A12 Chelmsford to A120 widening scheme

TR010060

6.3 ENVIRONMENTAL STATEMENT APPENDIX 7.5 GEOPHYSICAL SURVEY PHASE 1 REPORT – PART 3

APFP Regulation 5(2)(a)

Planning Act 2008

Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

Volume 6

August 2022

Infrastructure Planning

Planning Act 2008

A12 Chelmsford to A120 widening scheme

Development Consent Order 202[ ]

ENVIRONMENTAL STATEMENT APPENDIX 7.5 GEOPHYSICAL SURVEY PHASE 1 REPORT – PART 3

Regulation Reference	Regulation 5(2)(a)
Planning Inspectorate Scheme Reference	TR010060
Application Document Reference	TR010060/APP/6.3
Author	A12 Project Team & National Highways

Version	**Date**	**Status of Version**
Rev 1	August 2022	DCO Application

213750

F21.3

F21.2

F21.1

F20.1

213250

582500

nT
-1.0
2.0

0
50m
1:2,500 @ A3

PROJECT ATCE19
A12 Chelmsford to A120
Junctions 19 to 23
Essex

CLIENT Costain

HEADLAND ARCHAEOLOGY
Headland Archaeology Yorkshire & North
Unit 16 | Hillside, Beeston Road | Leeds LS11 8ND
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e yorkshireandnorth@headlandarchaeology.com
w www.headlandarchaeology.com

ILLUS 61 Processed greyscale magnetometer data; Sector 18

213750

213250

582500

F21.3

F21.2

F21.1

F20.1

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

213750

213250

582500

F21.3

F21.2

F21.1

F20.1

D24

D25

D26

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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Junctions 19 to 23
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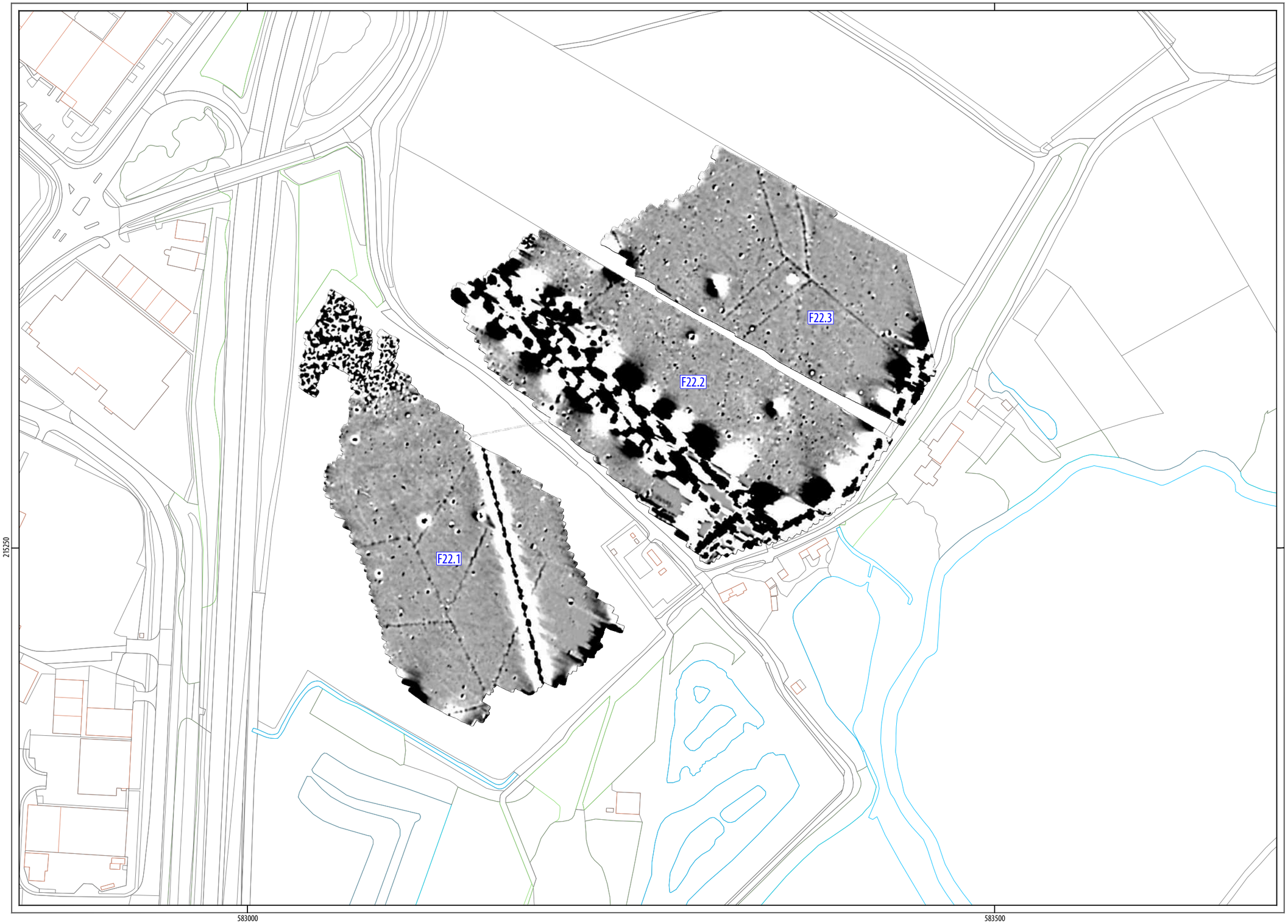
ILLUS 63 Interpretation plot of magnetometer data; Sector 18



nT
-1.0 2.0

0 50m
1:2,500 @ A3

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Junctions 19 to 23
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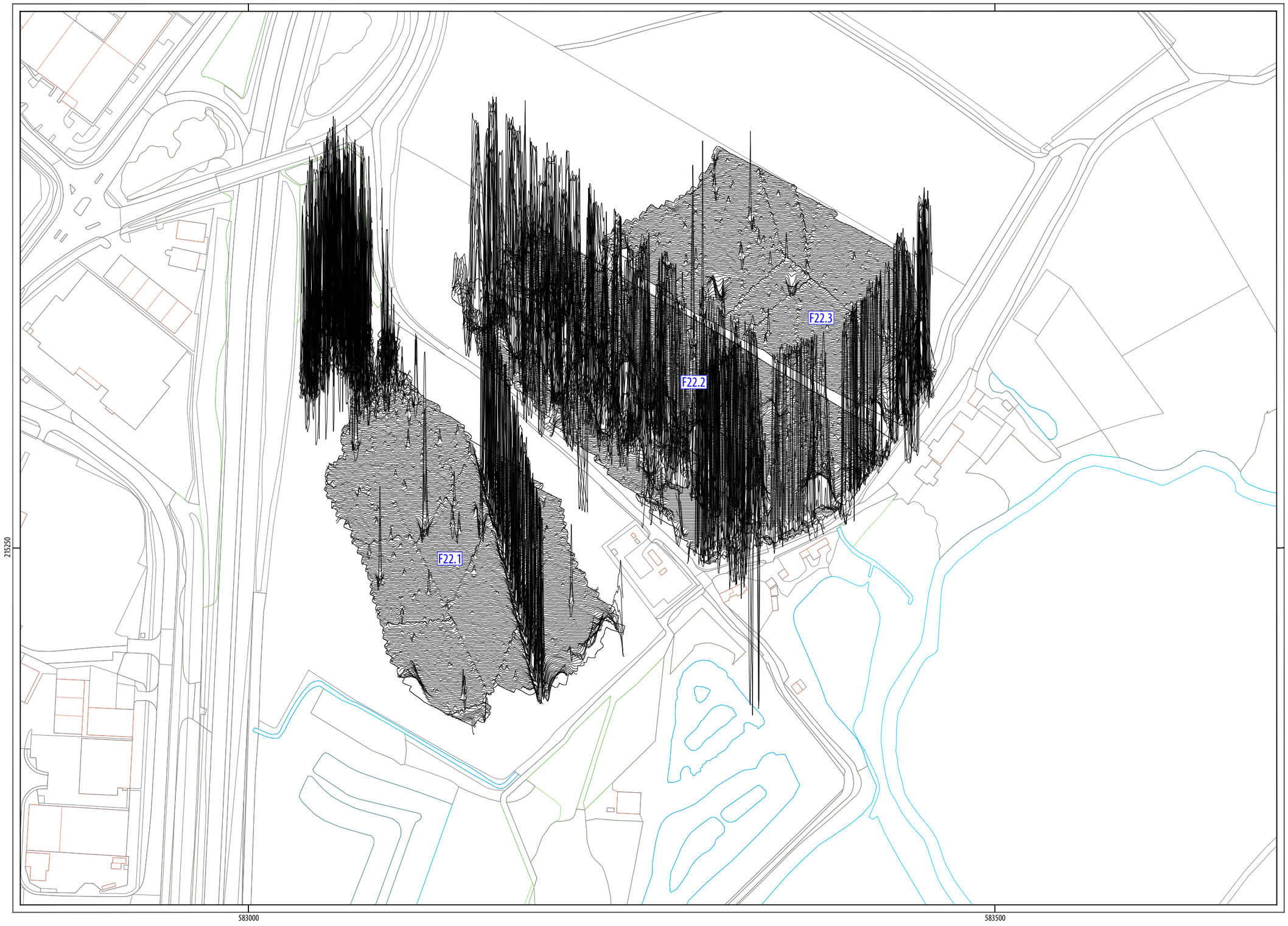
ILLUS 64 Processed greyscale magnetometer data; Sector 19



25.0nT/cm

0 50m

1:2,500 @ A3

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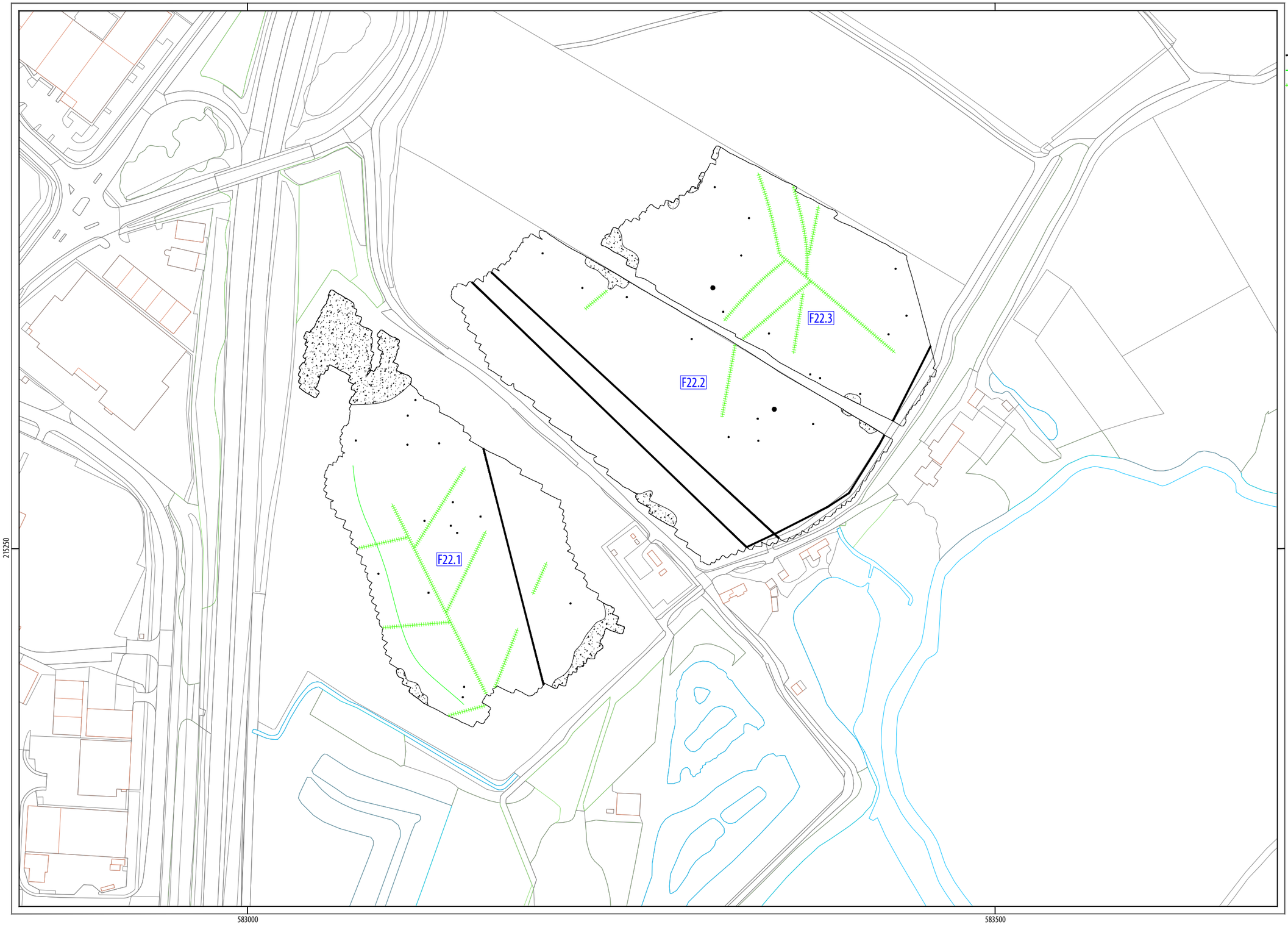
ILLUS 65 XY trace plot of minimally processed magnetometer data; Sector 19



