



Galileo 03 Ltd.

Mynydd Ty-talwyn Energy Park - Environmental Statement Volume III

Appendix 7.6: Geophysical Survey Report - Wind Turbines

Project Reference: 663870

Note: This document was produced to report the findings of the geophysical survey undertaken in line with the Written Scheme of Investigation agreed with Heneb. The scope of the survey reflects the design of the Proposed Development at that point in time. Whilst the design has since evolved the results of the survey remain relevant.

NOVEMBER 2025

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MYNYDD TY-TALWYN ENERGY PARK – WIND TURBINES

GEOPHYSICAL SURVEY REPORT

. PEDW ref. DNS CAS-03018-G7G6H7

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Commissioned by RSK Environment Ltd on behalf of Galileo 03 Ltd (part of Galileo Empower UK Ltd)

19/11/2025

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Note: It should be noted that since the geophysical survey was undertaken design iterations have led to alterations in design, including the removal of the BESS area and the relocation of the substation. This geophysical survey is now only relevant to the wind turbine areas of the Proposed Development and there are areas included that are no longer proposed for built development (field parcels F35, F42, F43).

PROJECT SUMMARY

Headland Archaeology (UK) Ltd was commissioned by RSK Environment Ltd (the Client), on behalf of Galileo 03 Ltd (part of Galileo Empower UK Ltd), to undertake a geophysical (magnetometer) survey on land south-east of Margam and north-west of Tondy in South Wales where it is proposed to construct an energy park generating electricity from both solar and wind (Mynydd Ty-talwyn Energy Park). This survey covers those parts of the wider site area that will be impacted by the construction and erection of the wind turbines and substation. This includes the six wind turbine locations and associated cut and fill hardstanding, the site of the substation, and a parcel of land in the south-eastern corner of the site (which has now been de-scoped for project reasons), a combined area of approximately 23.7 hectares. This report, together with the 2024 report on the survey of the areas where the solar panels and battery energy storage system (BESS) are proposed to be sited, will be submitted in support of the application for the future development of the site and will also inform future archaeological strategy.

Survey has been completed across all the selected areas. Unsurprisingly, a very similar range of anomalies has been recorded as were identified by the 2024 survey against a moderately variable magnetic background. Most of these anomalies are related to post-medieval agricultural activity (ridge and furrow and modern cultivation, boundary removal) or are natural in origin with the only area of definite archaeological activity limited to a small enclosure at the south-eastern tip of the site: it should be noted that the enclosure is situated outside any area likely to be directly impacted by the proposed development and has now been de-scoped for project reasons. Several linear and discrete anomalies categorised as of uncertain origin which are difficult to confidently interpret have also been recorded. The data from part of one survey block has been adversely affected by the likely spreading of 'green waste'.

The identification of a wide range of anomalies, including those of clear archaeological potential, again indicates that the survey data provide a reasonable indication of the archaeological potential of the site, notwithstanding the limitations of magnetometer survey to identify certain types, sizes, and period of archaeological features and keeping in mind the variability of response over sandstone bedrock.

Therefore, based on the results of both phases of the survey, the archaeological potential of most of the site is assessed as low, except in and around the clearly defined enclosure (an area which has now been de-scoped for project reasons), where it is assessed as high. In the field affected by green waste the potential is undetermined and uncertain in those areas where anomalies of no clear (uncertain) origin have been recorded.

TABLE OF CONTENTS

<u>1.</u>	<u>INTRODUCTION</u>	<u>7</u>
1.1.	SITE LOCATION, TOPOGRAPHY AND LAND-USE	7
1.2.	GEOLOGY AND SOILS	8
<u>2.</u>	<u>ARCHAEOLOGICAL BACKGROUND</u>	<u>8</u>
<u>3.</u>	<u>AIMS, METHODOLOGY & PRESENTATION</u>	<u>11</u>
3.1.	AIMS AND OBJECTIVES	11
3.2.	METHODOLOGY	11
3.3.	DATA PRESENTATION AND TECHNICAL DETAIL	12
<u>4.</u>	<u>RESULTS & DISCUSSION</u>	<u>13</u>
4.1.	SITE CONDITIONS	13
4.2.	ANOMALIES OF FERROUS AND MODERN ORIGIN	13
4.3.	AGRICULTURAL ANOMALIES	14
4.4.	ANOMALIES OF GEOLOGICAL ORIGIN	14
4.5.	ANOMALIES OF UNCERTAIN ORIGIN	14
4.6.	ANOMALIES OF POSSIBLE OR PROBABLE ARCHAEOLOGICAL ORIGIN	14
<u>5.</u>	<u>CONCLUSION</u>	<u>14</u>
<u>6.</u>	<u>REFERENCES</u>	<u>15</u>
<u>7.</u>	<u>APPENDICES</u>	<u>17</u>
	APPENDIX 1 MAGNETOMETER SURVEY	17
	APPENDIX 2 SURVEY LOCATION INFORMATION	18
	APPENDIX 3 GEOPHYSICAL SURVEY ARCHIVE	18
	APPENDIX 4 DATA PROCESSING	18

LIST OF ILLUSTRATIONS

Illus 1 Site location (1:40,000)

Illus 2 F34, looking north

Illus 3 F36, looking west

Illus 4 F40, looking north-east

Illus 5 F42, looking south-west

Illus 6 Survey location showing photograph locations (1:15,000)

Illus 7 Overall greyscale plot of processed magnetometer data (1:15,000)

Illus 8 Overall interpretation of magnetometer data (1:15,000)

Illus 9 Processed greyscale magnetometer data; Sector 1 (1:2,500)

Illus 10 XY trace plot of minimally processed magnetometer data; Sector 1 (1:2,500)

Illus 11 Interpretation of magnetometer data; Sector 1 (1:2,500)

Illus 12 Processed greyscale magnetometer data; Sector 2 (1:2,500)

Illus 13 XY trace plot of minimally processed magnetometer data; Sector 2 (1:2,500)

Illus 14 Interpretation of magnetometer data; Sector 2 (1:2,500)

Illus 15 Processed greyscale magnetometer data; Sector 3 (1:2,500)

Illus 16 XY trace plot of minimally processed magnetometer data; Sector 3 (1:2,500)

Illus 17 Interpretation of magnetometer data; Sector 3 (1:2,500)

Illus 18 Processed greyscale magnetometer data; Sector 4 (1:2,500)

Illus 19 XY trace plot of minimally processed magnetometer data; Sector 4 (1:2,500)

Illus 20 Interpretation of magnetometer data; Sector 4 (1:2,500)

Illus 21 Processed greyscale magnetometer data; Sector 5 (1:2,500)

Illus 22 XY trace plot of minimally processed magnetometer data; Sector 5 (1:2,500)

Illus 23 Interpretation of magnetometer data; Sector 5 (1:2,500)

Illus 24 Processed greyscale magnetometer data; Sector 6 (1:2,500)

Illus 25 XY trace plot of minimally processed magnetometer data; Sector 6 (1:2,500)

Illus 26 Interpretation of magnetometer data; Sector 6 (1:2,500)

Illus 27 Processed greyscale magnetometer data; Sector 7 (1:2,500)

Illus 28 XY trace plot of minimally processed magnetometer data; Sector 7 (1:2,500)

Illus 29 Interpretation of magnetometer data; Sector 7 (1:2,500)

MYNYDD TY-TALWYN ENERGY PARK – WIND TURBINES

GEOPHYSICAL SURVEY REPORT

1. INTRODUCTION

Headland Archaeology (UK) Ltd was commissioned by RSK Environment Ltd (the Client) on behalf of Galileo 03 Ltd (part of Galileo Empower UK Ltd), to undertake a geophysical (magnetometer) survey on land south-east of Margam and north-west of Tondy in South Wales (Illus 1) where an energy park generating electricity from both solar and wind is being proposed (Mynydd Ty-talwyn Energy Park). The current survey covers those parts of the wider site area that will be impacted by the wind power elements of the scheme being focussed on the six wind turbine locations and associated cut and fill and hardstanding and the substation location. This report, as well as that on an earlier survey, which covered the solar elements of the proposed scheme (Headland 2024), will be submitted in support of the application for the future development of the site and will also inform future archaeological strategy, if required.

This report has been prepared by Headland Archaeology on behalf of Galileo 03 Ltd (part of Galileo Empower UK Ltd) (hereinafter referred to as 'Galileo' or the 'Applicant').

The survey was undertaken in accordance with the requirements of Planning Policy Wales 2024 (Edition 12, Ch.6 The Historic Environment), and with the Written Scheme of Investigation for Geophysical Survey (WSI) (Headland Archaeology 2025).

The WSI, which was approved by Heneb (GGAT) prior to commencement, was produced to the

standards laid down in the European Archaeological Council's guideline publication, EAC Guidelines for the Use of Geophysics in Archaeology (Europae Archaeologia Consilium 2016) and the Chartered Institute for Archaeologists' (CIfA) Standard and Guidance for Archaeological Geophysical Survey (CIfA 2020). The survey was also carried out in line with the same best practice guidelines.

The survey was carried out between February 10th and February 14th, 2025.

