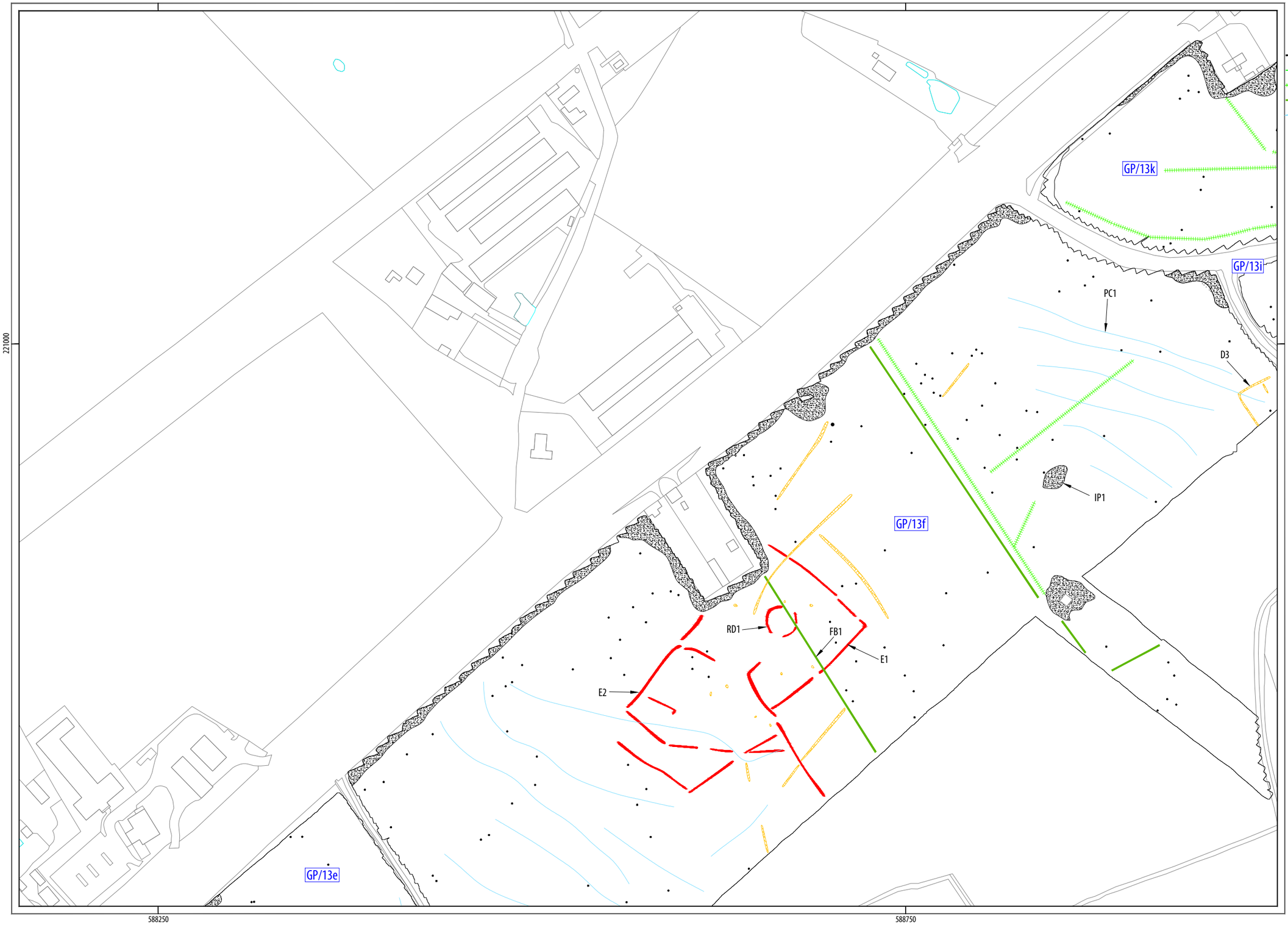
ILLUS 17 XY trace plot of minimally processed magnetometer data; Sector 4



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
magnetic enhancement	archaeology?
magnetic enhancement	archaeology

ABBREVIATIONS

D	ditch
E	enclosure
FB	former boundary
IP	infilled pond
PC	palaeochannel
RD	ring-ditch

0 50m
1:2,500 @ A3

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ILLUS 18 Interpretation of magnetometer data; Sector 4

nT
-1.0
2.0

0
50m
1:2,500 @ A3

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ILLUS 19 Processed greyscale magnetometer data; Sector 5