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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Junctions 19 to 23
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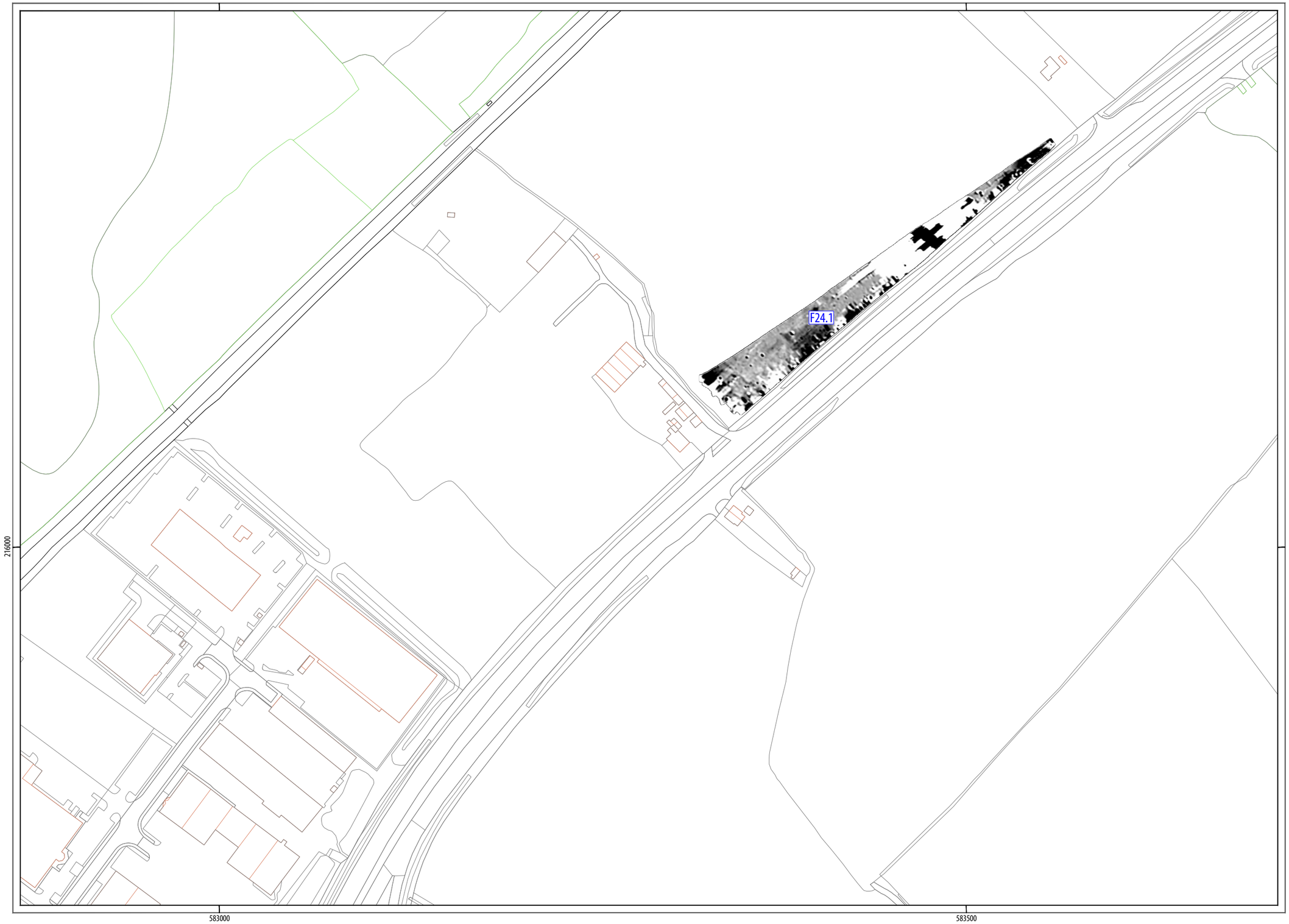
ILLUS 66 Interpretation of magnetometer data; Sector 19



-1.0 nT 2.0

0 50m

1:2,500 @ A3

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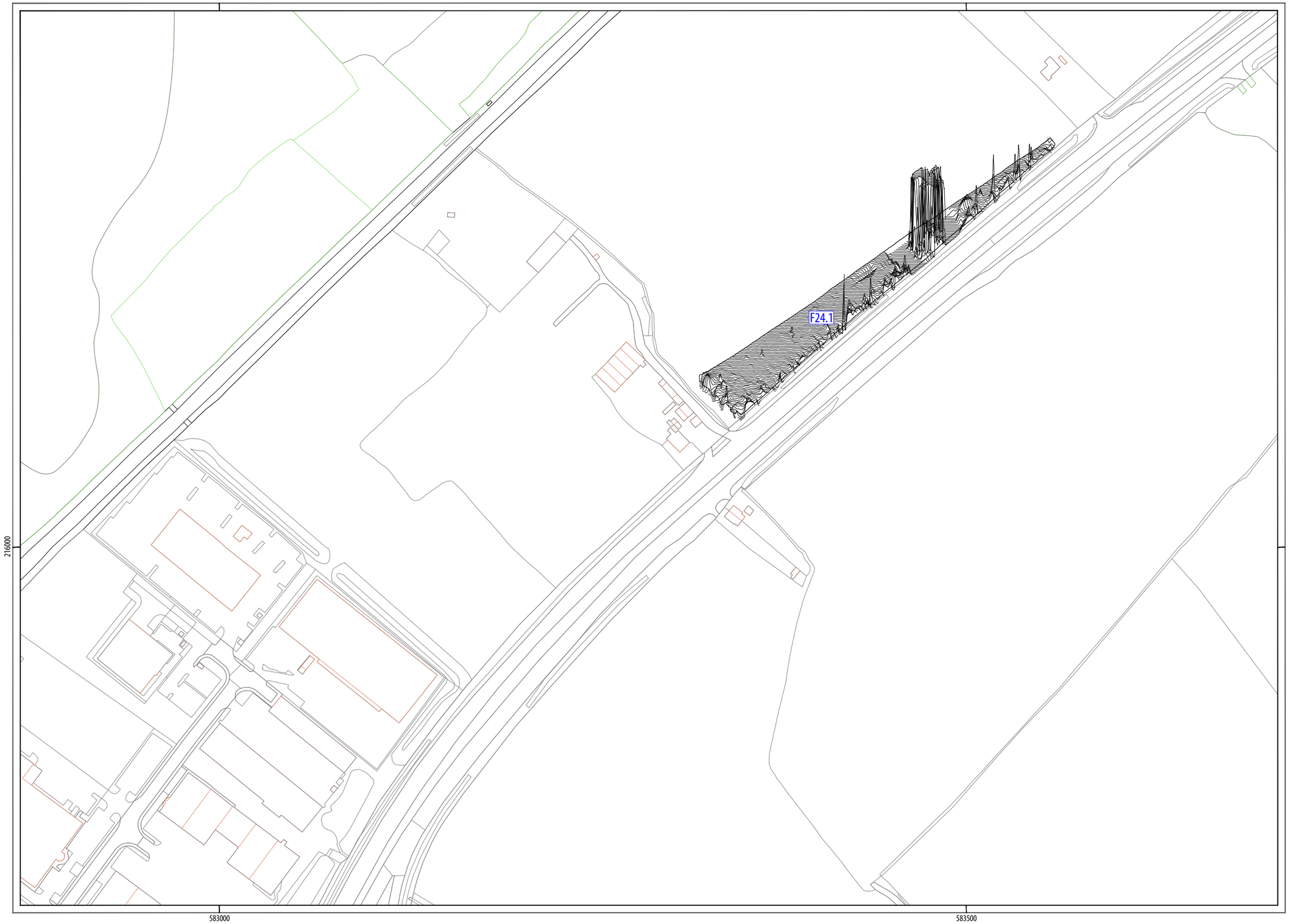
ILLUS 67 Processed greyscale magnetometer data; Sector 20



25.0nT/cm

0 50m

1:2,500 @ A3

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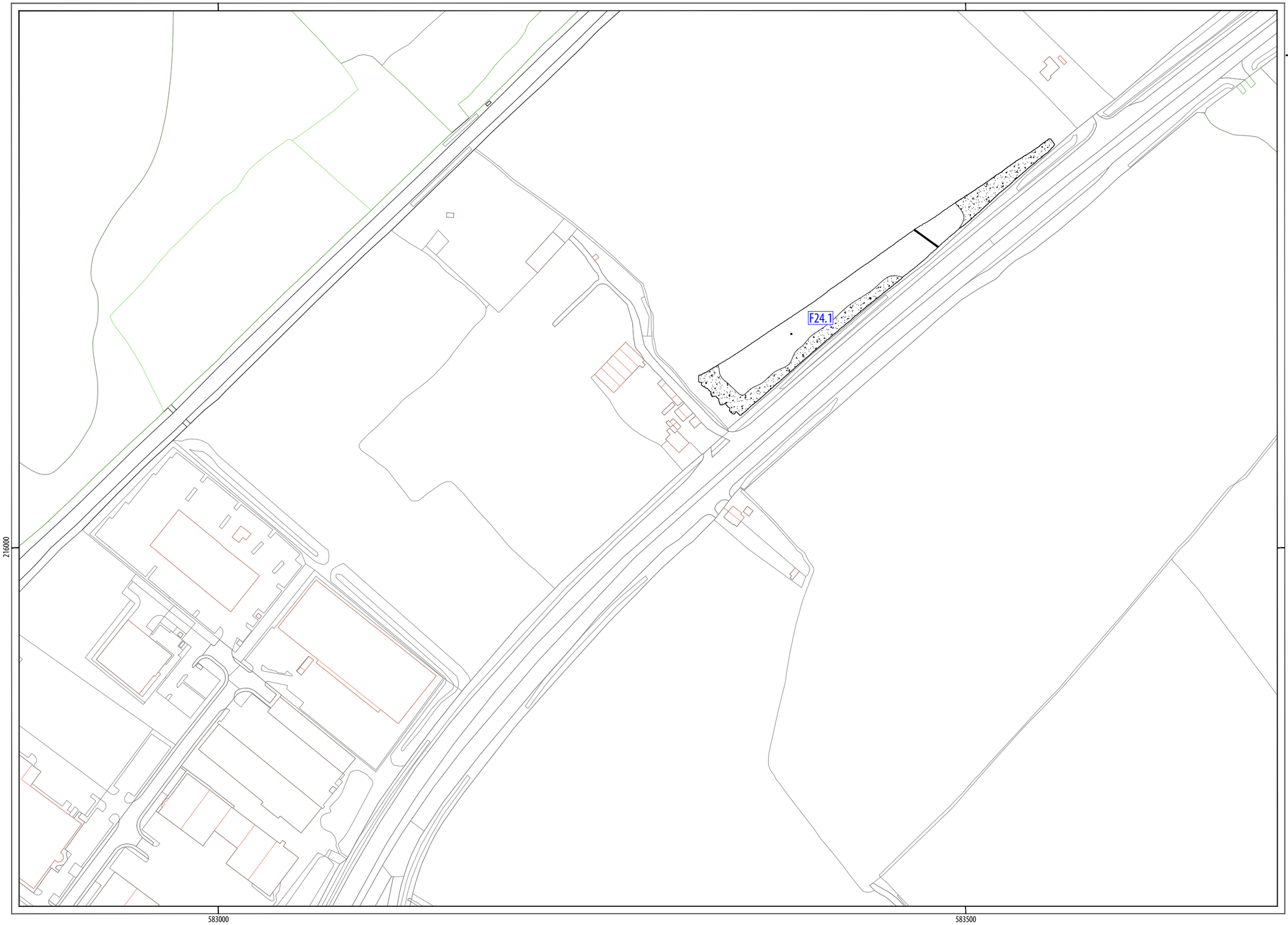
ILLUS 68 XY trace plot of minimally processed magnetometer data; Sector 20