1.1. SITE LOCATION, TOPOGRAPHY AND LAND-USE

The overall site boundary (Illus 1) comprises an irregular shaped block of land located to the north-west of Tondy, Bridgend, centred at NGR SS 286521, 186102. The geophysical survey areas (GSAs) comprised eight discrete parcels encompassing 10 fields (F34 to F43) and covering approximately 23.7 hectares.

Note – the field numbering sequence has been continued from that used for the previous 2024 survey.

The eight blocks of land comprise the locations of six (T1 to T6 inclusive) plus the proposed substation and the south-eastern corner of the site at Tondy (which was subsequently de-scoped for project reasons), each block covering a minimum area of 1 hectare. Each turbine area was broadly rectangular in shape and included a buffer around each preferred location to allow for micro-siting. This buffer was also expanded where necessary to cover all the area around the preferred turbine

location likely to be needed during construction for crane hardstanding or laydown areas.

The six turbine areas are in two broad clusters at the northern end of the site: the eastern cluster (T1, T2 and T3 – F38 to F41 inclusive), and the northern cluster (T4 and T5 - F34, F36 and F37) and T6 (F2) at the western edge of the site.

The approximate locations and elevations of each turbine location above Ordnance Datum (AOD) are given below.

T1 – NGR 286963 186078 – 200m AOD

T2 – NGR285647 186164 – 210m AOD

T3 – NGR 285662 186010 – 235m AOD

T4 – NGR285538 186609 – 225m AOD

T5 – NGR 285703 187015 – 220m AOD

T6 – NGR 284681 186297 – 250m AOD

The proposed substation is also at the northern end of the site, F35, centred at NGR 285664 186313, bordering a C-road.

The final survey area (alternate location for the substation) is at the opposite end of the site and extends across two fields, F42 and F43, at the south-eastern corner of the site, south-west of Tondy House Farm and immediately north of New Road, centred at NGR288432 184494. *It should be noted that this survey area was subsequently descope for project reasons.*

The survey areas were upland pasture (Illus 2 and Illus 3) or rough grazing (Illus 4). The survey area at Tondy was mostly covered with sedge (Illus 5).

1.2. GEOLOGY AND SOILS

The bedrock underlying the whole site are sedimentary in nature, formed in the Carboniferous period.

Two different formations of sandstone bedrock underlay the survey parcels. T3 and T6 are underlain by sandstone of the Rhondda Member whilst T1, T2, T4, T5 and the substation block are underlain by Brithdir Member sandstone.

Within the survey area at Tondy the prevailing bedrock comprises primarily mudstone, siltstone and sandstone of South Wales Middle Coal Measures Formation, sedimentary bedrock formed between 318 and 309.5 million years ago in the Carboniferous period. A narrow band of mudstone, siltstone and sandstone (South Wales Upper Coal Measures Formation) formed between 315.2 and 308 million years ago, runs from east to west along the northern edge of this block.

No overlying superficial deposits are recorded in any of the survey areas (UKRI 2025).

The soils are classified in Soilscape 13 Association and described as freely draining acid loams over rock across all the upland areas within the site boundary. On the lowland Coal Measures geology at Tondy the soils are slowly permeable wet very acid soils with a peaty surface and are classified in Soilscape 19 Association (Cranfield University 2025).

2. ARCHAEOLOGICAL BACKGROUND

The following is an abridged version of the archaeology baseline presented in the draft Heritage Desk-Based Assessment (Pegasus Group forthcoming). The baseline incorporates data within a 3km-radius study area measured from the wider site boundary.

Mesolithic and Neolithic

Prehistoric lithics ranging in date from the Mesolithic to the Early Bronze Age have been found at the south-eastern edge of the woodland covering the slopes of Mynydd Margam, approximately 1.9km north-west of the site (02102w, 05028w, 05029w). There is also record of a Neolithic axe having been found at Gelli Lenor in Maesteg (01277m).

Bronze Age

Near Maescadlawr in the northern part of the site, is a trapezoidal block of sandstone that has been

interpreted as a possible Bronze Age standing stone (00165m). It is unclear whether historic environment record (HER) 00990m, described as a standing stone marked on the 1918 Ordnance Survey (OS) map, is a duplicate record or is a separate monument.

On either side of the lane to the north of Baeden Farm, on the high ground below Mynydd Baeden in the southern-central part of the site, are recorded two earthwork mounds and nine cropmark ring ditches believed to indicate Bronze Age round barrows and/or ring cairns (04586m, 04587m; 02617m, 04578m–04585m). The findspot of an Early Bronze Age knife fragment is also recorded in the vicinity (06127m).

Known and possible Bronze Age ring cairns are also recorded at Moel Ton-mawr and on the south-east facing slopes of Mynydd Margam in the north-western part of the study area (00755w, 00117m, 00115m, 00753w, 00754w, 00752w, 00751w, 00750w). An Early Bronze Age flint scatter is also recorded to the west of Ton-mawr Farm, approximately 2.5km west of the Site (02209w).

Iron Age

Also, between Mynydd Margam and Moel Ton-mawr in the north-west of the study area are the earthworks of fortified enclosures of probable Iron Age date:

- Y Bwlwarcu Hillfort, 1.3km north-west of the site (00116m, 01155m);
- Caer Blaen-y-cwm Enclosure, 1.5km west of the site (00759w);
- Caer Cwmphilip (or Moel Ton-mawr) Earthwork and Cwm Philip West (or Danish Camp), 1.8km and 2.3km west of the site respectively (00774w, 00758w); and
- Ton-mawr Enclosure, 1.1km west of the site (00776w).

Linear earthworks in the vicinity of Caer Cwmphilip (or Moel Ton-mawr) Earthwork and Ton-mawr Enclosure may be associated with these monuments, either serving as additional defensive installations, strategic hollow-ways controlling the

approach to these monuments, or territorial boundary markers.

Roman

The Roman road between Cardiff and Neath (RR60) ran south-east to north-west, passing approximately 200m west and 1.2km south of the study area. The HER states that the road is defined as a cropmark 3.8km south-west of the site (01016.8w, 01016.10w). Roman milestones were formerly located here (01016.11w), and further north near Margam (00790W, 01016.15w).

Another Roman road is thought to be traced by the modern road from Laleston to Cefn Cross to Ffordd-y-Gyfraith through the site. An embanked Iron Age to Romano-British settlement and findspots of Roman coins are recorded on the west side of the road at Laleston, 3.7km south of the site (00188m, 00179m).

Another possible Roman road is recorded at Bryncethin at the eastern edge of the study area (05019m); and other Roman coins have been found at Aberkenfig and Pen-y-Fai, 1.1km, 1.5km and 2.6km from the site (00180m, 00181m, 01404m).

Early medieval (410 AD – 1066)

The landscape around Mynydd Baeden has been suggested as the location for the Battle of Mons Badonicus, or Battle of Mount Badon. Proponents argue that earthworks found within the site near Gilfach Uchaf, to the north and east of Mynydd Ty-talwyn, and on the east side of Mynydd Baeden represent 'entrenchments' associated with the battle.

However, the RCAHMW interprets the 'entrenchments' at Mynydd Baeden as hollow-ways (424515). The summary in the HER record states: "A series of parallel trenches, or banks and ditches. They may be the remains of quarrying or other industrial endeavours or part of a medieval road or trail." (04450m).

The 1899 edition OS map identifies an old quarry at the head of the earthworks at Gilfach Uchaf, and the 1918 and 1924 editions identify rises, springs,

and old coal levels on the east side of the earthworks at Mynydd Baeden. It is therefore possible that some of the earthworks could be associated with historic coal working and/or quarrying. Recent literature has also suggested that some of the earthworks derive from recent farming or forestry work.

Carved stones believed to be of early medieval date have been discovered at Bettws (Carreg Fedyddiol Sculptured Stone), 2.2km east of the Site (00368m); Sychbant Farm, 2.7km north-west of the site (01616m); and a short distance upslope from Y Bwlwarcau hillfort, 2.3km north-west of the site (00809w).

Medieval (1066 – 1539)

Near Maescadlawr in the northern part of the site is a complex of earthworks representing the remains of a medieval settlement (00126m / 15245). It is designated as a Scheduled Monument under the name 'British Fortified Residence' (GM086). Three medieval wells are recorded 110m to its north (01142m, 01143m, 01144m).

The 'British Fortified Residence' was excavated in the 1930s by Cyril and Aileen Fox, and again in 2011 by volunteers from the Llynfi Valley Historical Society. Fox and Fox originally considered the site, and other nearby house platforms (see below), to be early medieval but later revised their dating to medieval. The recent excavations recovered 14th-century pottery.

Across the central swathe of the site are numerous earthworks recorded by the HER and the RCAHMW as medieval house platforms (00127m–00133m, 06013m, 06129m 06320m – west side of lane; 01712m, 01713m, 01714m, 04228m, 04225m, 00135m – east side of lane)) and associated enclosures (00134m, 01731m / 24328) and trackways or droeways (08074m, 08075m, 06128m – west side of lane). A medieval well is recorded among the house platforms at Mynydd ty-Talwyn (01145m).