25.0nT/cm

0 50m

1:2,500 @ A3

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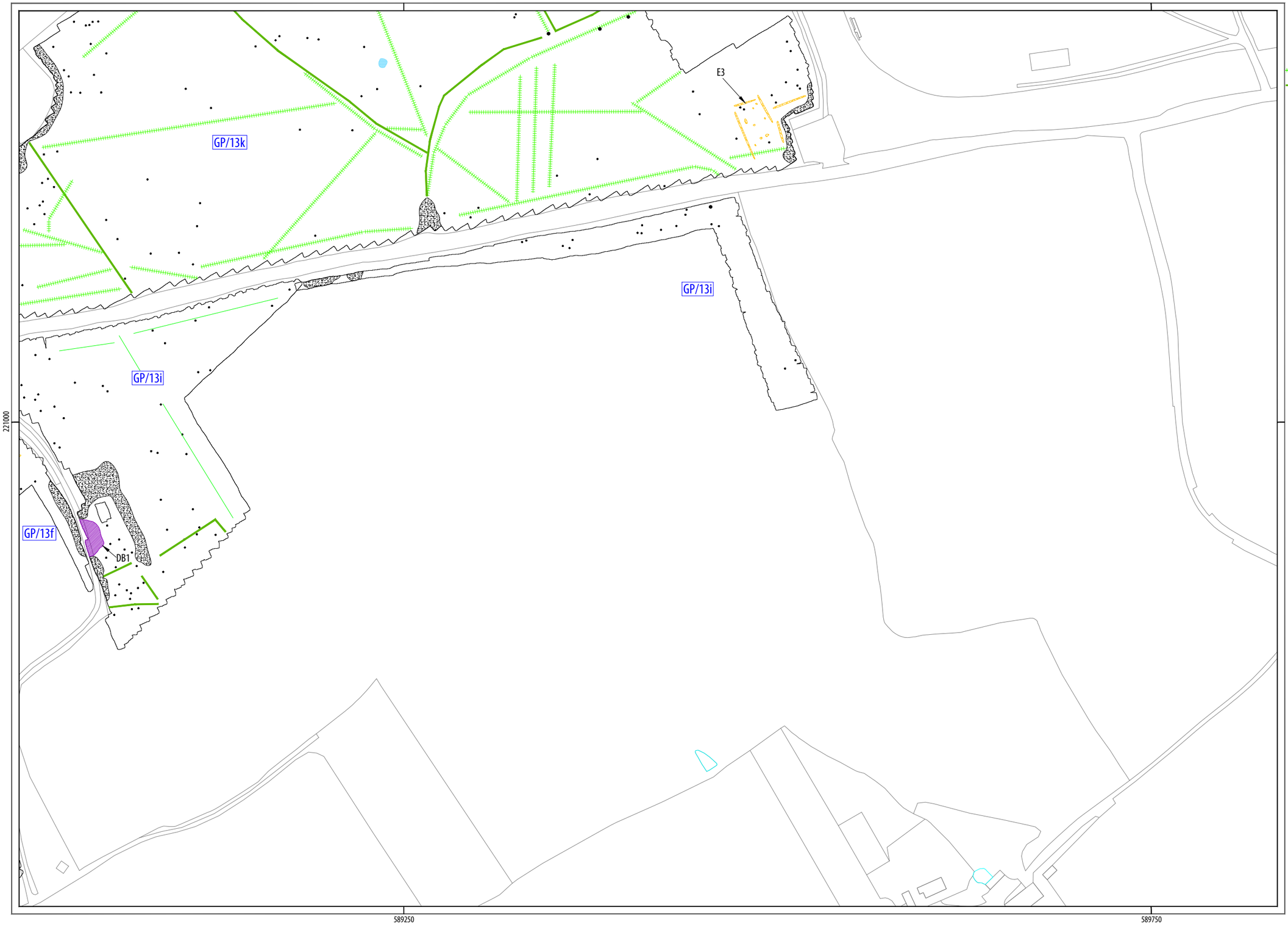
ILLUS 20 XY trace plot of minimally processed magnetometer data; Sector 5



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

ABBREVIATIONS

DB demolished building

E enclosure

0 50m

1:2,500 @ A3

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ILLUS 21 Interpretation of magnetometer data; Sector 5

222000

221500

589000

GP/14b

GP/13k

GP/13l

GP/14c

-1.0 nT 2.0

0 50m

1:2,500 @ A3

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ILLUS 22 Processed greyscale magnetometer data; Sector 6

222000

221500

589000

GP/14c

GP/13l

GP/13k

GP/14b

25.0nT/cm

0 50m

1:2,500 @ A3

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ILLUS 23 XY trace plot of minimally processed magnetometer data; Sector 6

222000

221500

589000

FB2

GP/14a

GP/14b

GP/14c

GP/13k

GP/13l

TYPE OF ANOMALY | INTERPRETATION

- dipolar isolated | ferrous material
- magnetic disturbance | ferrous material
- linear trend | field drain
- linear | former field boundary