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

0 50m
1:2,500 @ A3

PROJECT ATCE19
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Junctions 19 to 23
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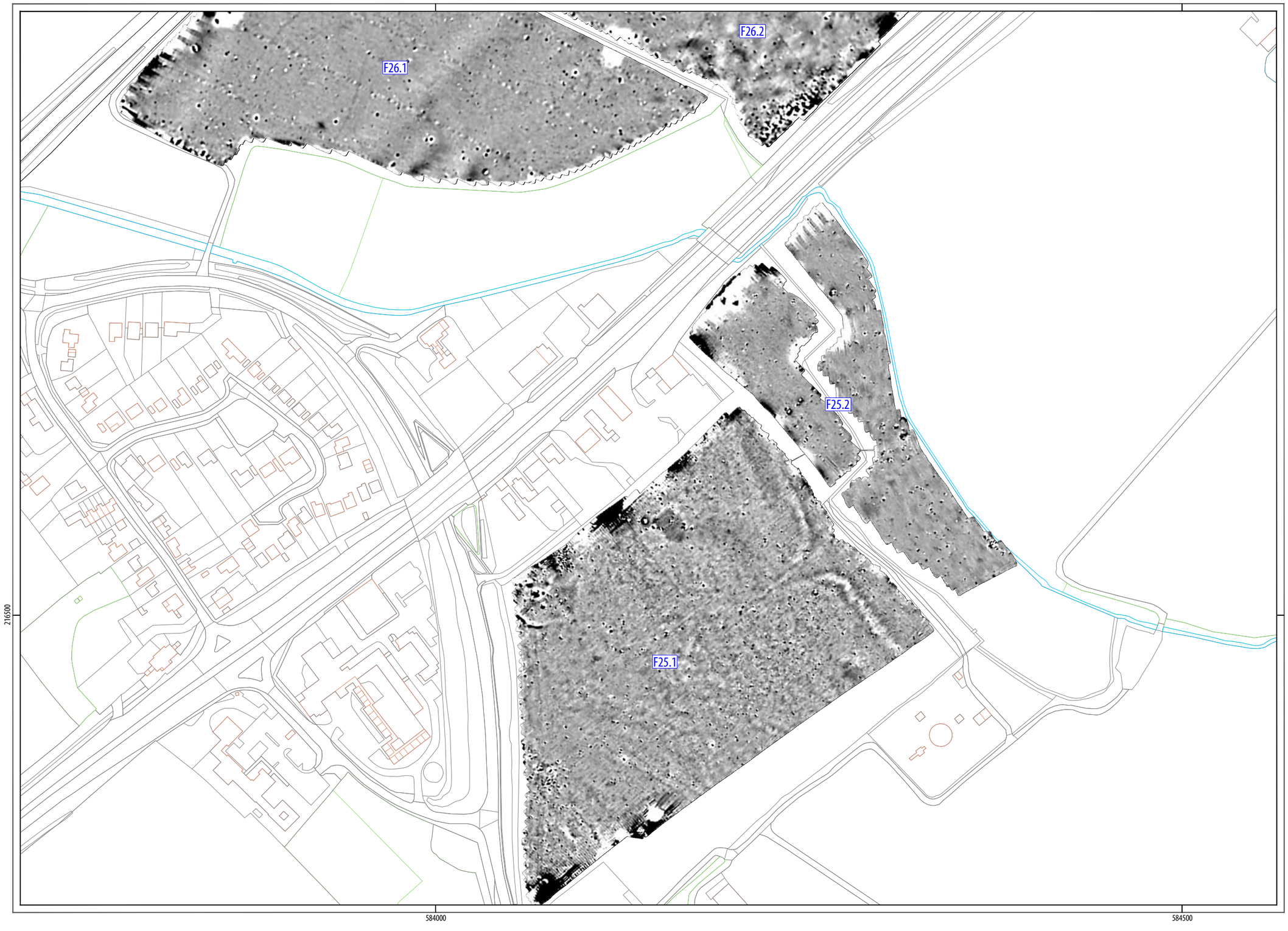
ILLUS 69 Interpretation of magnetometer data; Sector 21



-1.0 nT 2.0

0 50m

1:2,500 @ A3

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Junctions 19 to 23
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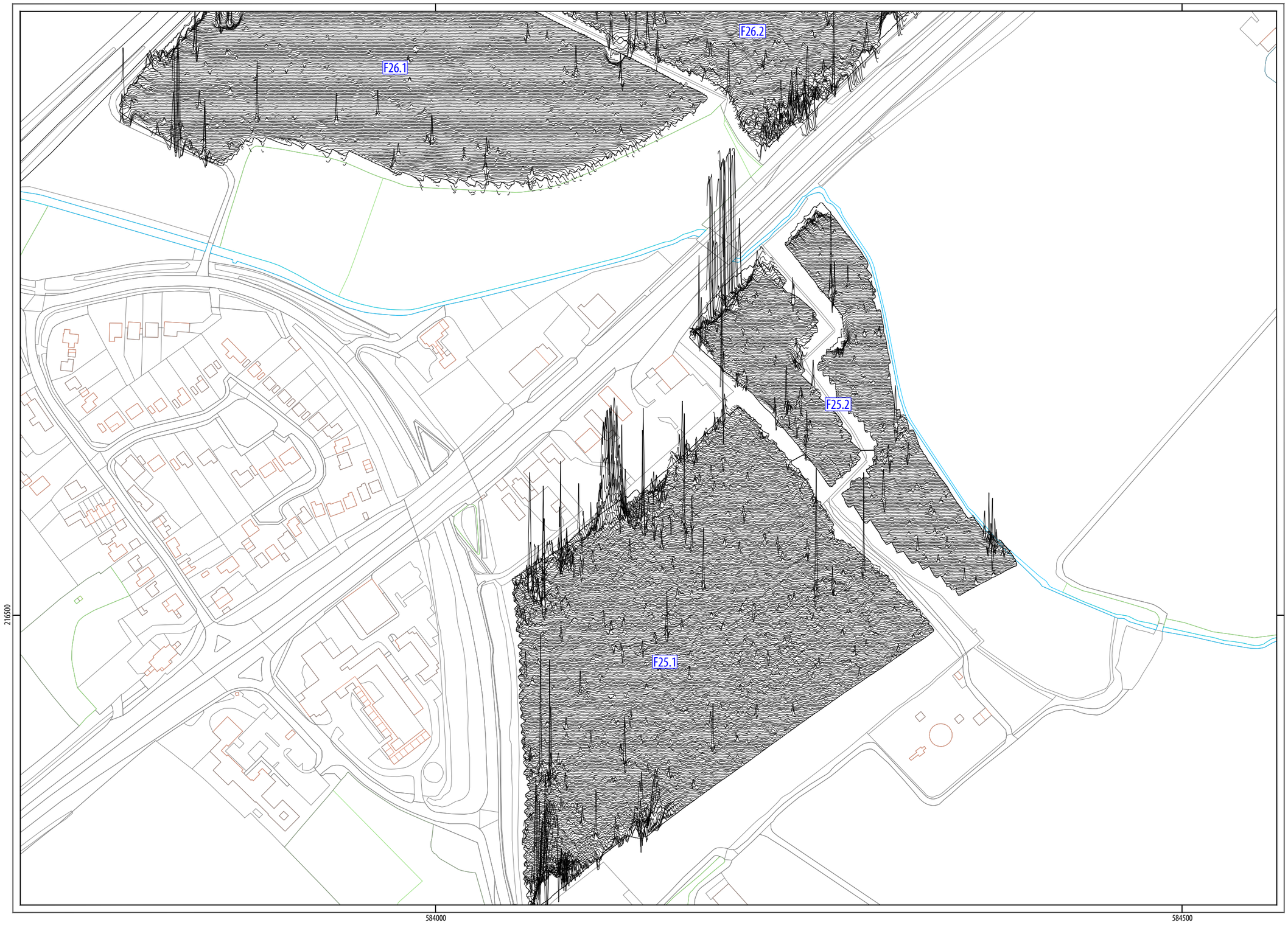
ILLUS 70 Processed greyscale magnetometer data; Sector 21



25.0nT/cm

0 50m

1:2,500 @ A3

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Junctions 19 to 23
Essex

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

F26.1

F26.2

F25.2

F25.1

K1

216500

584000

584500

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

PROJECT ATCE19
A12 Chelmsford to A120
Junctions 19 to 23
Essex

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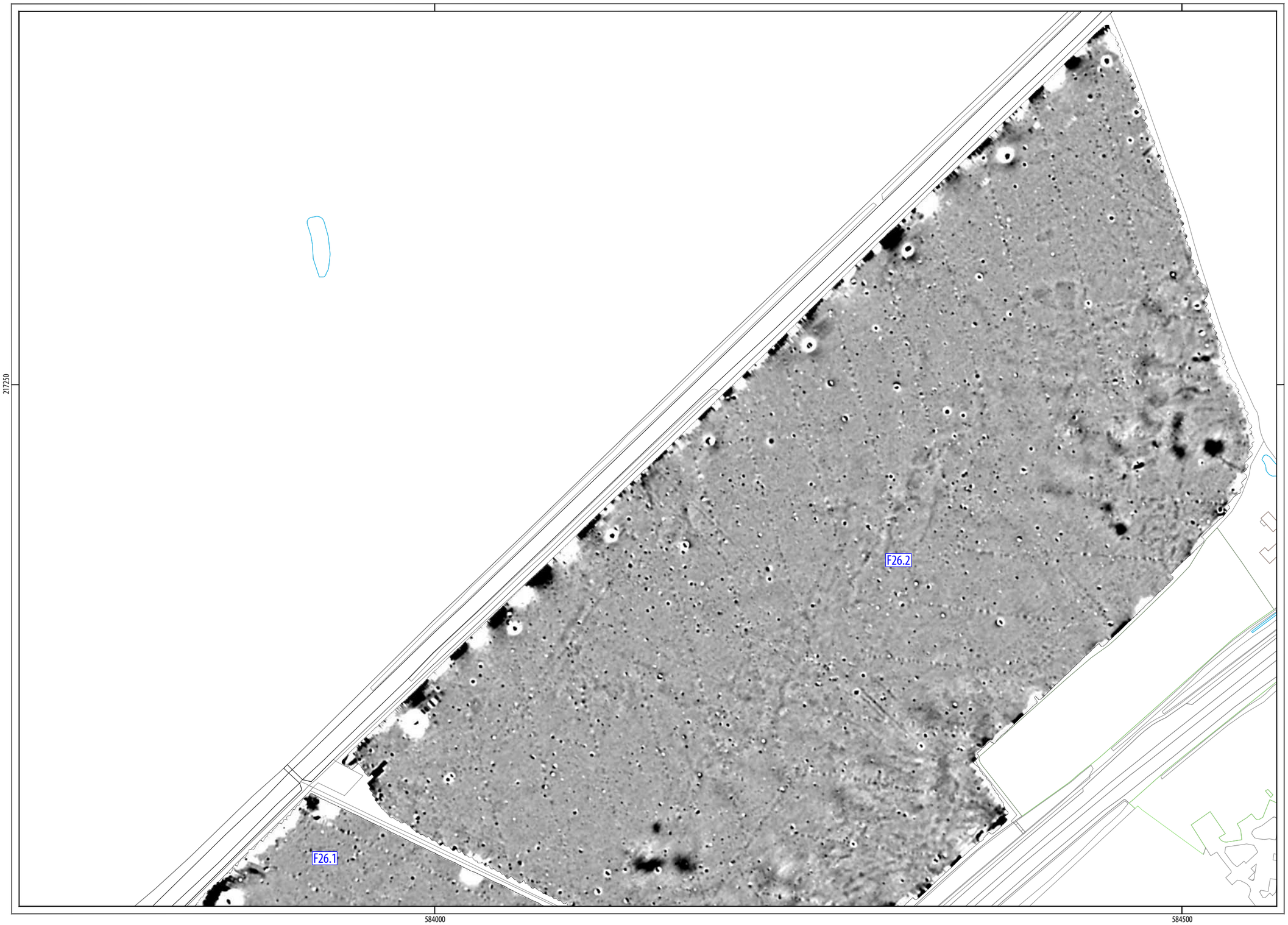
ILLUS 72 Interpretation of magnetometer data; Sector 21