Also recorded within the site is an enclosure within the north-western boundary near Gilfach (15408); the former location of the Chapel of St Thomas of

Creitic, c.295m north-west of Baeden Farm (00138m); a medieval well at Cefn Ydfa Farm (07946m); and the holy well of Ffynnon Gilfach Isaf at the northern boundary of the site roughly halfway between Gilfach and Bryn Cynan (07946m).

The route of a medieval trackway Ffordd y Gyfraith ('Road of the Law'), allegedly used by officials travelling from the lowlands into the wild hill country, traces the modern road through the site and branches off to the 'British Fortified Residence' and Mynydd Baeden (03111.0m).

Post-medieval (1540 – 1750), Early Modern (1750 – 1901) and Modern (1901 – present)

The vast majority of HER 'monuments' recorded within the 3km study area (totalling 662) are post-medieval and modern in date. There are 48 such records within the site, comprising the ruins of farmsteads, houses, field boundaries, sheepfolds, sandstone quarries and bell pit/prospection hollows.

Data from the Coal Authority, available through the British Geological Survey's Interactive Map Viewer, indicates that historic coal mining activity within the site may have been more widespread than recorded by the HER. Mine adits are identified within Craig yr Aber to the south-west; at Cefn Parc/Ton Philip in the south; at Cwmrisga to the south-east; to the south-east and east of Mynydd Baeden; and at Maescadlawr to the north.

The earliest available historic mapping of the site is the 1839 tithe map for the parish of Llangynwyd. This shows a patchwork of small rectilinear fields in the north-western, northern, eastern and southern parts of the site. There is little correlation with extant field systems. There is some survival of the tithe field boundaries in the north and east, but there are considerably fewer fields in the east and south and a plantation has replaced the fields to the north-west.

Myndd Ty-talwyn Energy Park – Solar Panels and BESS Geophysical Survey

A previous geophysical survey (Headland Archaeology 2024) carried out across those areas of the site that will accommodate panels and infrastructure associated with the solar elements of the energy park recorded a range of magnetic anomalies of non-archaeological origin as well as a small number of clear archaeological features, among them three enclosures. A large number of linear, curvilinear and sinuous trend anomalies of varying strengths and alignments were also identified but were difficult to confidently interpret. Former boundaries, the location of a former structure recorded on historic mapping, field drains, and several buried services were also recorded.

Of the three enclosures two were sub-rectangular in shape located on prominent topographic locations on high ground at Mynydd Baeden. Other ephemeral anomalies were recorded close to the enclosures but were too faint to interpret with more confidence. The third large circular enclosure was recorded east of Maescadlawr Farm.

The survey also recorded a cluster of pit-like anomalies on the plateau of Mynydd Baeden, as well as various linear, curvilinear and sinuous trends all of which have been classified as of uncertain origin but that could in some cases be of anthropogenic origin. Map regression showed that some of these anomalies broadly correlate with earthworks the origin of which are also uncertain. Some of these uncertain anomalies are likely to be geological or caused by topographic variation. Other possible causes include former mineral extraction or other industrial activity.

The report concluded that *'based on the results of the survey the archaeological potential of the majority of the site is assessed as low, except in and around the clearly defined enclosures, where it is assessed as high'*. In fields affected by 'green waste' the potential was assessed as *'undetermined and uncertain in those areas where anomalies of no clear (uncertain) origin'* were recorded.

3. AIMS, METHODOLOGY & PRESENTATION

3.1. AIMS AND OBJECTIVES

The principal objectives of the geophysical survey are to gather information to establish the presence/absence, character, and extent of any archaeological remains within the GSAs, and to inform the planning application and any further evaluation or mitigation strategies.

The aims of the survey are:

- to provide information about the possible interpretation of any magnetic anomalies,
- to therefore determine the likely presence/absence and extent of any buried archaeological features, and
- to prepare a comprehensive site archive and report.

3.2. METHODOLOGY

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

Magnetometry is the most widely used geophysical survey technique in archaeology as it can quickly evaluate large areas and, under favourable conditions, identify a wide range of archaeological features including infilled cut features such as large pits, gullies and ditches, hearths, and areas of burning, and kilns and brick

structures. It is therefore good at locating settlements of all periods, prehistoric field systems and enclosures, and areas of industrial or modern activity, amongst others. It is less successful in identifying smaller features such as post-holes and small pits (except when using a non-standard sampling interval), unenclosed (prehistoric) settlement sites and graves and burial grounds. However, magnetometry is by far the single most useful technique and was assessed as the best non-intrusive methodology for this site.

The survey was undertaken using four Bartington Grad601 sensors mounted at 1m intervals 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 spaced 4m apart in order to secure comprehensive coverage. The magnetometer system was linked to a Trimble R12 Real Time Kinetic (RTK) differential Global Positioning System (dGPS) outputting in NMEA mode to ensure a high positional accuracy of each data point; +/- 1cm for each reading.

At the start of each day the magnetometer was left idle whilst switched on for approximately 30 minutes to allow the instrument to acclimatise to the site conditions. The instrument was thereafter re-balanced when necessary to compensate for instrument drift.

The data was stored on an external weatherproof laptop and later downloaded for processing and interpretation. Anomaly GeoSurvey v1.12.3 (Lichenstone Geoscience) and QGIS v.3.28.5 software was used to process and present the data respectively.

3.3. DATA PRESENTATION AND TECHNICAL DETAIL

A general site location plan detailing the site boundary and the GSAs is shown in Illus 1 at a scale of 1:40,000. Illus 2 to Illus 5 inclusive are site condition photographs.

Illus 6 shows the location and direction of the site condition photographs at 1:15,000. Illus 7 and Illus 9 are overall plans of the processed

magnetometer data and interpretation respectively, also at a scale of 1:15,000. These overall plans also show the sector boundary locations for the detailed 1:2,500 illustrations. Fully processed (greyscale) data, minimally processed (XY trace plot) data and interpretative plans are presented by Sector, at 1:2,500, in Illus 9 to Illus 29 inclusive.

Note - where the current GSAs border or overlap with data collected during the earlier, 2024, survey the previous data and interpretation has also been re-presented in the appropriate graphics. Also, for consistency and to avoid possible confusion, the running sequence of anomalies from the previous survey has been continued into the current phase of survey. This is also the case with the field numbering sequence.

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.

The survey methodology, report and any recommendations comply with the Written Scheme of Investigation (Headland Archaeology 2024), guidelines outlined by Europae Archaeologia Consilium (EAC 2016) and by the Chartered Institute for Archaeologists (CIfA 2020).

All illustrations using Ordnance Survey (OS) base mapping are reproduced with the permission of the controller of His Majesty's Stationery Office (© Crown copyright).

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

4. RESULTS & DISCUSSION

4.1. SITE CONDITIONS

Magnetometer survey is generally recommended over any sedimentary bedrock but the average response over sandstone geologies can be poor and may be variable depending on the presence of overlying superficial deposits although there are no superficial deposits recorded within the site boundary (English Heritage 2008; Table 4). Magnetometry was therefore the most appropriate non-intrusive geophysical technique for evaluating the site taking account of the limitations noted in Section 3.2 and above.

Surface conditions varied across the GSAs, ranging from good in F34 (Illus 2) to moderate in F36 (Illus 3) to very poor in F40 and F42 (Illus 4 and Illus 5) where the topography was either very steep or the ground marshy respectively.

Data quality was generally good with only minimal post-processing required. Other than the challenging terrain no problems were encountered during the fieldwork and all the GSAs were surveyed in their entirety.

Given the geographic extent of the site and varying topography across the site it is not unexpected that the magnetic background should also vary across the site. However, there are no obvious differences between the magnetic background across the two sandstone bedrocks on the upland areas or between the two types of Coal Measures geology on the lowland area at Tondy.

The magnetic background is particularly variable in the north-western quarter of T1 (F41 – Illus 24 and Illus 25) suggesting that 'green waste', a soil improver which is not conducive for clear survey results, had been spread over at least part of this field. Green waste had also been spread across several fields surveyed during the previous survey (Headland Archaeology 2024). The strength and density of the magnetic 'noise' resulting from the spreading of this material has all but precluded the identification of any sub-surface archaeological

features, if present, and therefore the archaeological potential of this block remains undetermined.

Against this magnetic background, anomalies of various origins have been recorded (Illus 7 and Illus 8), although some of the responses are low magnitude and not easy to discriminate against the variable magnetic background.

The mapping of a range of magnetic anomalies confirms that there was sufficient magnetic contrast for the detection of potentially archaeological features, notwithstanding the limitations of magnetometer survey to identify the types, sizes, and period of archaeological features as described in Section 3.2 and keeping in mind the variability of results over sandstone bedrock geologies. The results of the survey are therefore determined likely to provide a reasonable indication of the extent of the archaeological potential of the GSAs.

The anomalies are discussed below according to their interpreted origin.

4.2. ANOMALIES OF FERROUS AND MODERN ORIGIN

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

A single very high magnitude linear anomaly (Illus 17 - SP7) locates a buried service pipe aligned south-west to north-east along the western edge of the substation GSA in F35. The same feature has probably also been detected in the north-western corner of the BESS block in F7 on the other side of the C-road.