ABBREVIATIONS

FB field boundary

0 50m

1:2,500 @ A3

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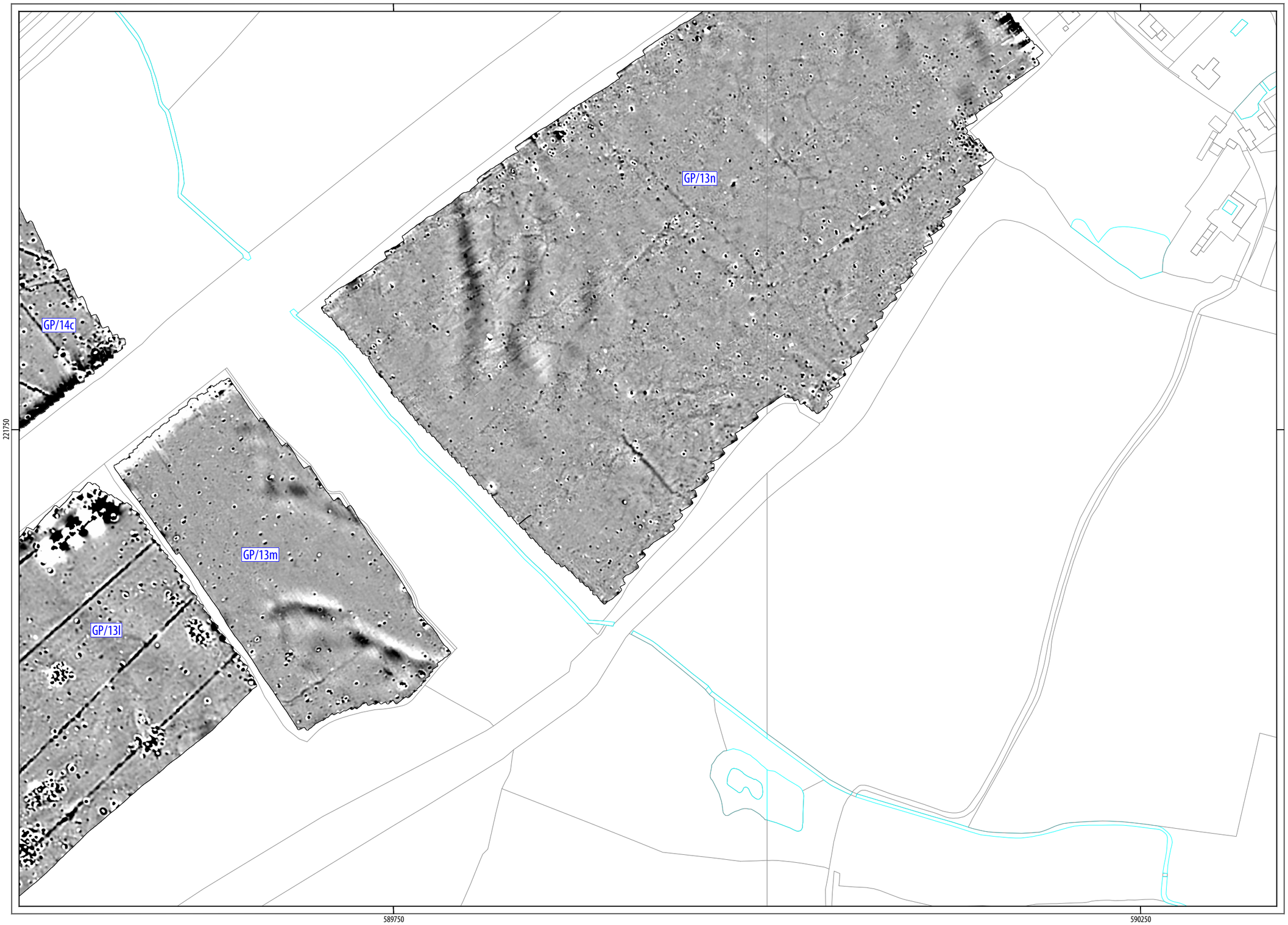
ILLUS 24 Interpretation of magnetometer data; Sector 6



nT
-1.0 2.0

0 50m
1:2,500 @ A3

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ILLUS 25 Processed greyscale magnetometer data; Sector 7

GP/14c

GP/13n

GP/13m

GP/13l

221750

589750

590250

25.0nT/cm

0 50m

1:2,500 @ A3

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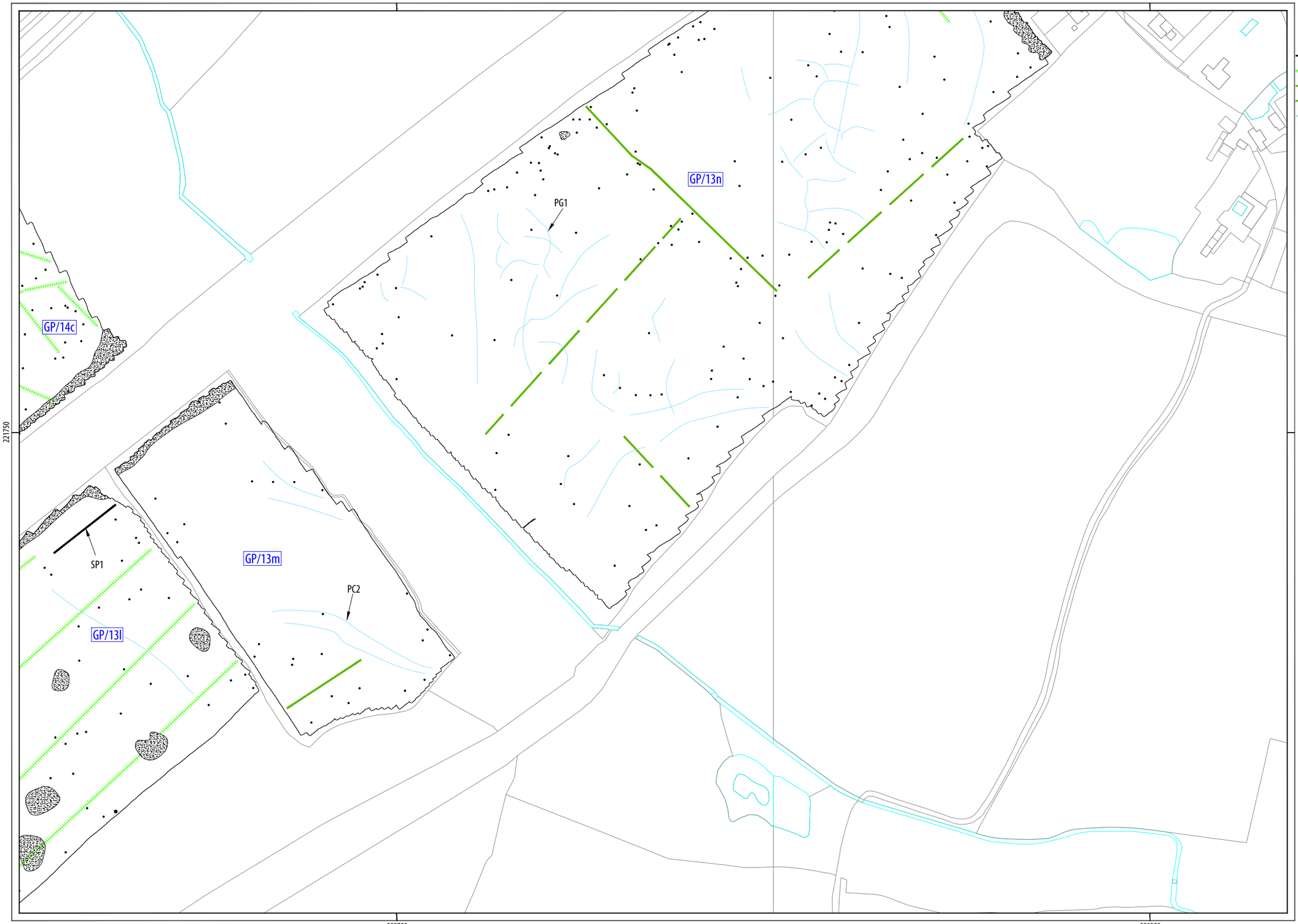
ILLUS 26 XY trace plot of minimally processed magnetometer data; Sector 7