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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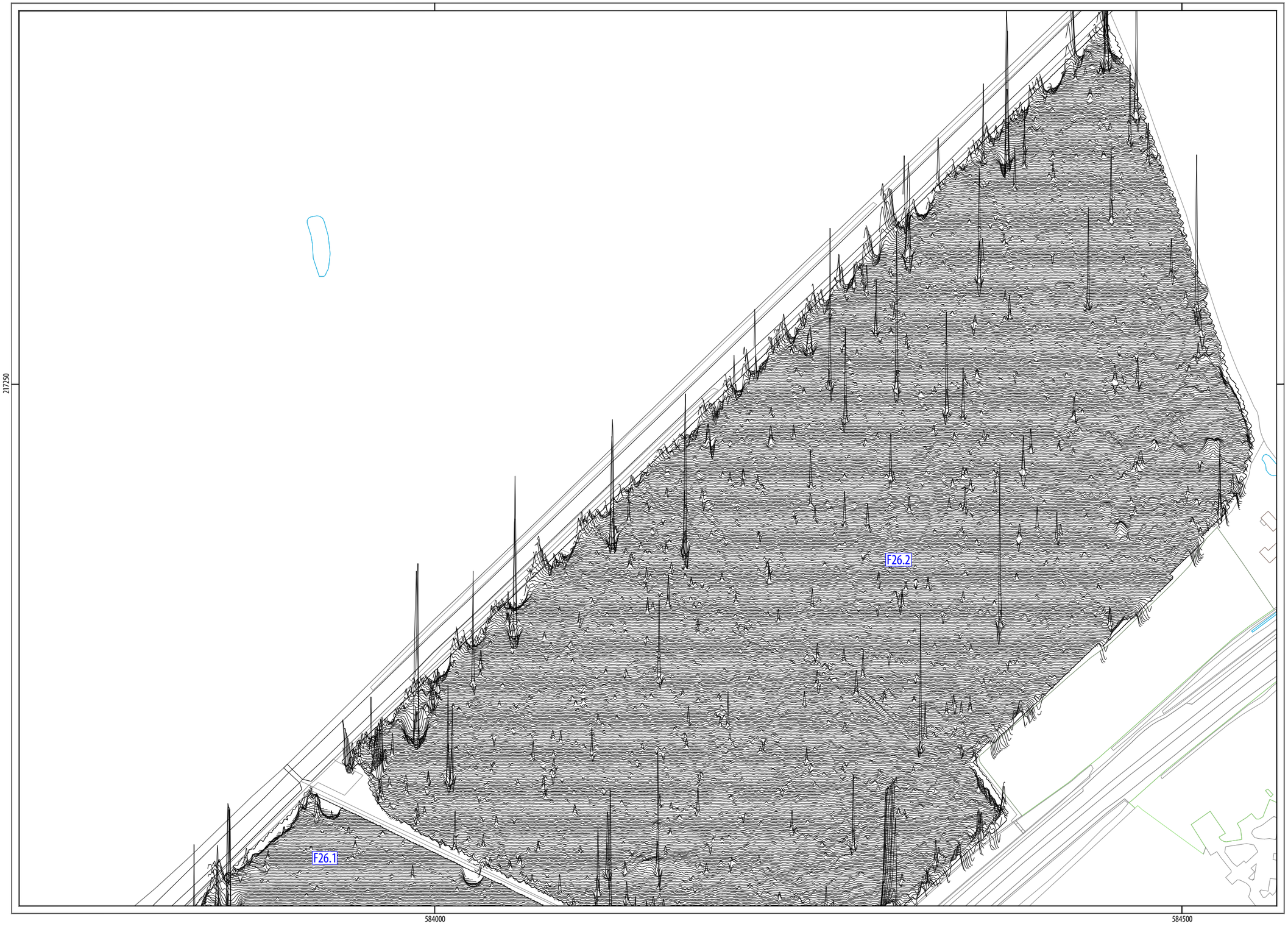
ILLUS 73 Processed greyscale magnetometer data; Sector 22



25.0nT/cm

0 50m

1:2,500 @ A3

PROJECT ATCE19
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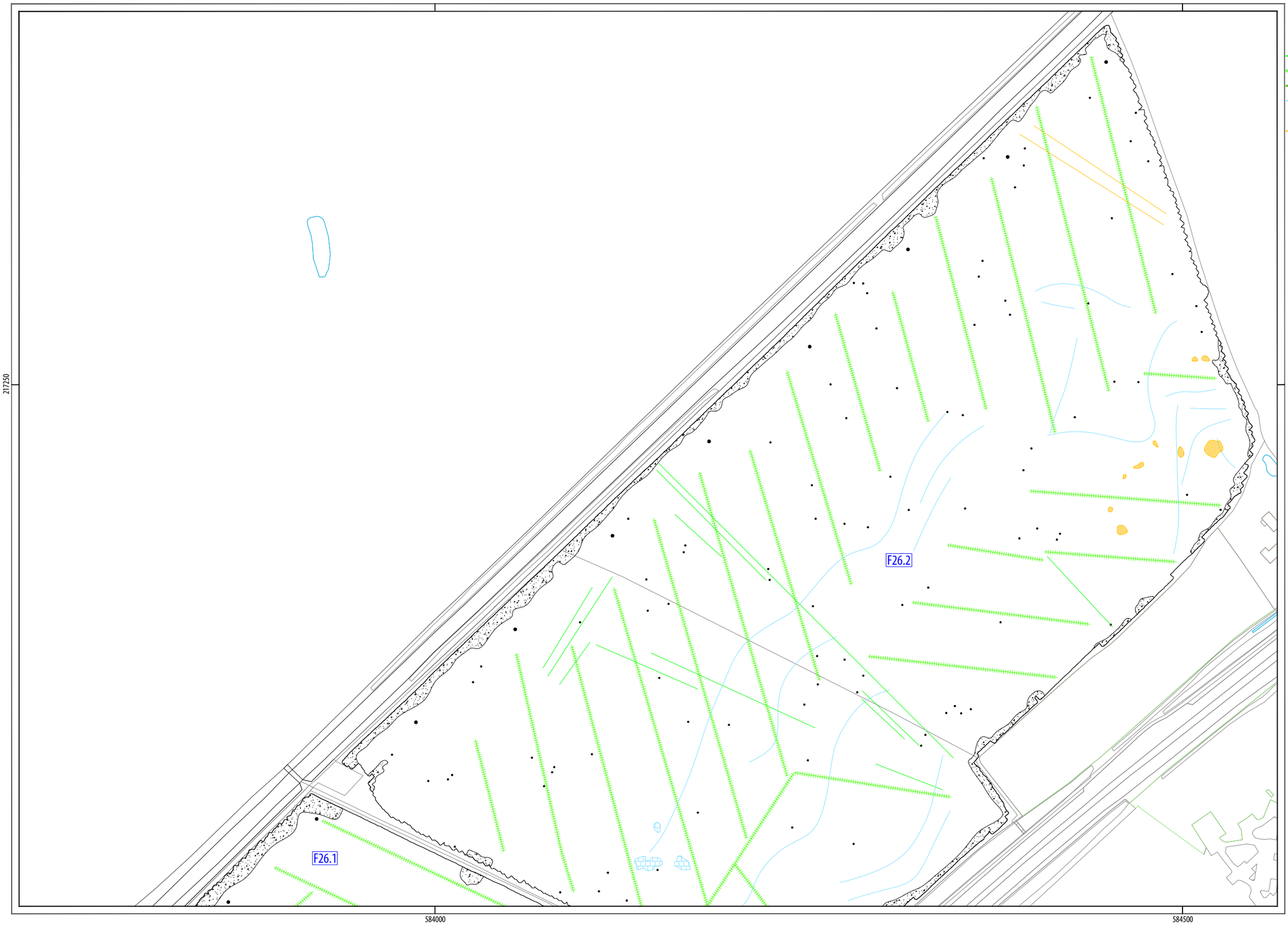
ILLUS 74 XY trace plot of minimally processed magnetometer data; Sector 22



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

PROJECT ATCE19
A12 Chelmsford to A120
Junctions 19 to 23
Essex
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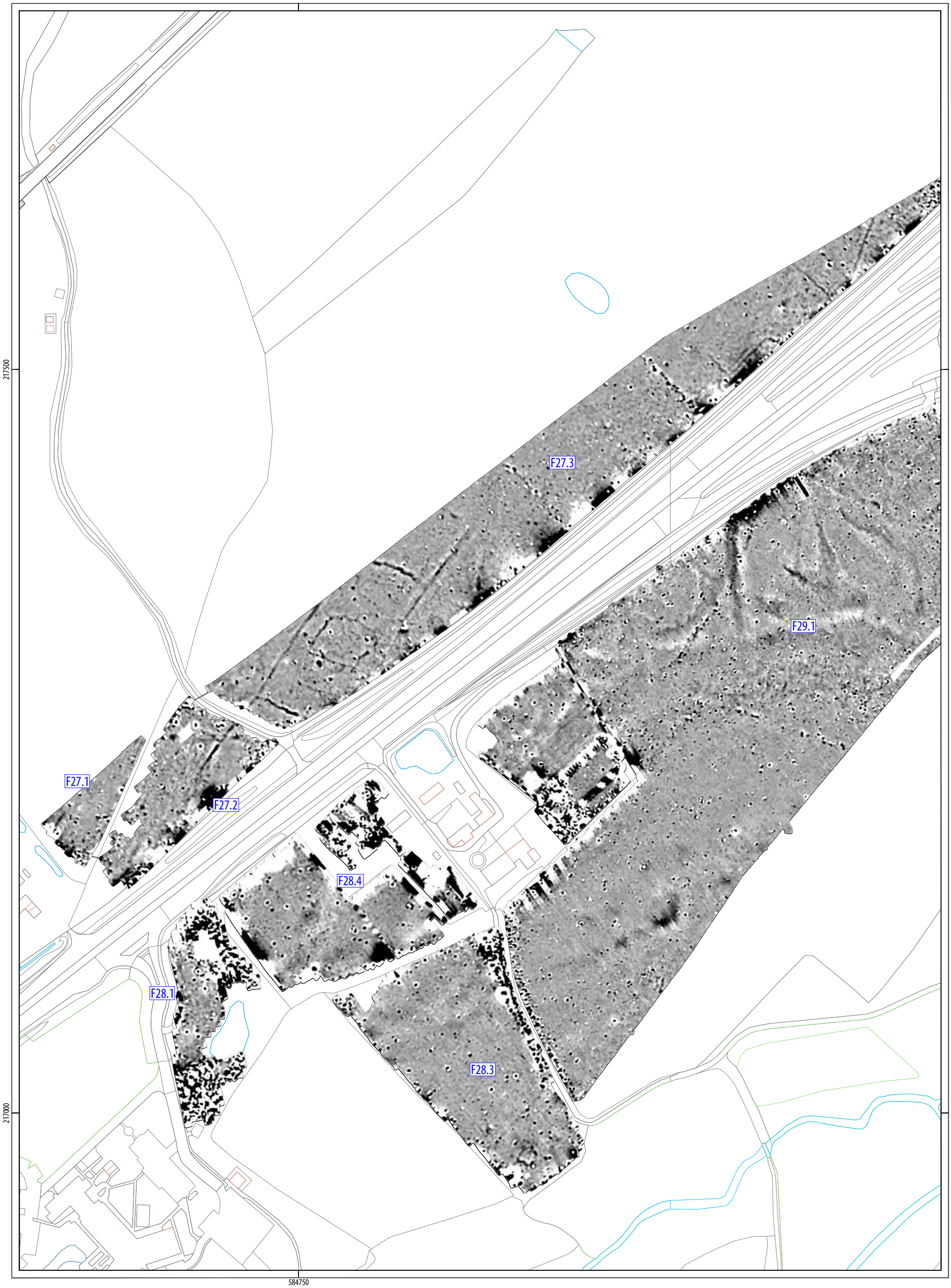
ILLUS 75 Interpretation of magnetometer data; Sector 22