A t-shaped band of disturbance in T2 (Illus 21 – Illus 23) in F39 is caused by a wire mesh fence subdividing the field.

4.3. AGRICULTURAL ANOMALIES

As previously stated, it remains difficult to differentiate between many of the linear trends recorded across the site. Many of the more regular anomalies are considered likely to be indicative of agricultural activity, including traces of possible ridge and furrow in F34 (Illus 14) and in F42 and F43 (Illus 29).

Others linear trends, such as the parallel anomalies recorded in F2 (L1 and L2 from the 2024 survey), F34 (Illus 14 – L13), and L17 and L18, in F42 and F43 respectively (Illus 29) are probably indicative of former boundaries although these are not recorded on historic mapping.

4.4. ANOMALIES OF GEOLOGICAL ORIGIN

The data in T3 (F38 – Illus 18) has a ‘crazy paving’ or ‘cracked’ appearance. This is due to fissuring in the sedimentary sandstone bedrock. The effects of the geology on the data can also be seen in T4 (F36 and F37 – Illus 15 to Illus 17) and in T2 (F39 and F40 (Illus 21 to Illus 23) with the more linear anomalies also of natural origin perhaps being caused by accumulations of topsoil along the base of, or breaks in, slope.

4.5. ANOMALIES OF UNCERTAIN ORIGIN

Anomalies which cannot be confidently interpreted in any of the other categories are classed as of uncertain origin. During the previous survey (Headland 2024) it was difficult to interpret the cause of multiple linear, curvilinear and sinuous anomalies with varying magnetic signatures. These anomalies do not align with topographic variation or extant field boundaries. In such instances these anomalies are interpreted as of uncertain origin.

In the current survey anomalies of uncertain origin are identified as the very faint curvilinear anomaly U7 in F34 (T5), linear anomalies L15 and L16 in T2 (Illus 23) and L18 in F43 (Illus 29), possible areas of burning, B?1 and B?2, in F34 and F43 respectively (Illus 14 and Illus 29) and discrete areas of

magnetic enhancement ME10 (T5 – F34 – Illus 14) and ME 11 in F43 (Illus 29). These latter two anomalies exhibit a magnetic signature indicative of an anthropogenic cause, but their location restricts a more confident interpretation, and their archaeological potential remains undetermined.

4.6. ANOMALIES OF POSSIBLE OR PROBABLE ARCHAEOLOGICAL ORIGIN

The only anomalies of possible and probable archaeological origin were recorded in the eastern corner of F43, in the south-eastern corner of the site. Here three sides of a small enclosure, E7, have been identified (Illus 27 to Illus 29). A possible area of burning, B?2, together with several discrete pit-type responses have also been recorded within the enclosure. A discrete area of enhanced readings, ME11, recorded just east of the enclosure may be associated with the enclosure but is given an uncertain classification (see Section 4.5 above).

It should be noted that F43, the area which covers all the anomalies described in the paragraph above, has now been de-scoped for project reasons.

No anomalies of possible or probable archaeological origin have been recorded by the survey other than in the now de-scoped area in F43.

5. CONCLUSION

Survey has been completed across all the selected areas. Unsurprisingly, a very similar range of anomalies has been recorded against a moderately variable magnetic background as were identified by the 2024 survey.

Most of these anomalies are related to post-medieval agricultural activity (ridge and furrow and modern cultivation, boundary removal) or are natural in origin with the only area of definite archaeological activity limited to a small enclosure at the south-eastern tip of the site.

It should be noted that the enclosure is situated in an area unlikely to be directly impacted by the currently proposed development and which has now been de-scoped for project reasons.

No anomalies of possible or probable archaeological origin have been recorded other than in the now de-scoped area.

Several linear and discrete anomalies categorised as of uncertain origin which are difficult to confidently interpret have also been recorded. The data from part of one survey block has been adversely affected by the likely spreading of 'green waste'.

The identification of a wide range of anomalies, including those of clear archaeological potential, again indicates that the survey data provide a reasonable indication of the archaeological potential of the site, notwithstanding the limitations of magnetometer survey to identify certain types, sizes, and period of archaeological features and keeping in mind the variability of response over sandstone bedrock.

Therefore, based on the results of both phases of the survey, the archaeological potential of most of the site is assessed as low, except in and around the clearly defined enclosure (in a now de-scoped area), where it is assessed as high. In the field affected by green waste the potential is undetermined and uncertain in those areas where anomalies of no clear (uncertain) origin have been recorded.

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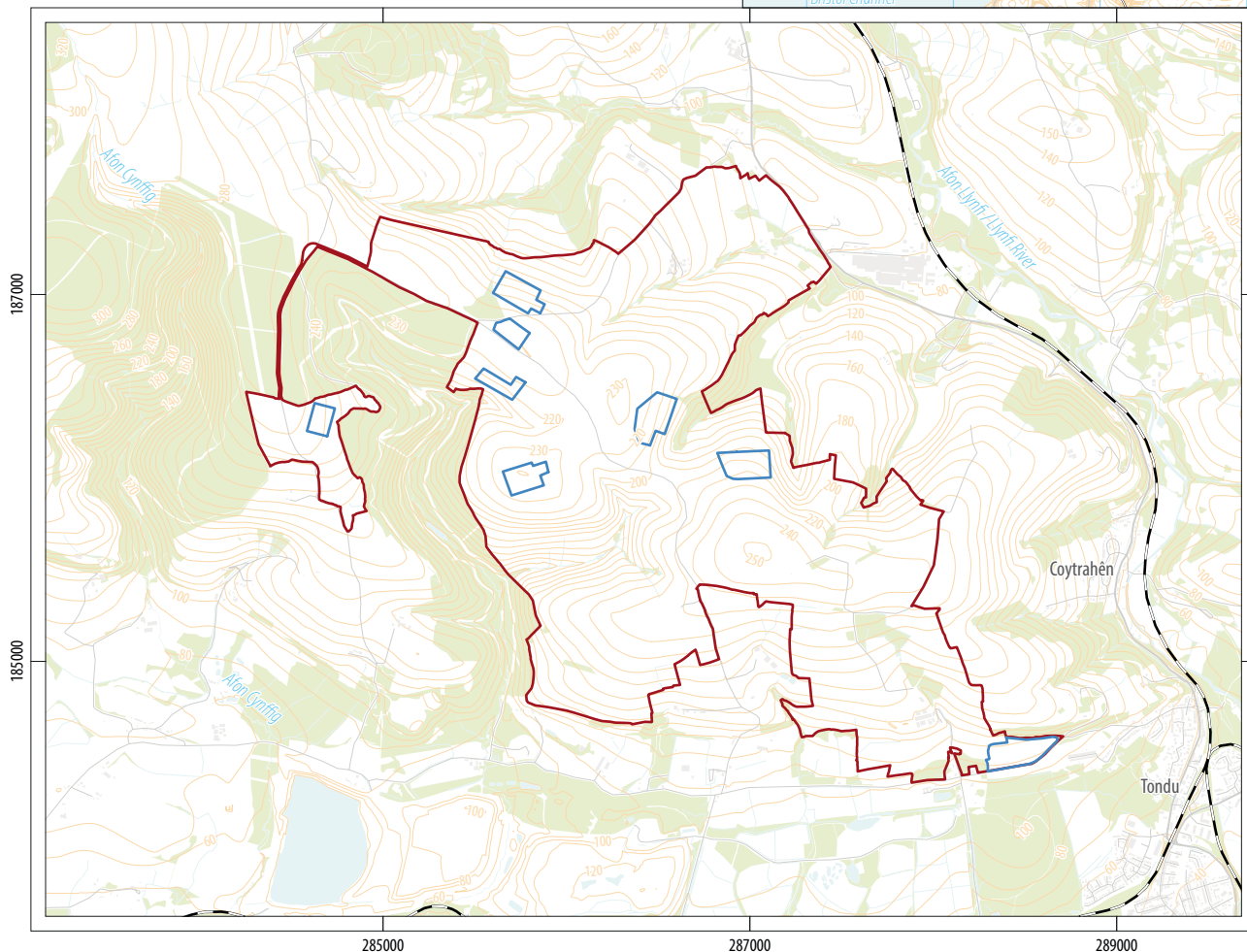
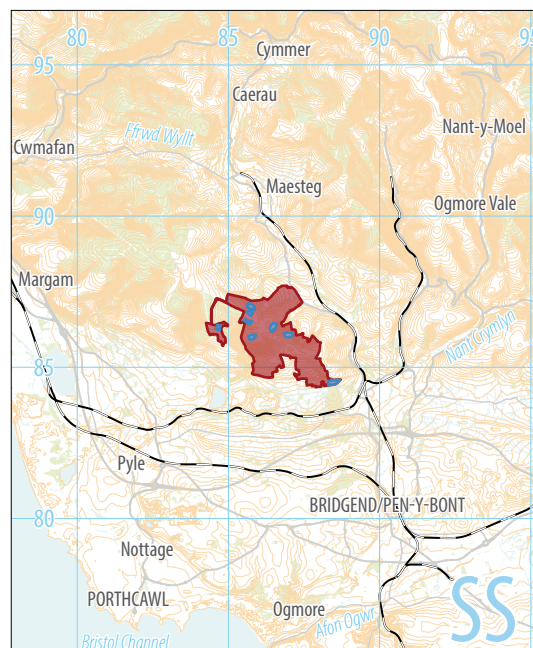
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Mynydd Ty-talwyn Energy Park
Wind Turbines and Substation