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

ABBREVIATIONS

PC	palaeochanncel
PG	periglacial
SP	service pipe

0 50m
1:2,500 @ A3

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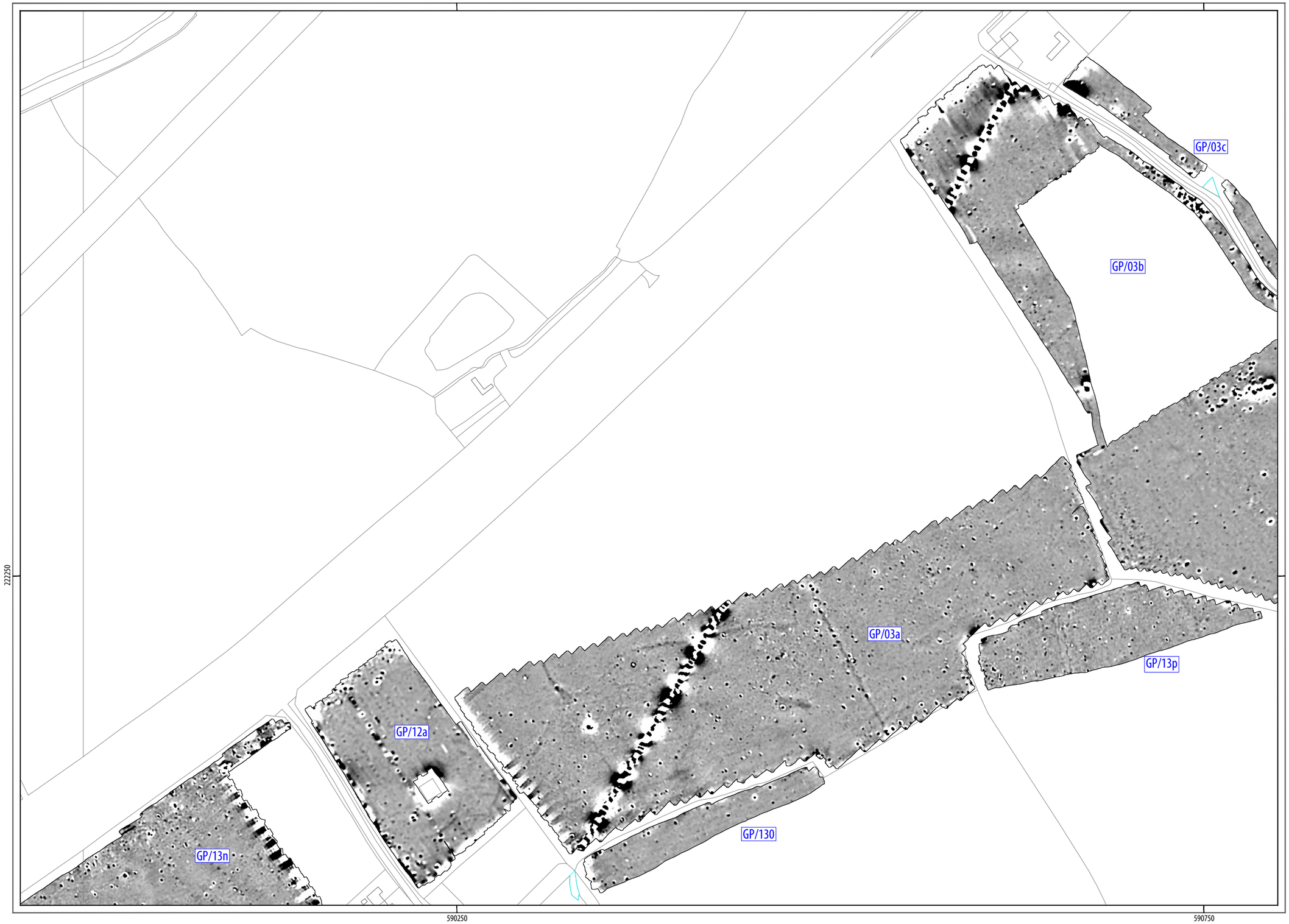
ILLUS 27 Interpretation of magnetometer data; Sector 7