nT
-1.0 2.0

0 50m
1:2,500 @ A3

PROJECT ATCE19
A12 Chelmsford to A120
Junctions 19 to 23
Essex

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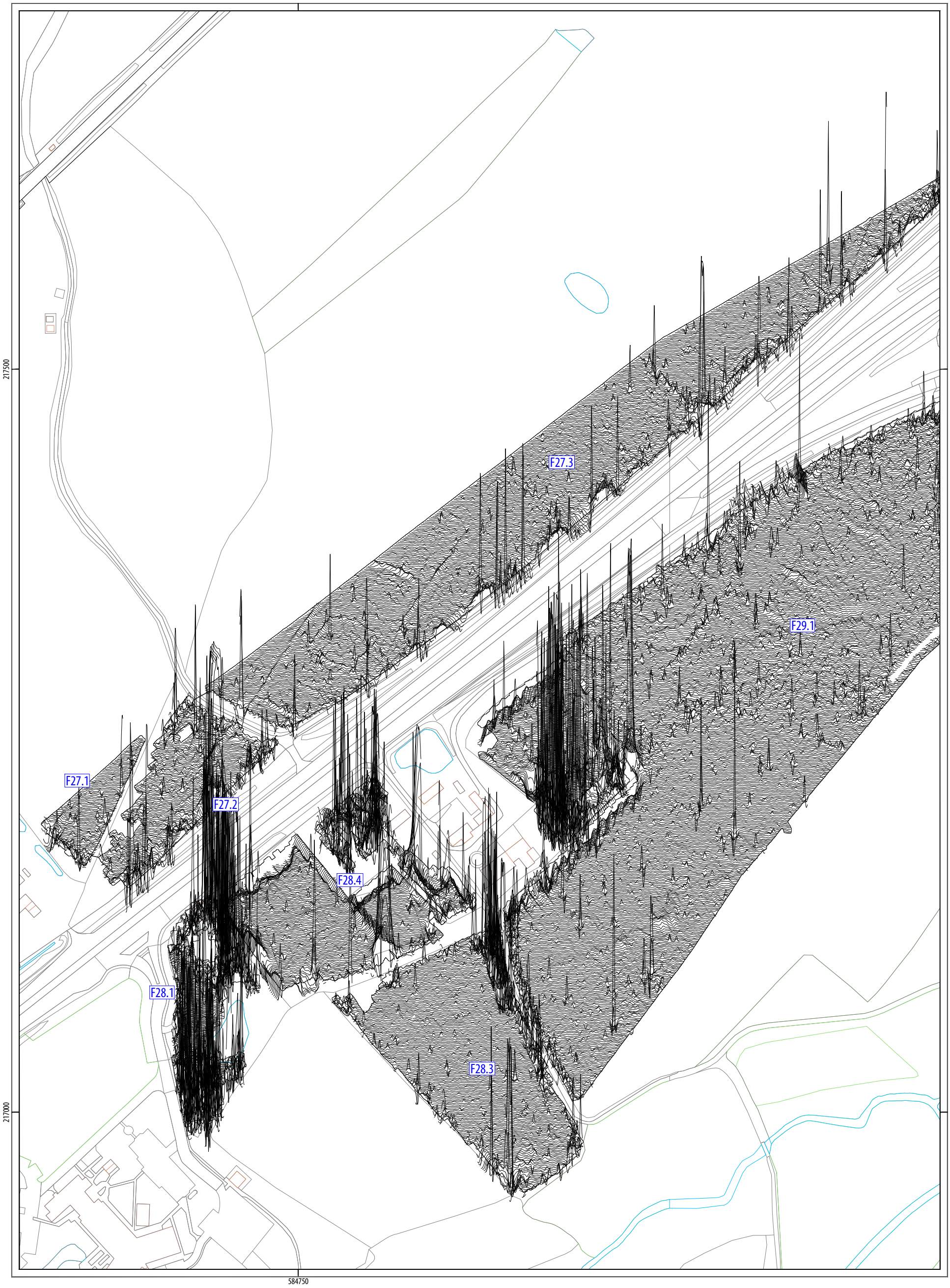
ILLUS 76 Processed greyscale magnetometer data; Sector 23



25.0nT/cm

0 50m

1:2,500 @ A3

PROJECT ATCE19
A12 Chelmsford to A120
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

F27.1

F27.2

F29.1

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

PROJECT ATCE19
A12 Chelmsford to A120
Junctions 19 to 23
Essex

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e yorkshireandnorth@headlandarchaeology.com
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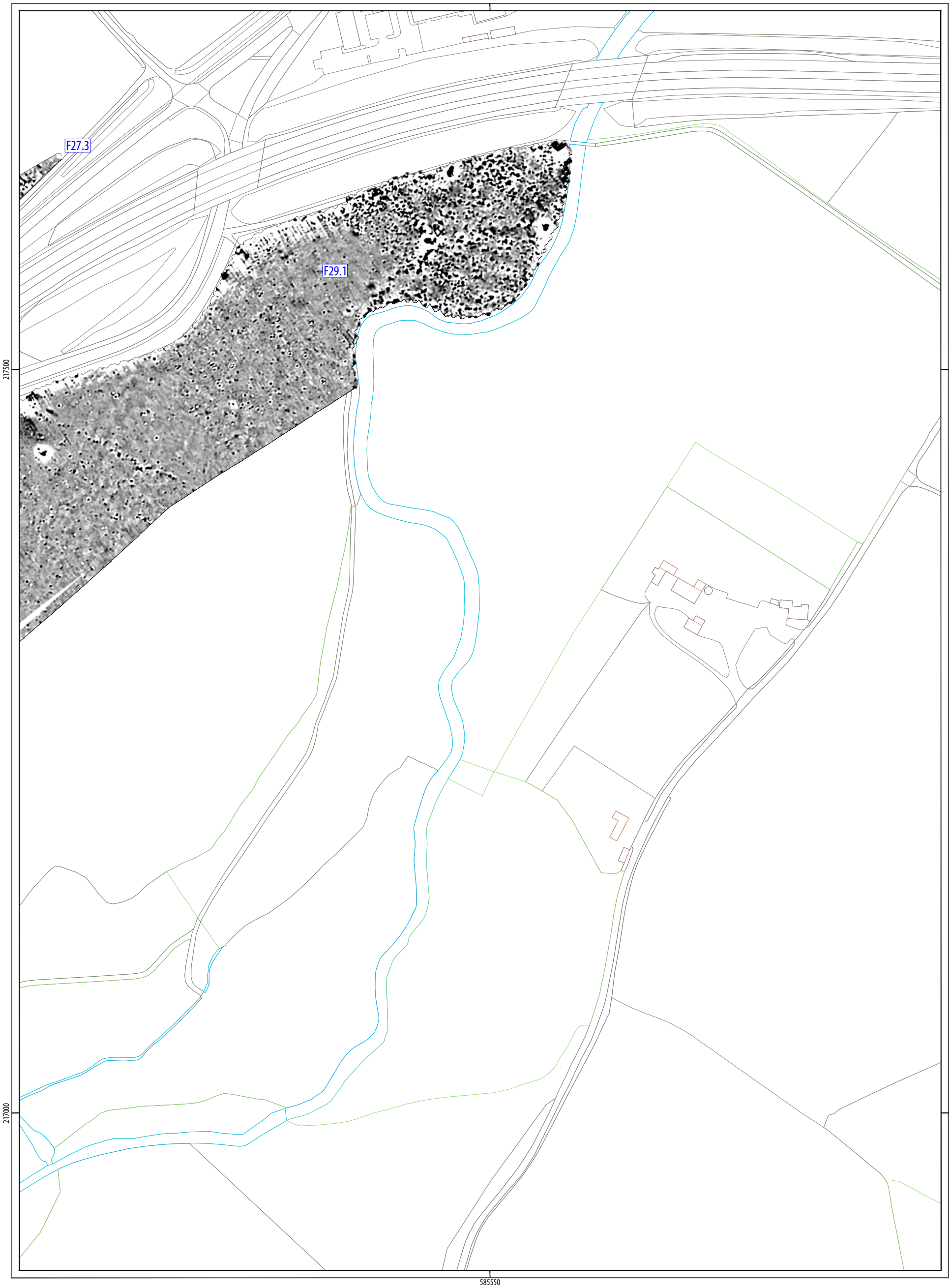
ILLUS 78 Interpretation of magnetometer data; Sector 23



-1.0 nT 2.0

0 50m

1:2,500 @ A3

PROJECT ATCE19
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Junctions 19 to 23
Essex

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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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Junctions 19 to 23
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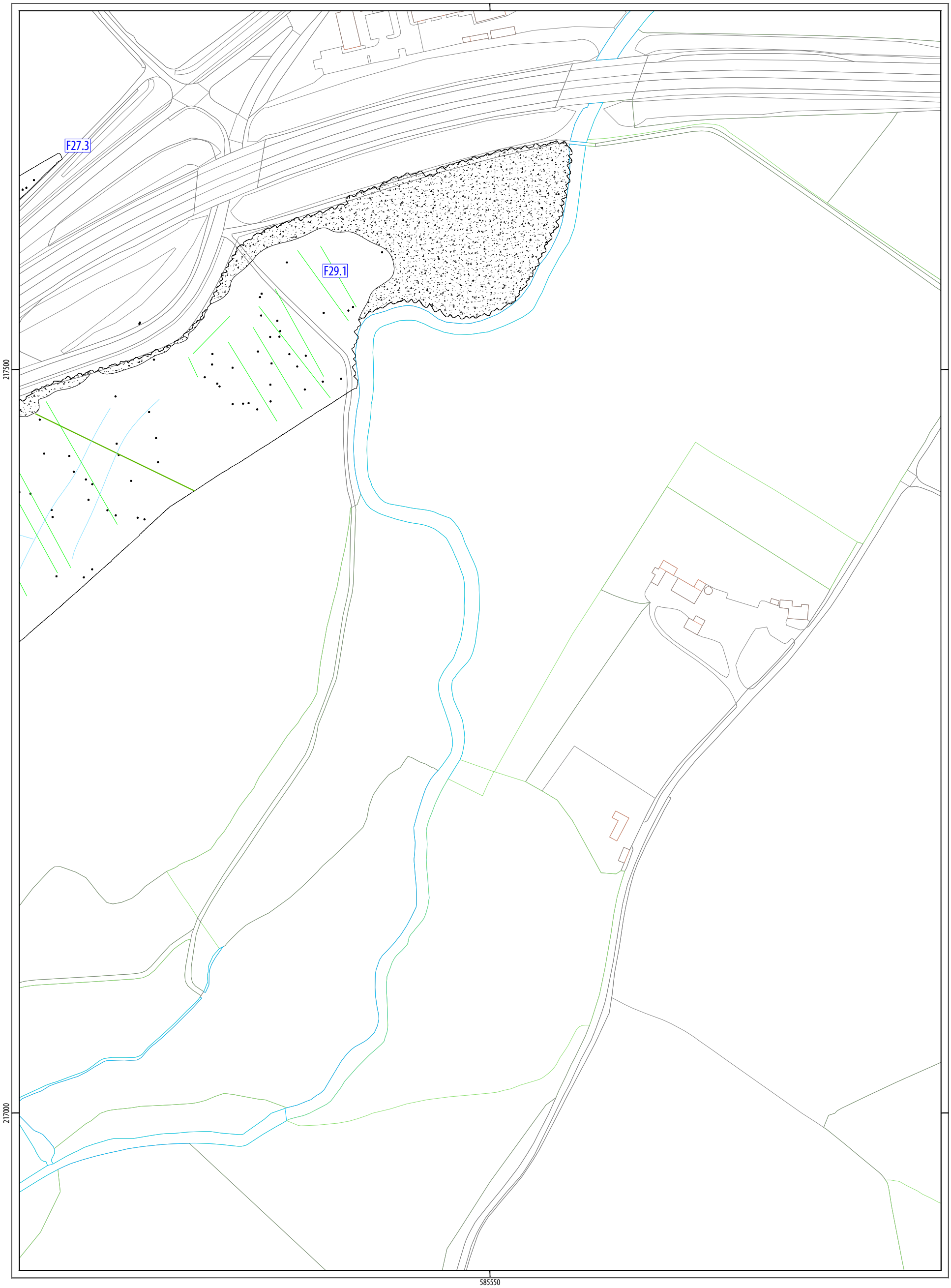
ILLUS 80 XY trace plot of minimally processed magnetometer data; Sector 24



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
A12 Chelmsford to A120
Junctions 19 to 23
Essex

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ILLUS 81 Interpretation of magnetometer data; Sector 24

nT
-1.0 2.0

0 50m
1:2,500 @ A3

PROJECT ATCE19
A12 Chelmsford to A120
Junctions 19 to 23
Essex

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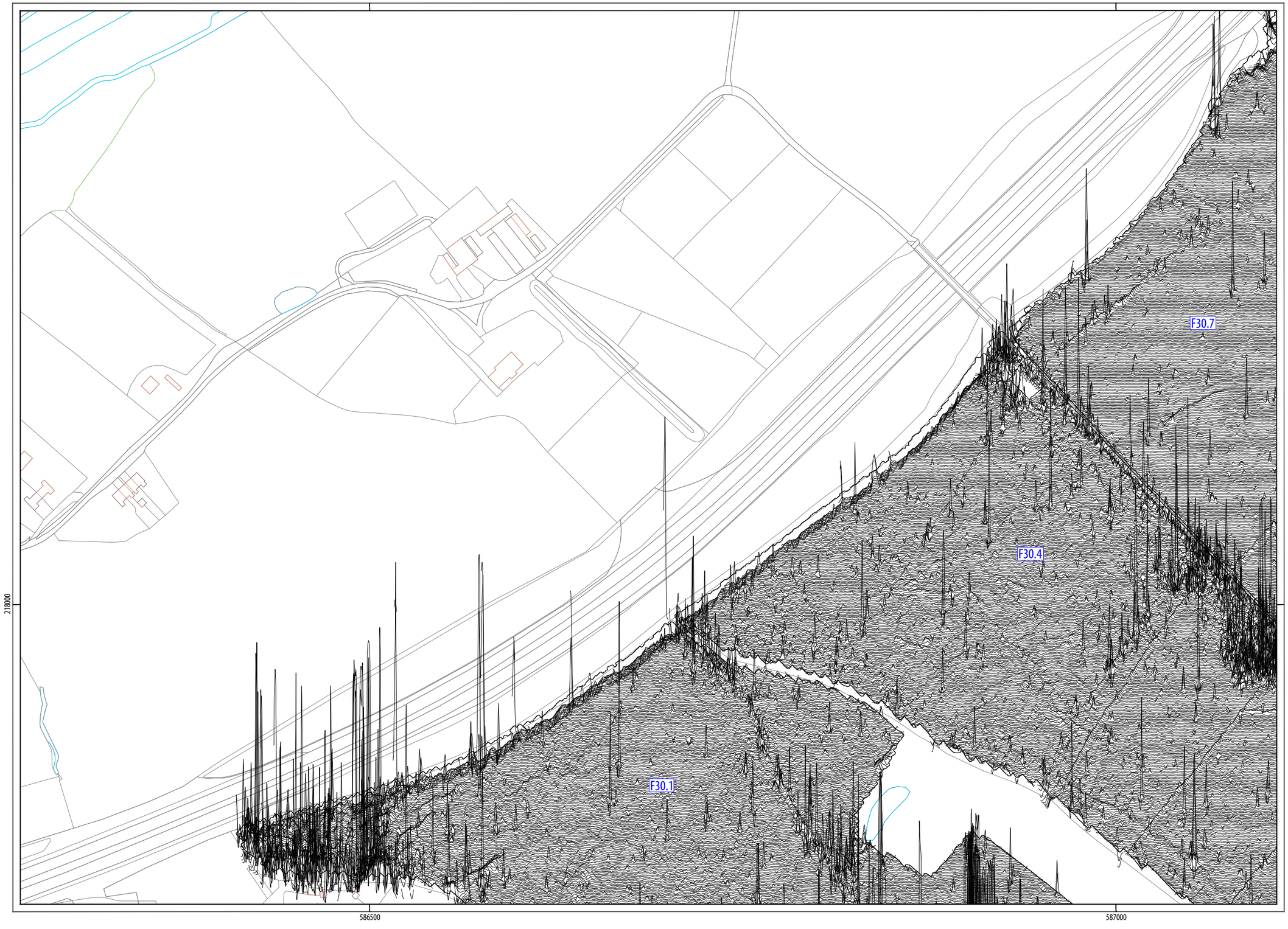
ILLUS 82 Processed greyscale magnetometer data; Sector 25