0 200km
1:12,500,000 @ A4



0 1km
1:40,000 @ A4

site boundary
geophysical survey area

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e yorkshireandnorth@headlandarchaeology.com
w www.headlandarchaeology.com



Illus 2 F34, looking north



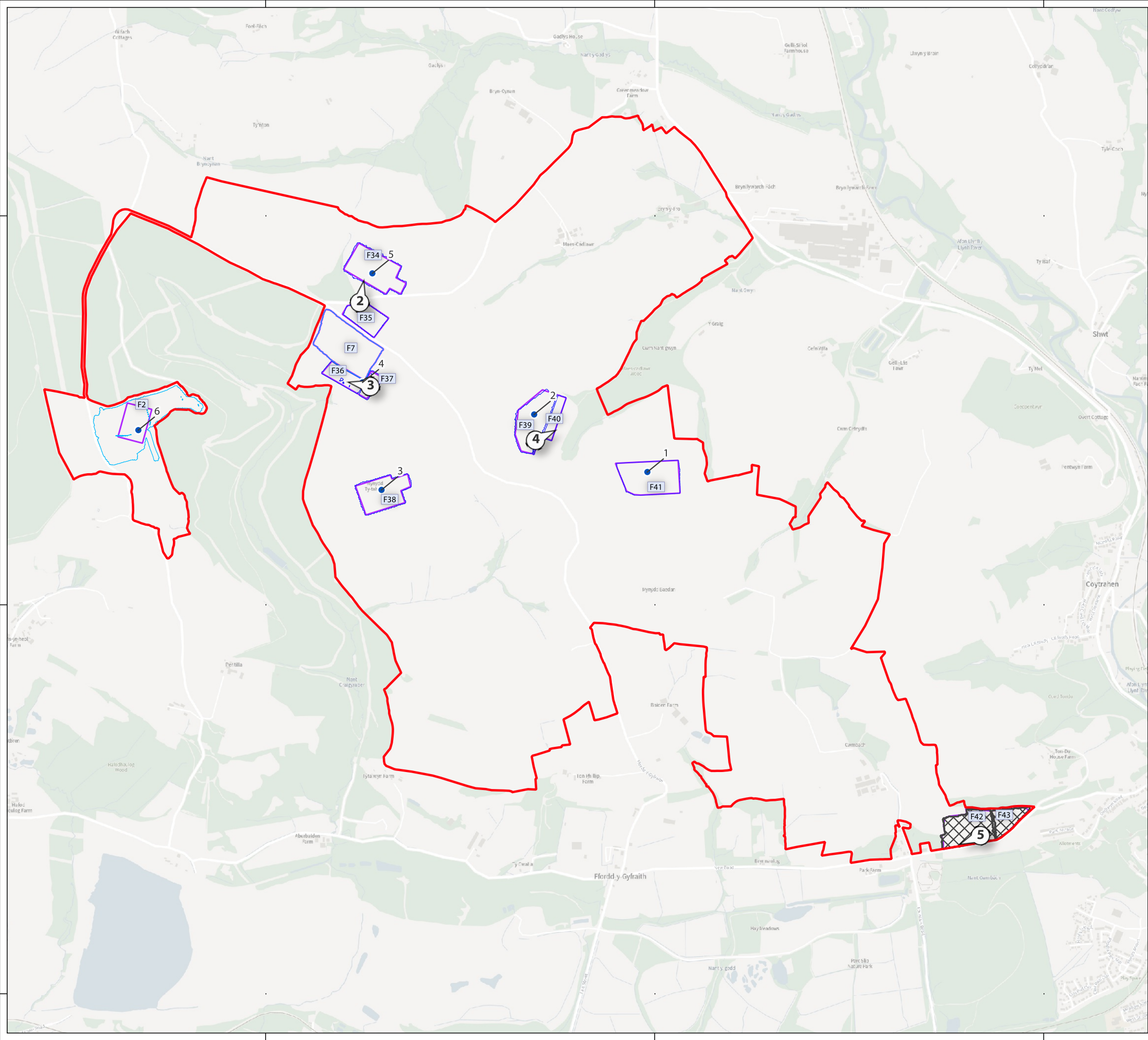
Illus 3 F36, looking west

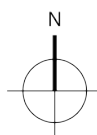


Illus 4 F40, looking north-east



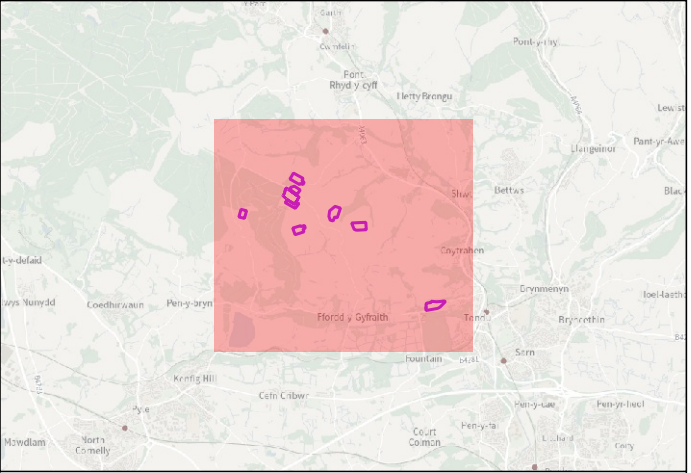
Illus 5 F42, looking south-west





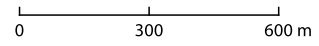


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Key

-  Site Boundary
-  Geophysical Survey Area
-  Location and Direction for Illus 02 to 05
-  Turbine Location
-  2024 Survey Extent
-  Survey Extent
-  Area de-scoped post-survey