nT
-1.0
2.0

0
50m
1:2,500 @ A3

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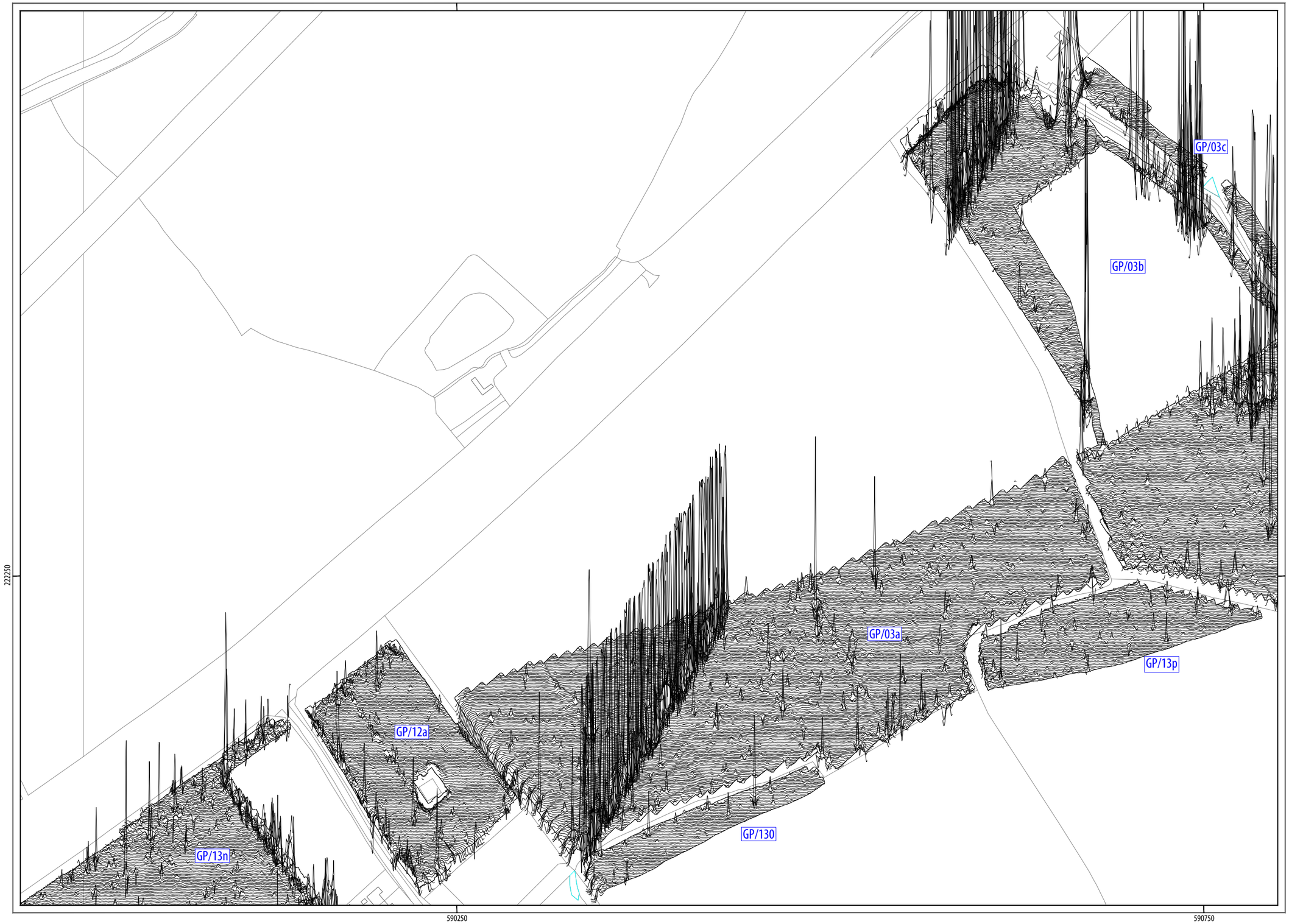
ILLUS 28 Processed greyscale magnetometer data; Sector 8