25.0nT/cm

0 50m

1:2,500 @ A3

PROJECT ATCE19
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Junctions 19 to 23
Essex

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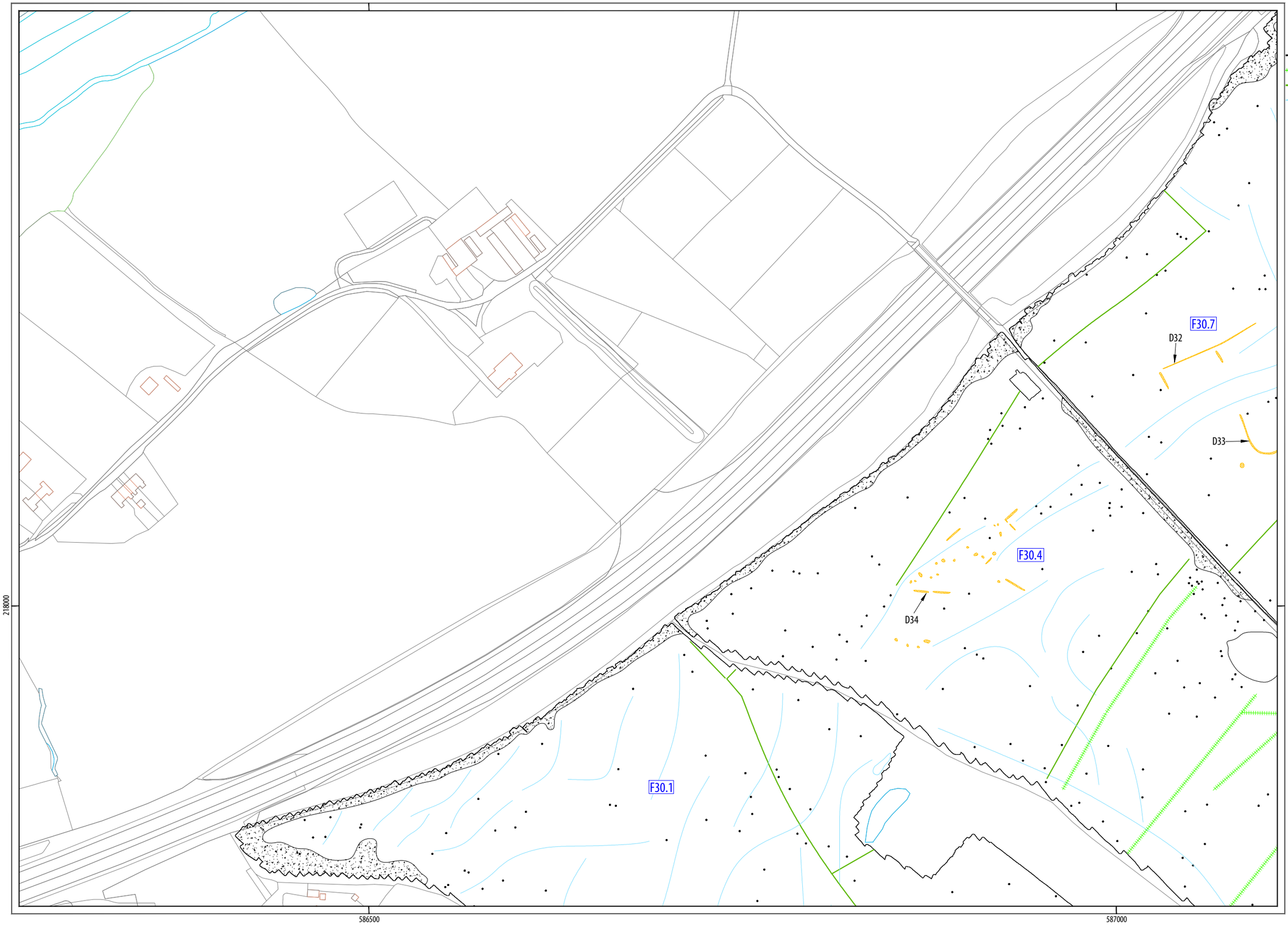
ILLUS 83 XY trace plot of minimally processed magnetometer data; Sector 25



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

PROJECT ATCE19
A12 Chelmsford to A120
Junctions 19 to 23
Essex

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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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Junctions 19 to 23
Essex

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ILLUS 85 Processed greyscale magnetometer data; Sector 26

25.0nT/cm

0 50m

1:2,500 @ A3

PROJECT ATCE19
A12 Chelmsford to A120
Junctions 19 to 23
Essex

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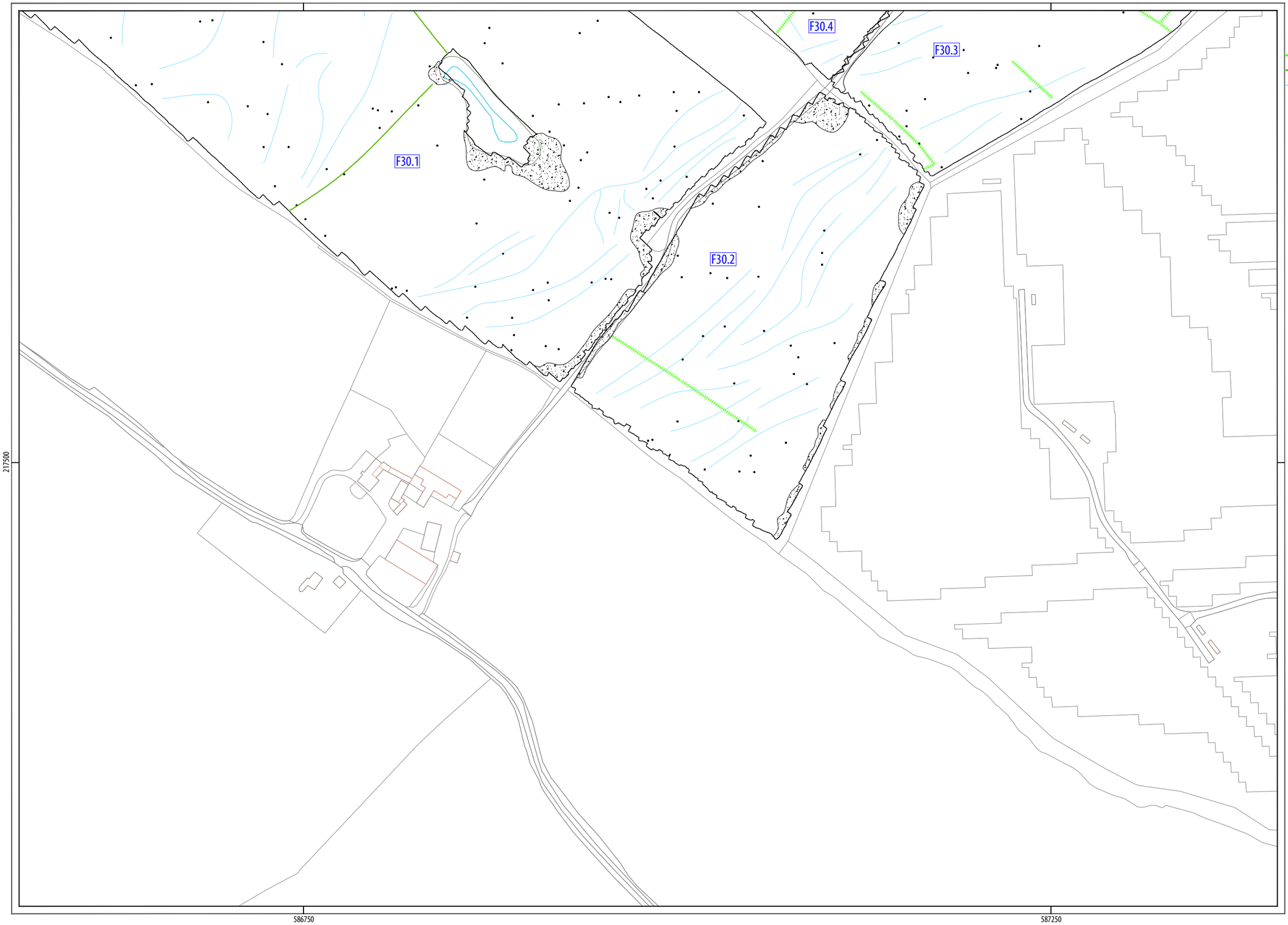
ILLUS 86 XY trace plot of minimally processed magnetometer data; Sector 26



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

PROJECT ATCE19
A12 Chelmsford to A120
Junctions 19 to 23
Essex

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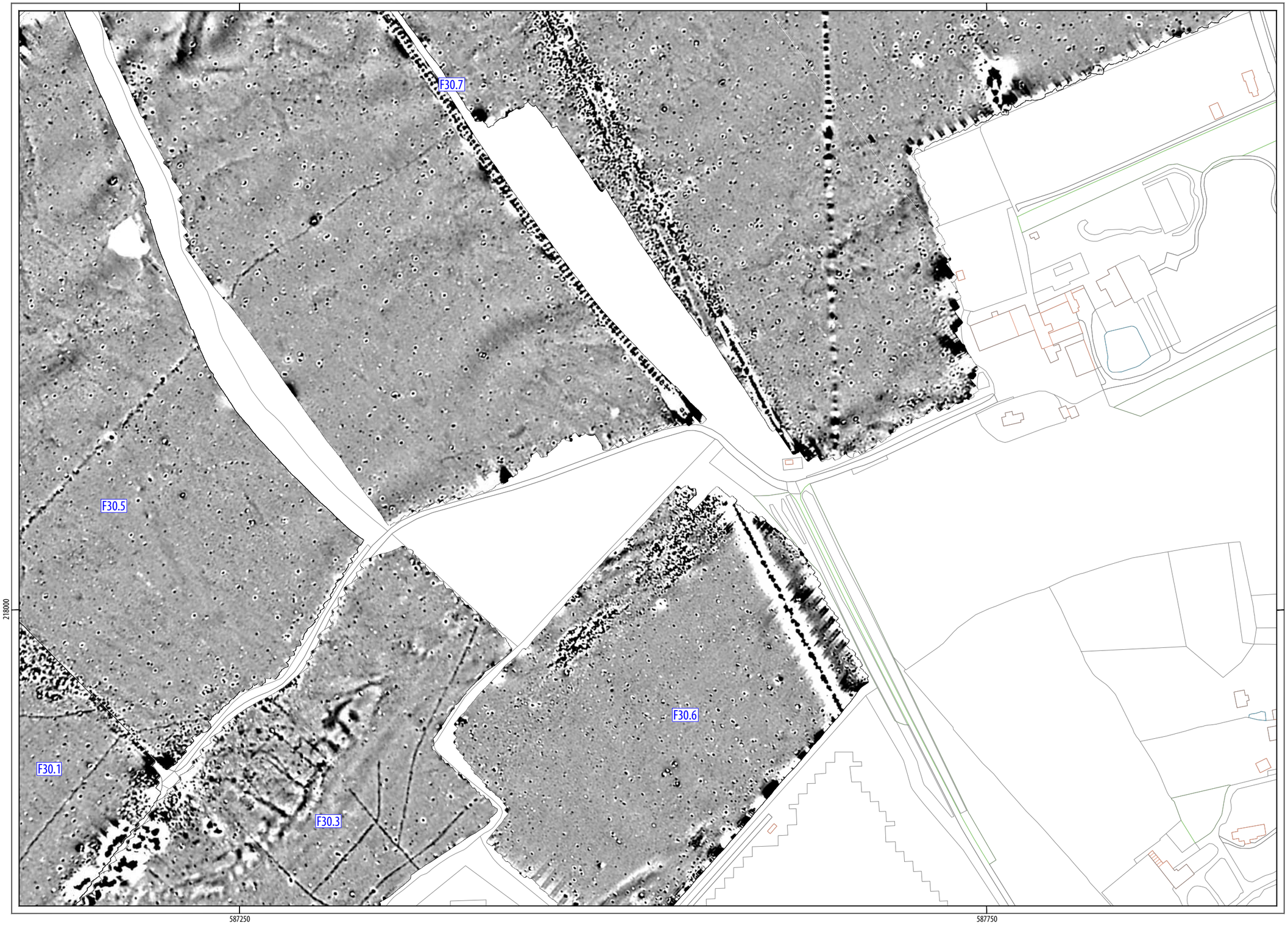
ILLUS 87 Interpretation of magnetometer data; Sector 26