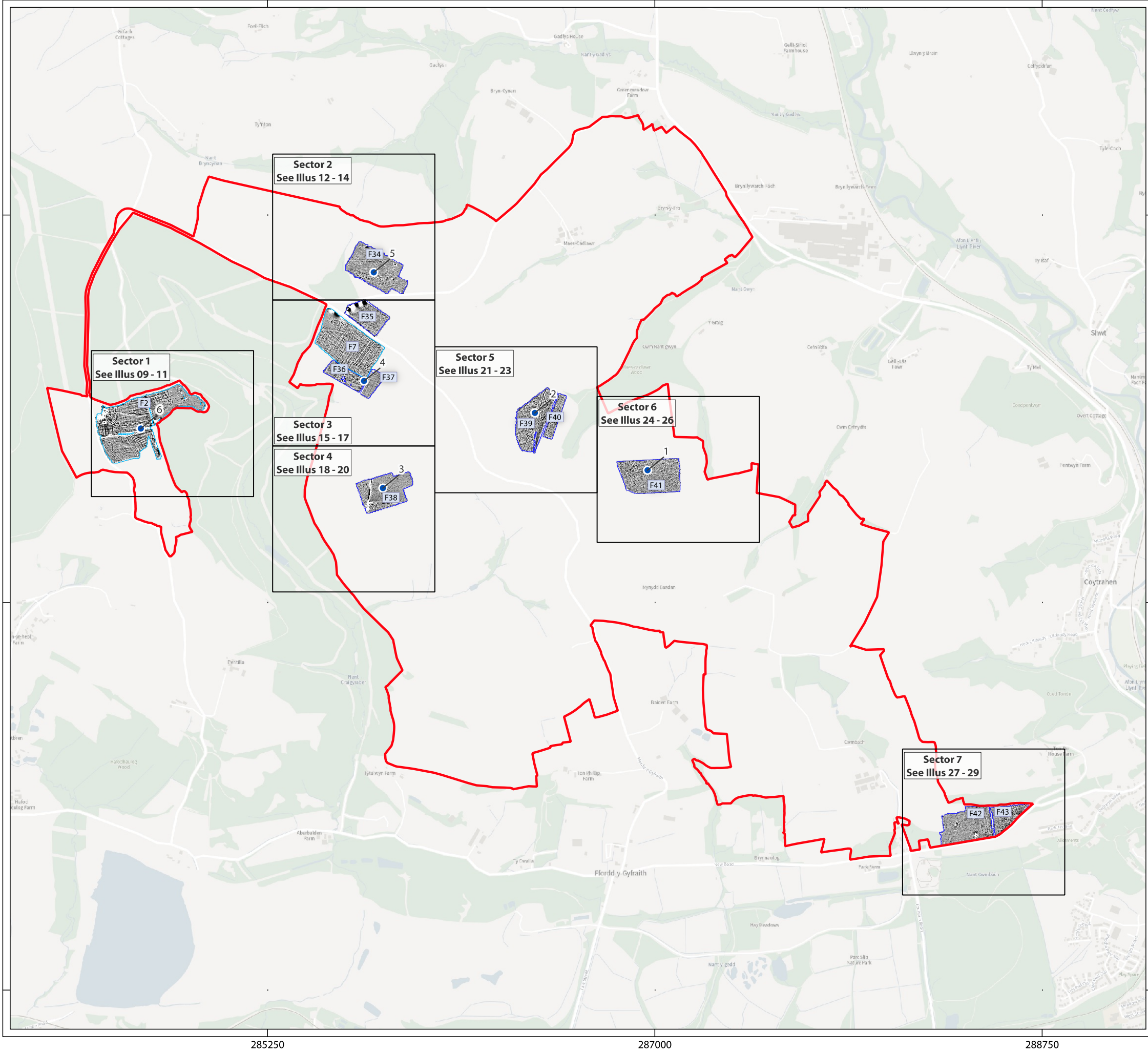


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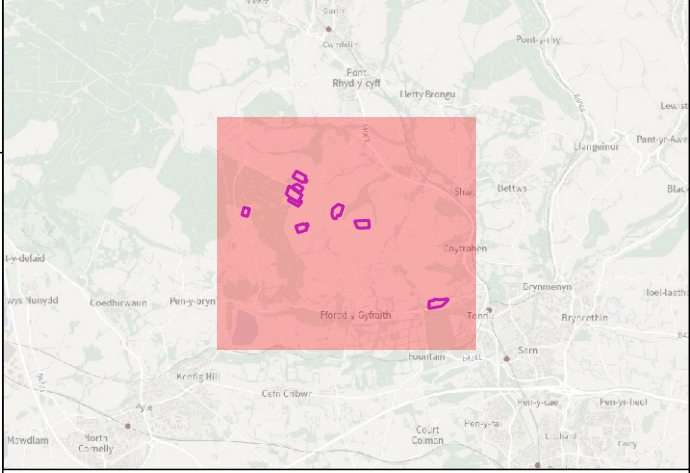
Illus 06 - Survey location showing photograph locations



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Key

Site Boundary

2024 Survey Extent

Survey Extent

Location of Illus 09 - 29

Turbine Location

+2nT

-1nT

0

300

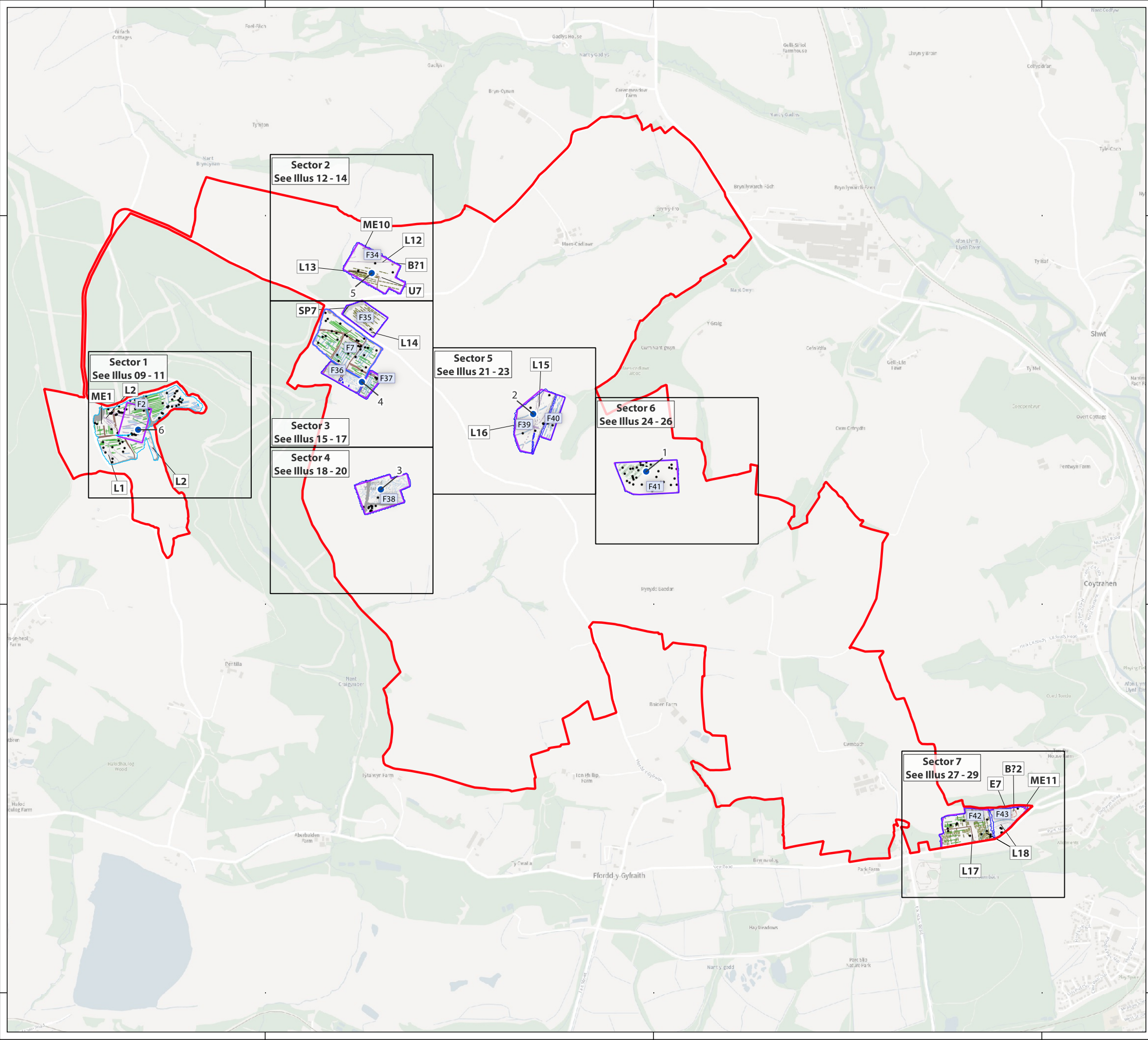
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Illus 07 - Overall greyscale plot of processed magnetometer data



Key

Site Boundary

Geophysical Survey Area

2024 Survey Extent

Survey Extent

Location of Illus 09 - 29

Turbine Location

Ferrous Objects

Agriculture

Field Boundary

Possible Field Boundary

Field Drain

Natural

Service

Uncertain

Ridge and Furrow

Archaeology

Magnetic Disturbance (Above Ground)

Magnetic Disturbance (Below Ground)

Natural

Possible Archaeology

Uncertain

Burning?

Green Waste

Abbreviation

B? Burning?

E Enclosure

L Linear

ME Magnetic Enhancement

SP Service Pipe

U Uncertain

0

300

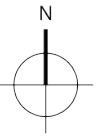
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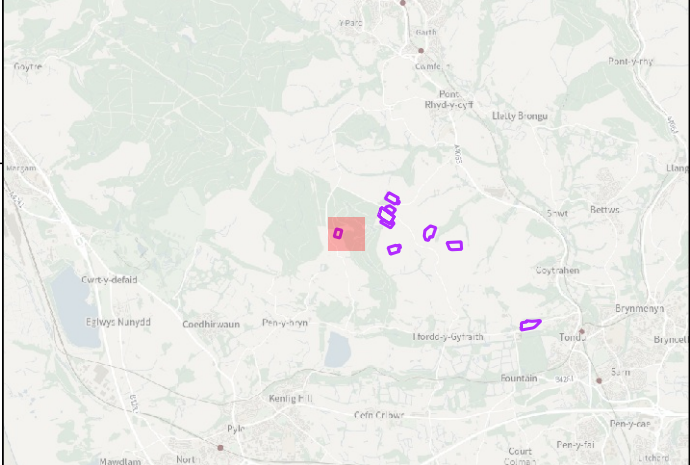
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Illus 08 - Overall interpretation of magnetometer data