25.0nT/cm

0 50m

1:2,500 @ A3

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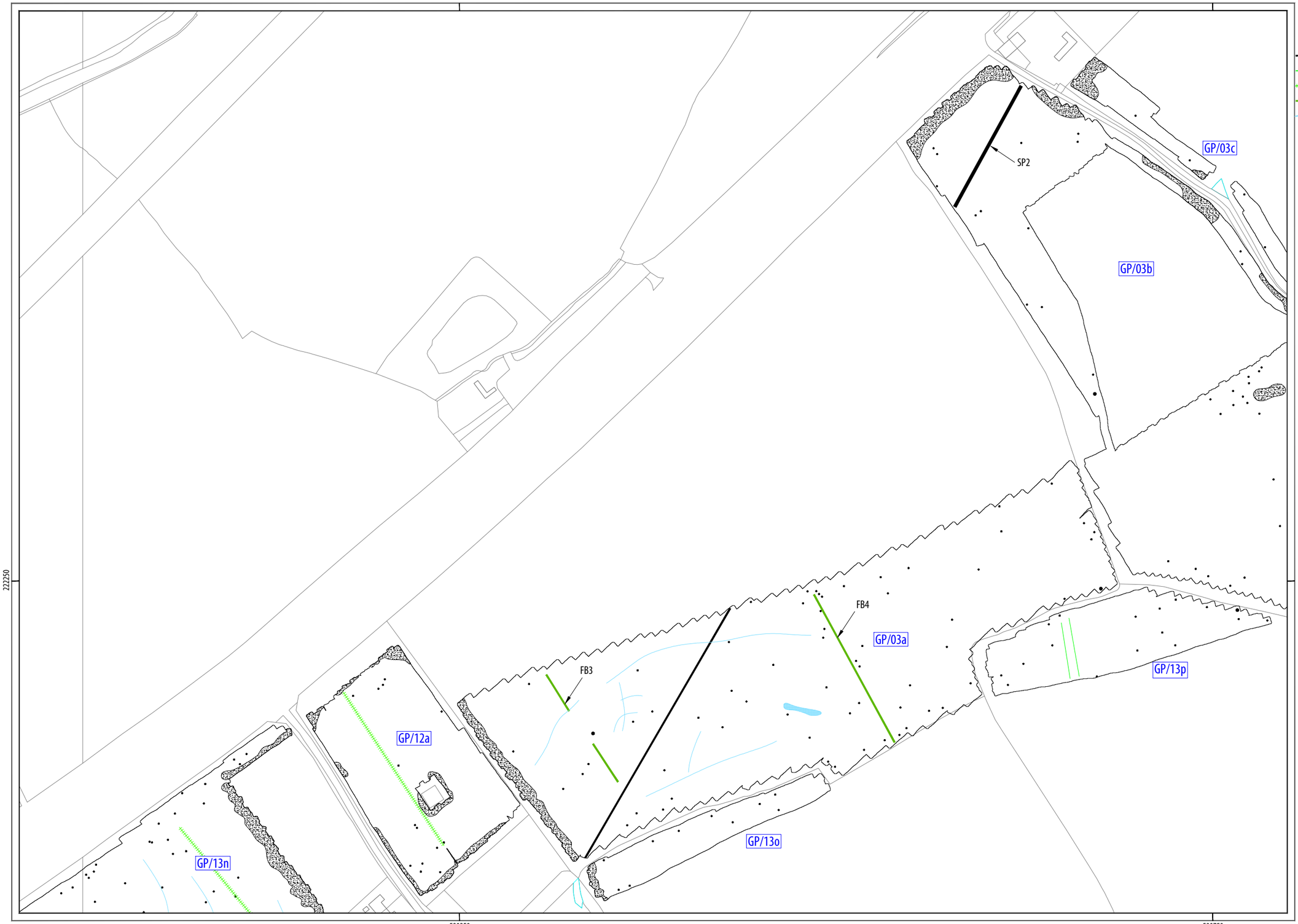
ILLUS 29 XY trace plot of minimally processed magnetometer data; Sector 8



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

ABBREVIATIONS

FB	field boundary
SP	service pipe

0 50m
1:2,500 @ A3

PROJECT ATCE20
A12 Chelmsford to A120
Junctions 23 to 25
Essex

CLIENT Costain

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ILLUS 30 Interpretation of magnetometer data; Sector 8

nT
-1.0 2.0

0 50m
1:2,500 @ A3

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ILLUS 31 Processed greyscale magnetometer data; Sector 9