nT
-1.0 2.0

0 50m
1:2,500 @ A3

PROJECT ATCE19
A12 Chelmsford to A120
Junctions 19 to 23
Essex

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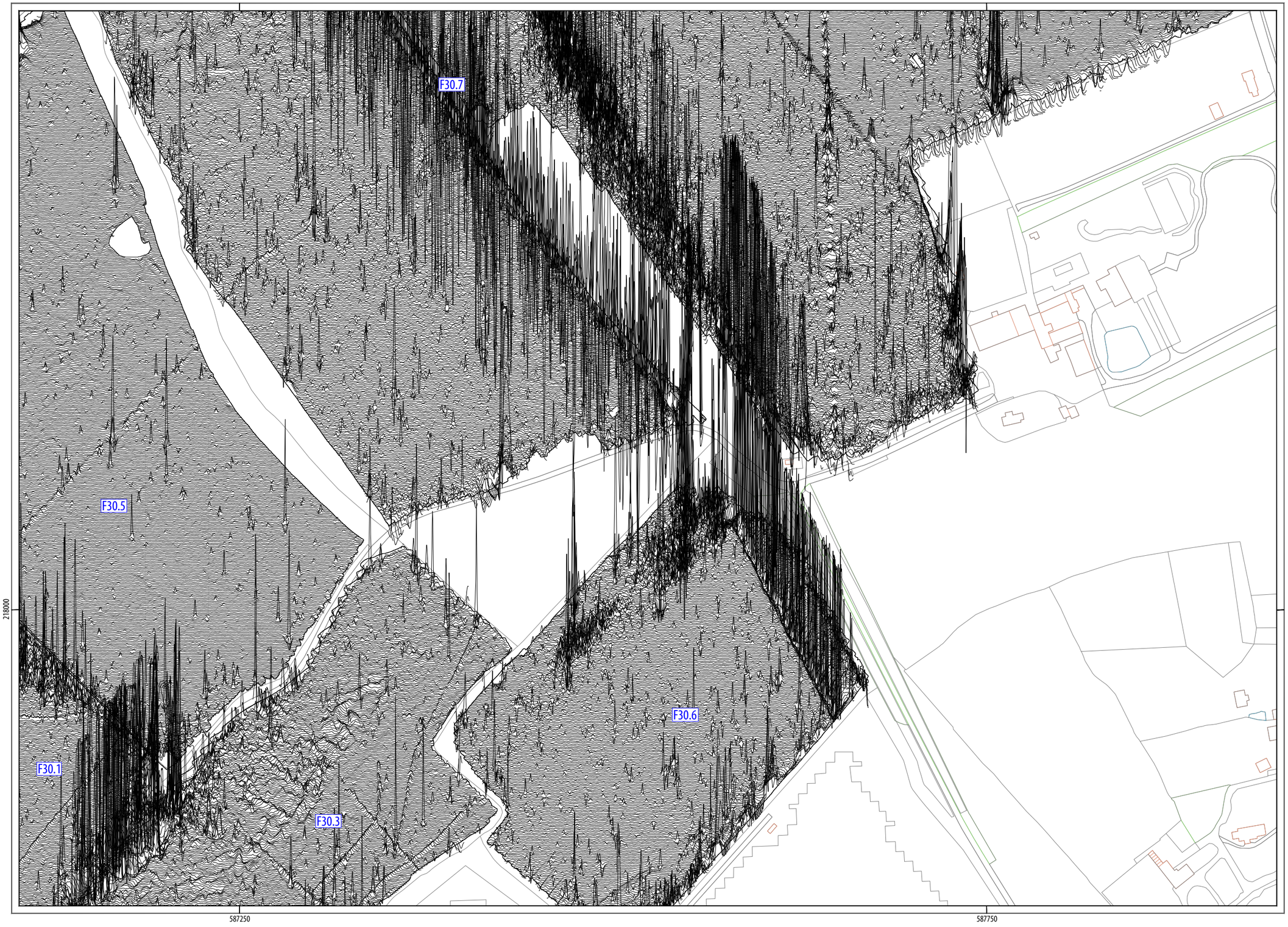
ILLUS 88 Processed greyscale magnetometer data; Sector 27



25.0nT/cm

0 50m

1:2,500 @ A3

PROJECT ATCE19
A12 Chelmsford to A120
Junctions 19 to 23
Essex

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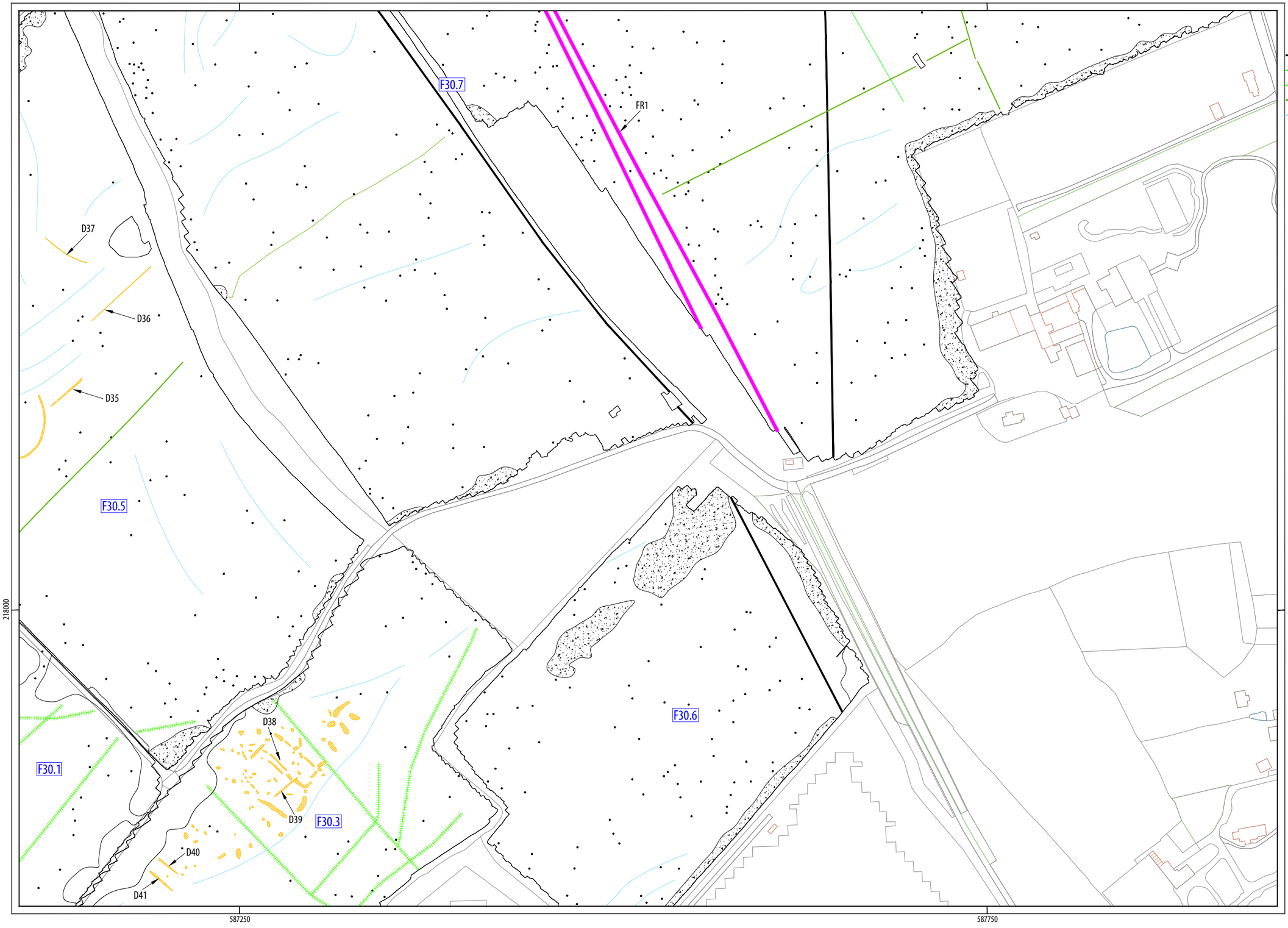
ILLUS 89 XY trace plot of minimally processed magnetometer data; Sector 27



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

HEADLAND ARCHAEOLOGY

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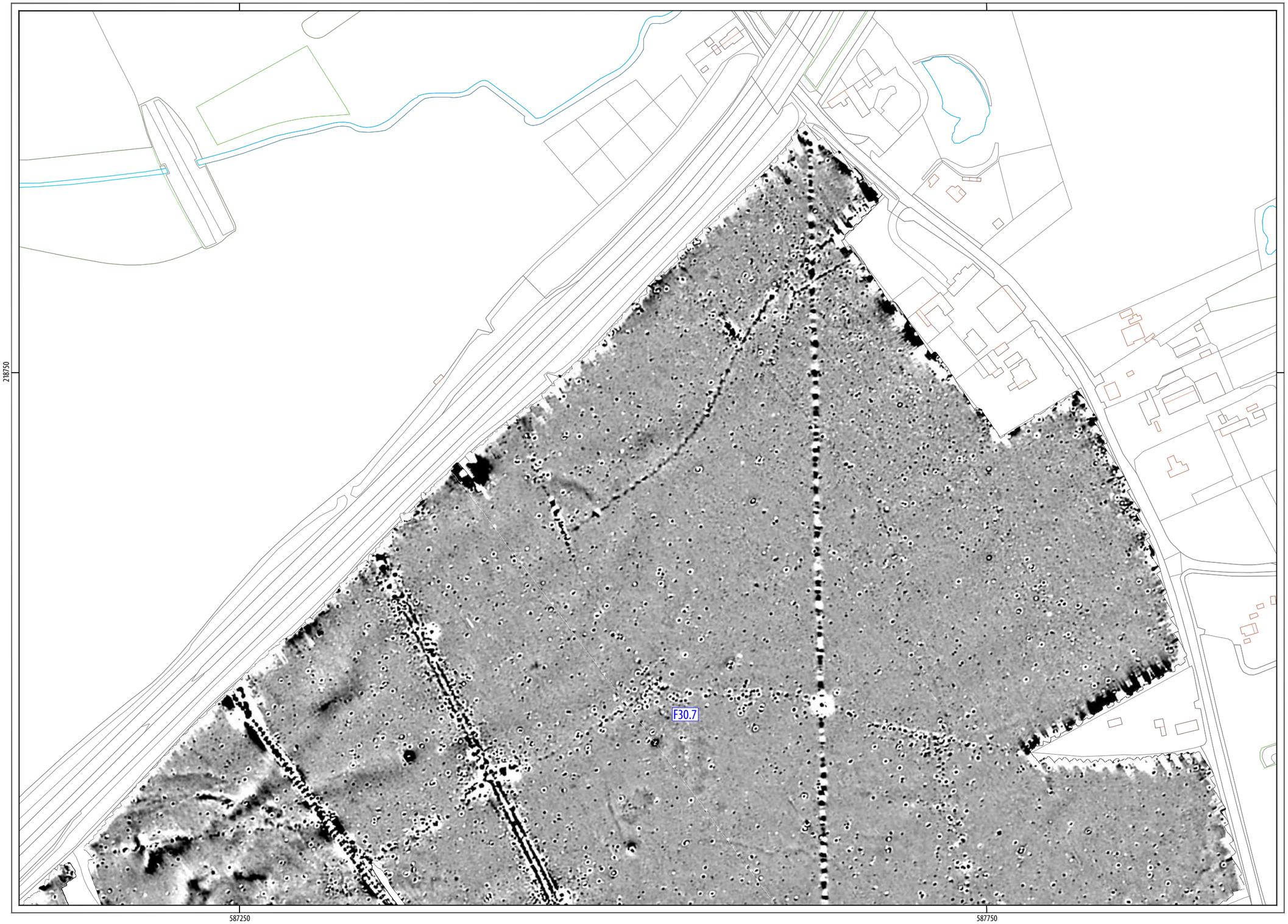
ILLUS 90 Interpretation of magnetometer data; Sector 27