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Key

 2024 Survey Extent



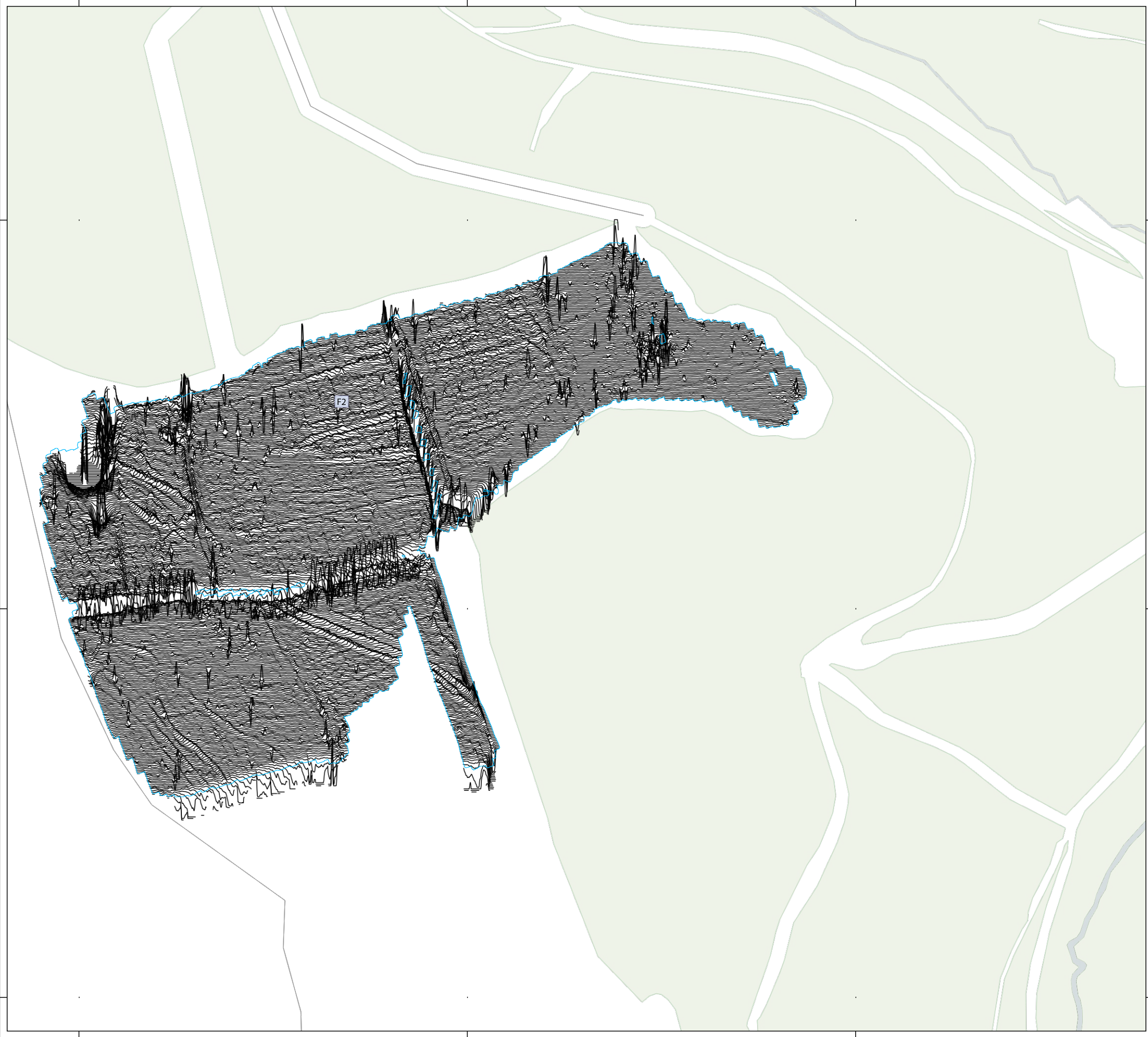
+2nT
-1nT

0 50 100 m

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Key

2024 Survey Extent

XY Trace (25nT/cm)

0

50

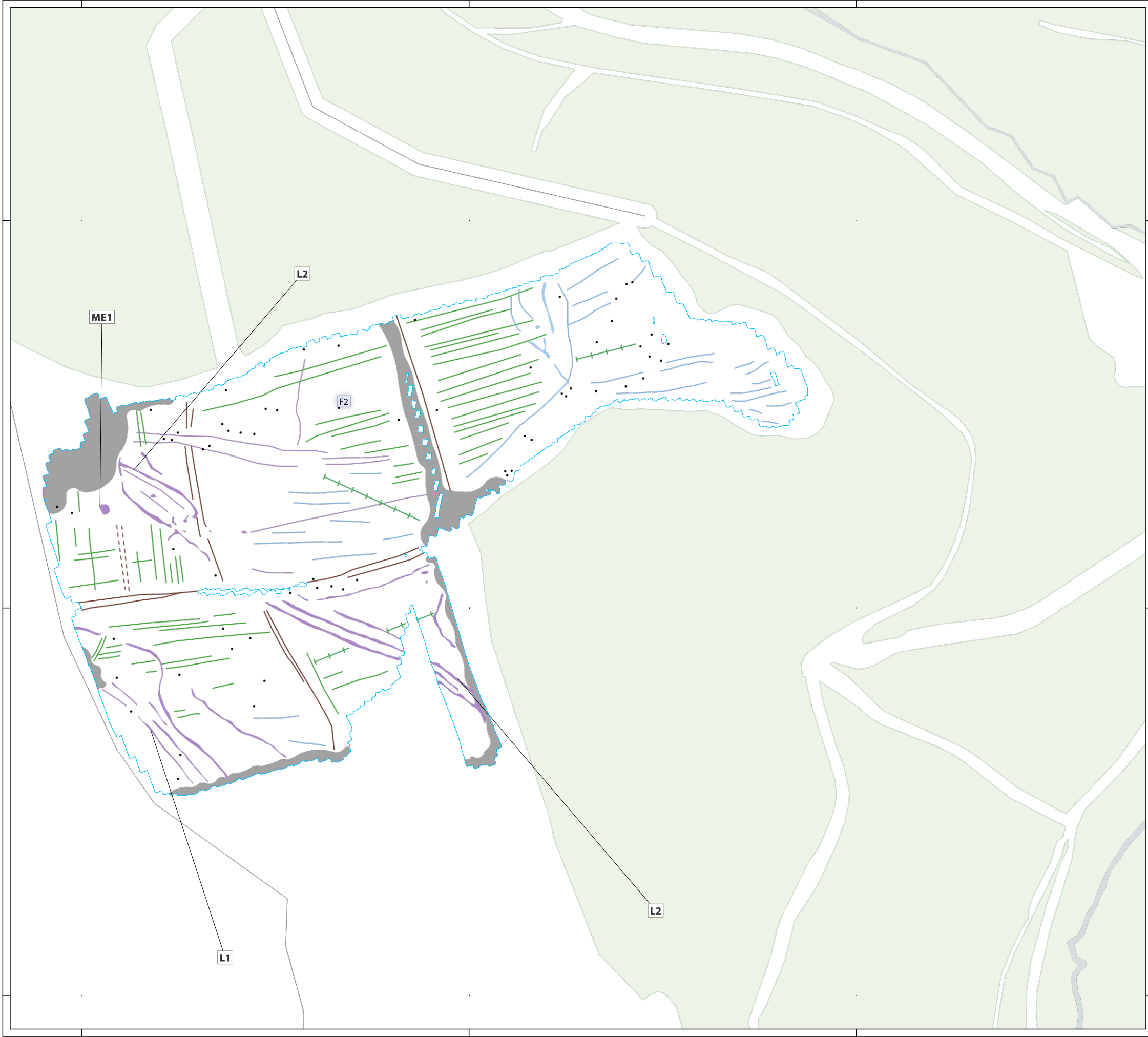
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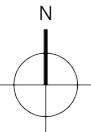
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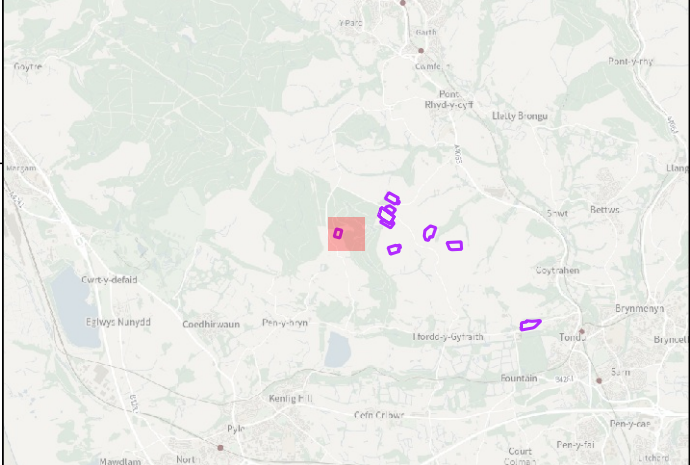
Illus - 10 XY trace plot of minimally processed magnetometer data; Sector 1







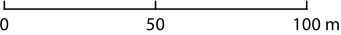
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Key

- 2024 Survey Extent
- Ferrous Objects
- Agriculture
- Field Boundary
- Possible Field Boundary
- Field Drain
- Natural
- Uncertain
- Magnetic Disturbance (Above Ground)
- Natural
- Uncertain