GP/03h
GP/03e
GP/03f
GP/03g
GP/03c
GP/03b
GP/03d
222500
591000
591500
25.0nT/cm
0
50m
1:2,500 @ A3
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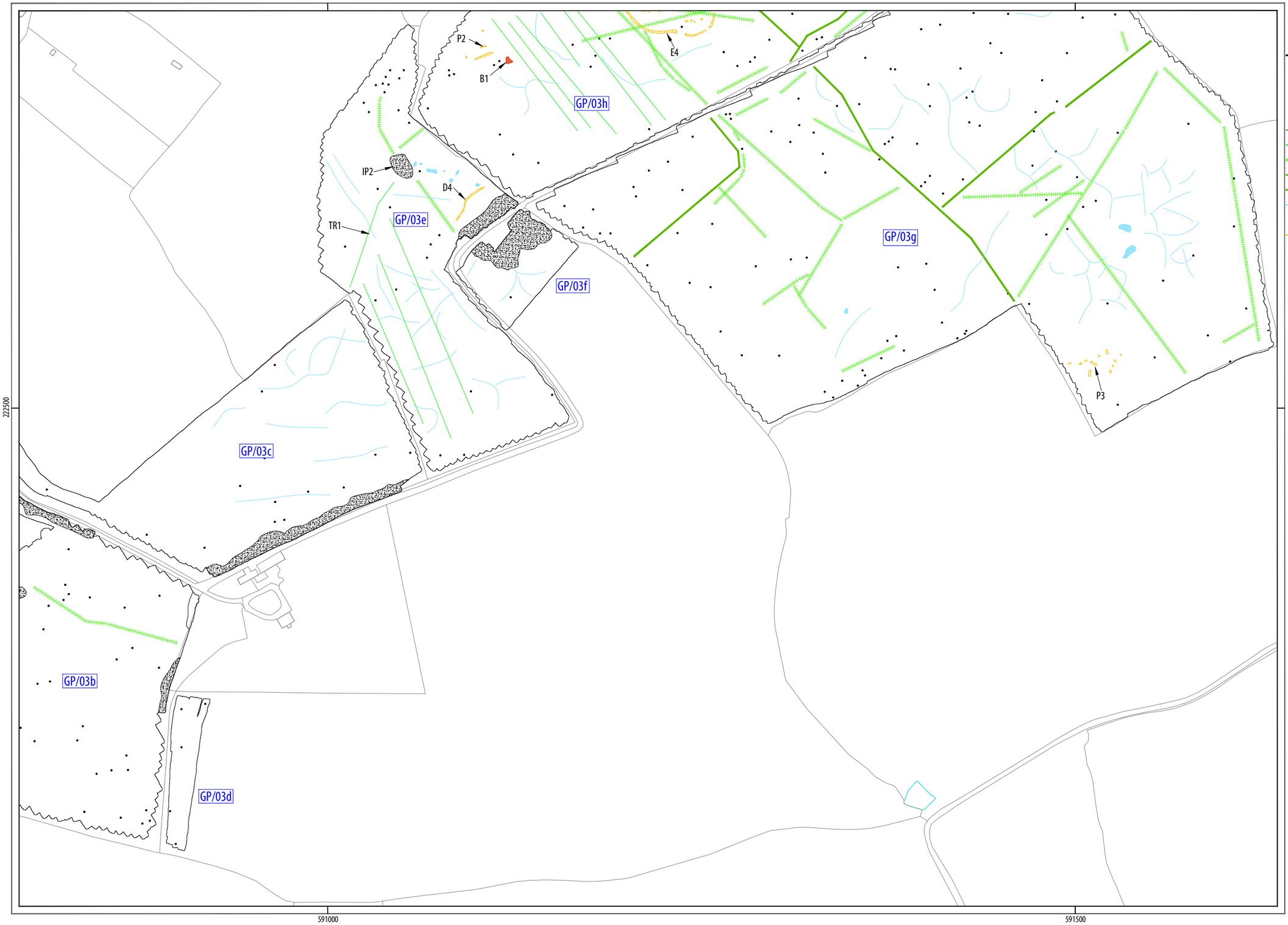
ILLUS 32 XY trace plot of minimally processed magnetometer data; Sector 9



TYPE OF ANOMALY	INTERPRETATION
dipolar isolated	ferrous material
magnetic disturbance	ferrous material
dipolar linear	service pipe
null value	overhead cables
magnetic xxxxxxxxxx	quarrying
magnetic disturbance	former building
magnetic enhancement	LIRM
linear trend	ridge and furrow
linear trend	agricultural
linear trend	field drain
linear	former field boundary
linear	former field boundary?
linear trend	geological variation
magnetic enhancement	geology
linear trend	archaeology?
magnetic enhancement	archaeology?
magnetic enhancement	kiln/burning
magnetic enhancement	archaeology

ABBREVIATIONS

B	burning
E	enclosure
IP	infilled pond
P	pit
TR	track

0 50m

1:2,500 @ A3

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ILLUS 33 Interpretation of magnetometer data; Sector 9