-1.0 nT 2.0

0 50m
1:2,500 @ A3

PROJECT ATCE19
A12 Chelmsford to A120
Junctions 19 to 23
Essex

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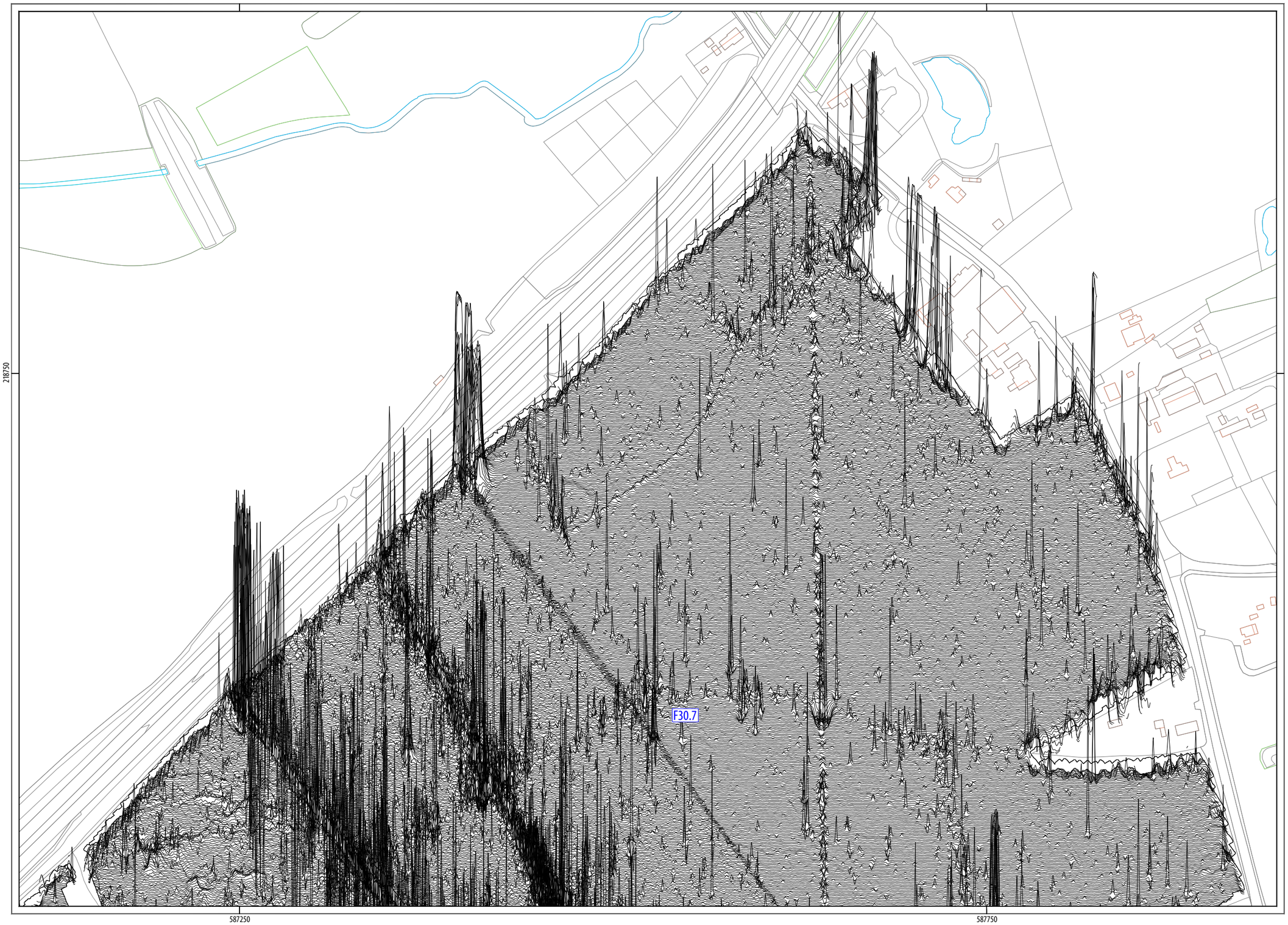
ILLUS 91 Processed greyscale magnetometer data; Sector 28



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1:2,500 @ A3

PROJECT ATCE19
A12 Chelmsford to A120
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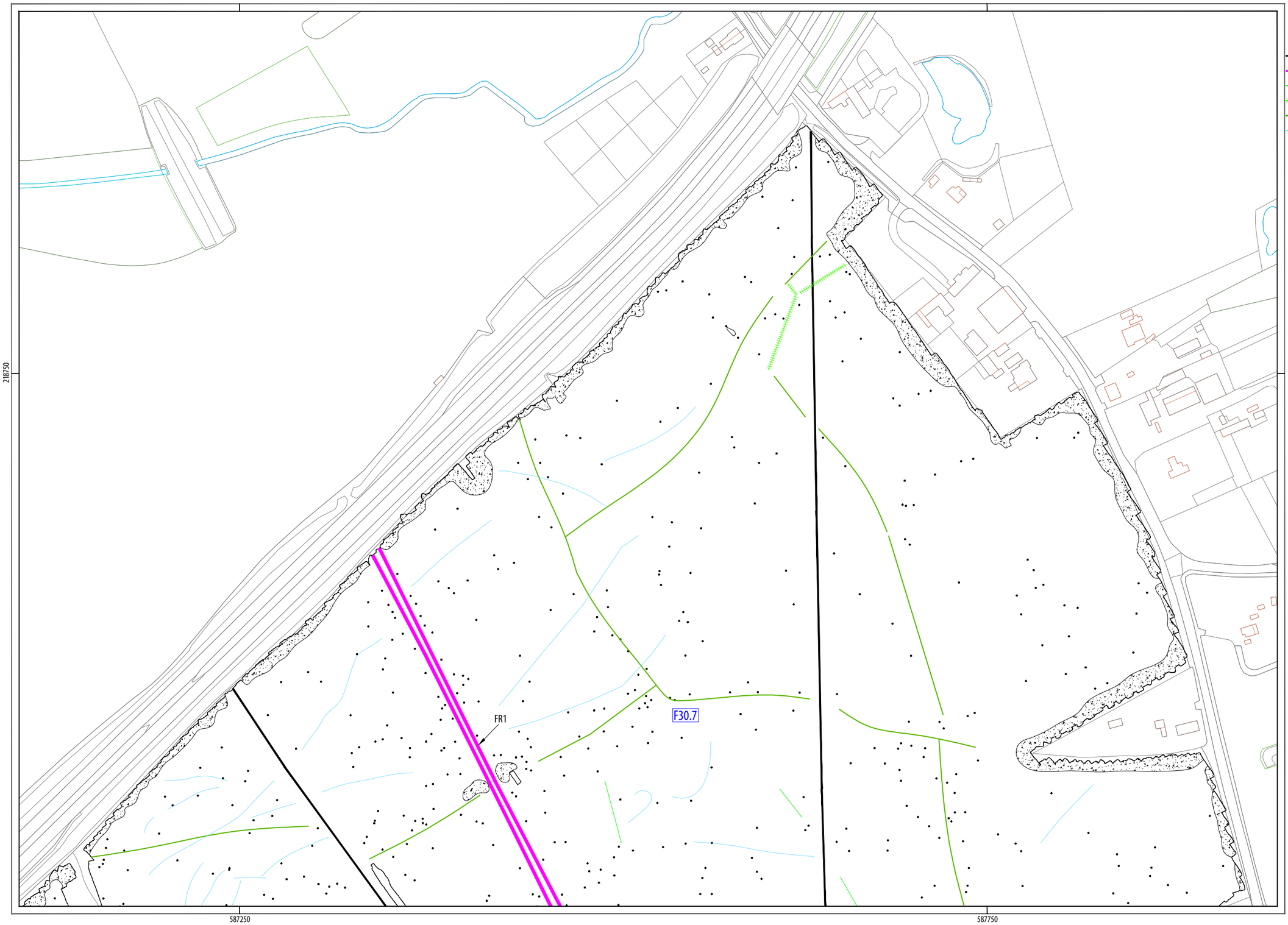
ILLUS 92 XY trace plot of minimally processed magnetometer data; Sector 28



TYPE OF ANOMALY | INTERPRETATION

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

F31.3

F31.2

F31.1

219750

219250

588000

nT
-1.0
2.0

0
50m
1:2,500 @ A3

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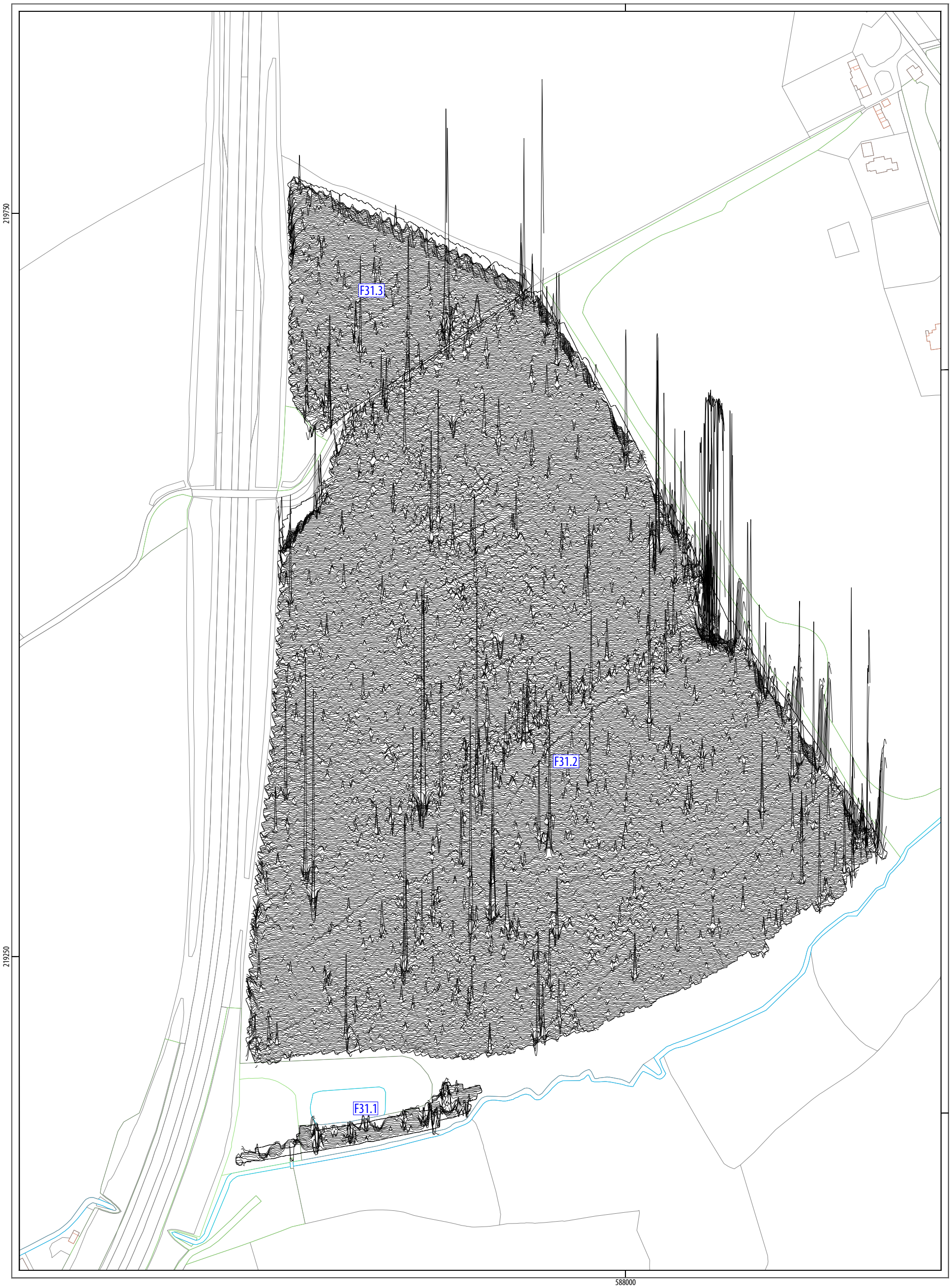
ILLUS 94 Processed greyscale magnetometer data; Sector 29



25.0nT/cm

0 50m

1:2,500 @ A3

PROJECT ATCE19
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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

PROJECT ATCE19
A12 Chelmsford to A120
Junctions 19 to 23
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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 ([redacted] 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

Entered by	Sam Harrison (sam.harrison@headlandarchaeology.com)
Entered on	3 September 2020

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