223500

GP/03k

GP/03i

GP/03h

GP/03g

223000

591500

nT
-1.0 2.0

0 50m
1:2,500 @ A3

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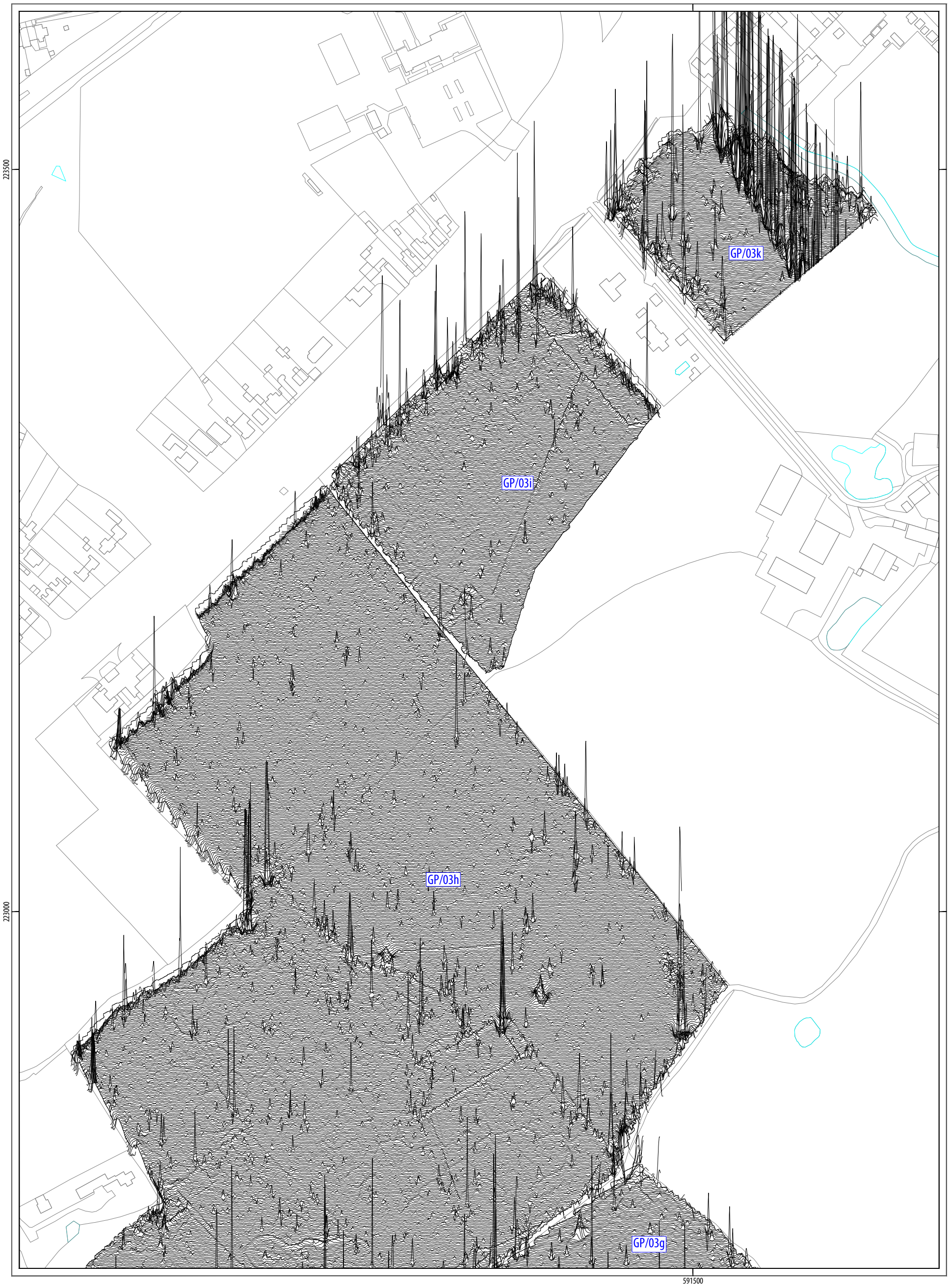
ILLUS 34 Processed greyscale magnetometer data; Sector 10



25.0nT/cm

0 50m

1:2,500 @ A3

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ILLUS 35 XY trace plot of minimally processed magnetometer data; Sector 10

223500

223000

591500

GP/03k

GP/03i

GP/03h

GP/03g

E5

E4

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
magnetic enhancement	geology
magnetic enhancement	archaeology?

ABBREVIATIONS

E enclosure

0 50m

1:2,500 @ A3

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ILLUS 36 Interpretation of magnetometer data; Sector 10

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 burntmaterial, 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: headland5-412144

PROJECT DETAILS	
Project name	A12 Chelmsford to A120, Junction 23–25, Essex
Short description of the project	Headland Archaeology (UK) Ltd undertook a geophysical (magnetometer) survey of 140 hectares on land between junctions 23 and 25 within the A12 Chelmsford to A120 Proposed Scheme (PS), to inform an archaeological assessment of the proposed road. The survey has successfully evaluated the geophysical survey areas within the Proposed Scheme except in a small number of areas where ground conditions were deemed unsuitable for survey. Anomalies of either likely, or possible, archaeological potential have been identified. Of high archaeological potential are a series of enclosures containing a ring ditch immediately south of the old Roman Road at area GP/13f, a discrete curvilinear enclosure of possible archaeological origin in GP/13a, small rectilinear enclosures on the edge of the Proposed Scheme in GP/13k and GP/13h and curvilinear and possible pit-like anomalies in GP/22e, GP/03h and GP/03g. 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, land drains, trackways, backfilled pits and fences. Numerous linear anomalies, corresponding with field boundaries marked on historic Ordnance Survey maps, have also been identified throughout the survey areas. Several irregularly shaped low magnitude anomalies have been detected which are probably due to natural or geological causes. Overall, most of the PS contains no anomalies of any archaeological potential and therefore the PS is assessed as having low to moderate archaeological potential, although locally high in the vicinity of the clearly defined areas of archaeological activity.
Project dates	Start: 02-09-2020 End: 14-10-2020
Previous/future work	Yes / Yes
Any associated project reference codes	ATCE20 - Site code
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	Boulder Clay And Morainic Drift
Techniques	Magnetometry
PROJECT LOCATION	
Country	England
Site location	Essex Colchester Marks Tey A12 Chelmsford to A120, Junction 23–25, Essex
Study area	140 Hectares
Site coordinates	TL 87544 18974 51.837322566585 0.722517658046 51 50 14 N 000 43 21 E Line
Site coordinates	TL 91517 23480 51.876438167852 0.782617171364 51 52 35 N 000 46 57 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	"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, Junction 23–25, Essex
Author(s)/Editor(s)	Berry, M
Date	2021
Issuer or publisher	Headland Archaeology
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Description	A4 Glue bound report and PDF/A
Entered by	Sam Harrison (sam.harrison@headlandarchaeology.com)
Entered on	11 January 2021

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