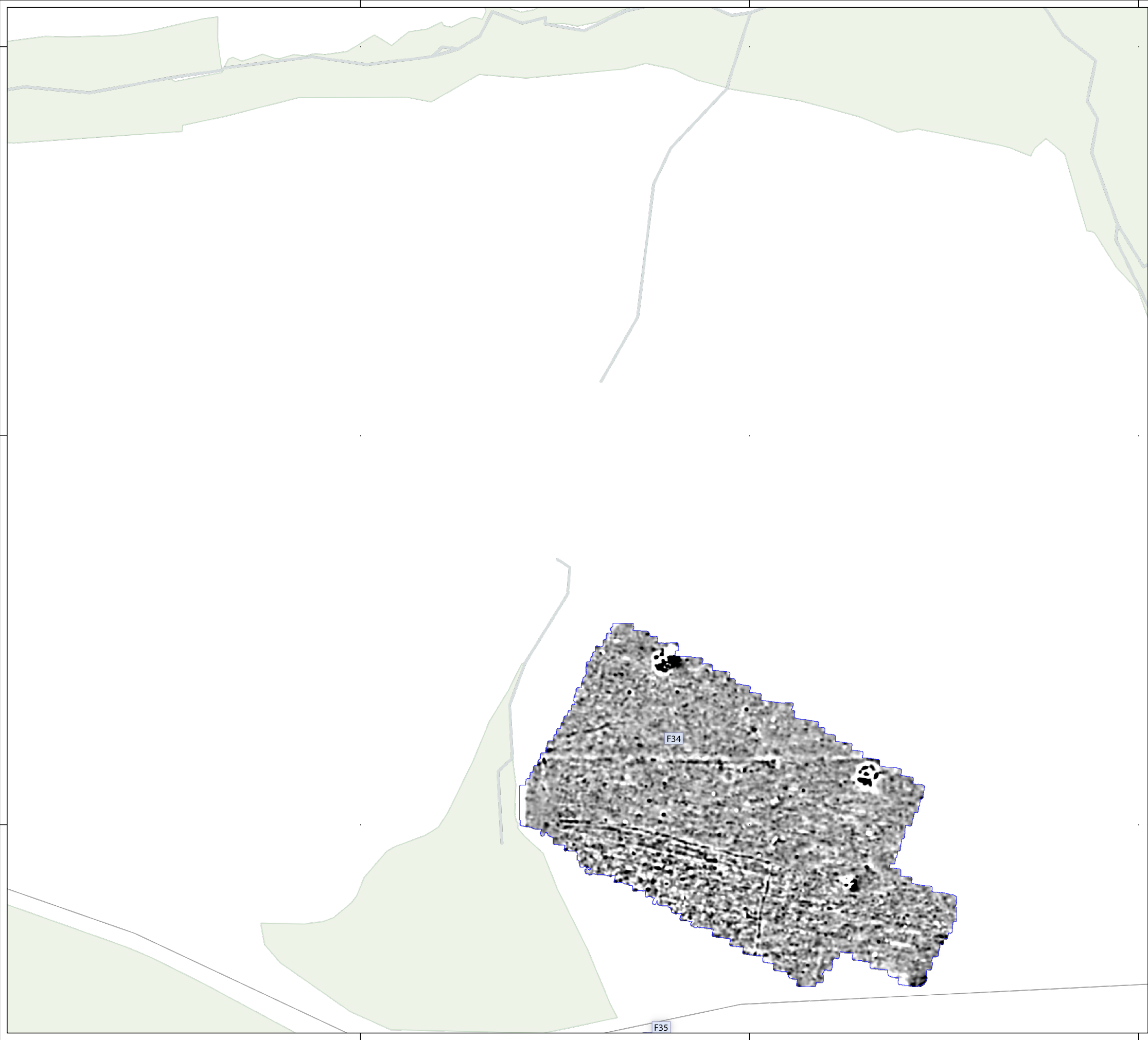
Abbreviation	
L	Linear
ME	Magnetic Enhancement

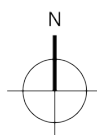


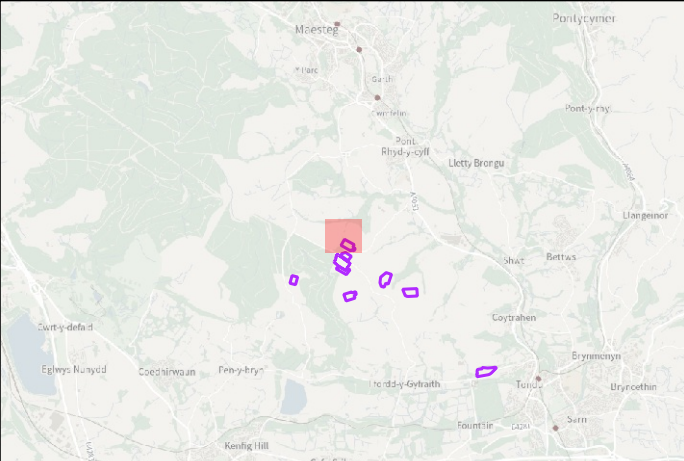
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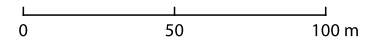






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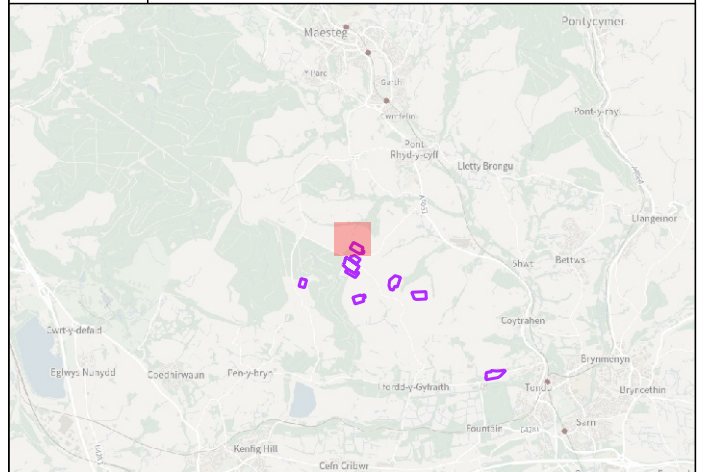
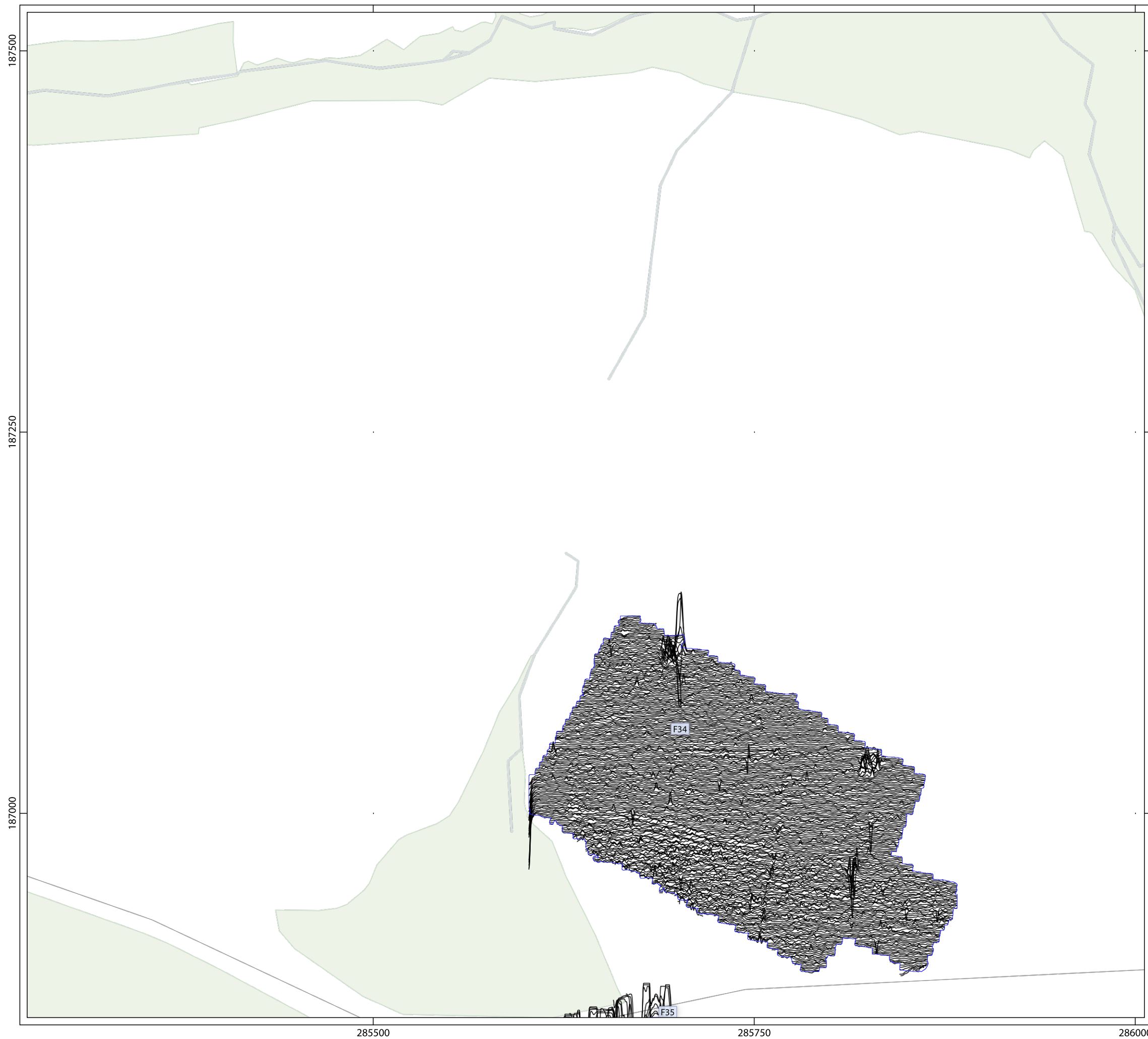
 Survey Extent



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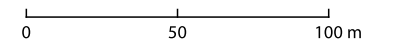
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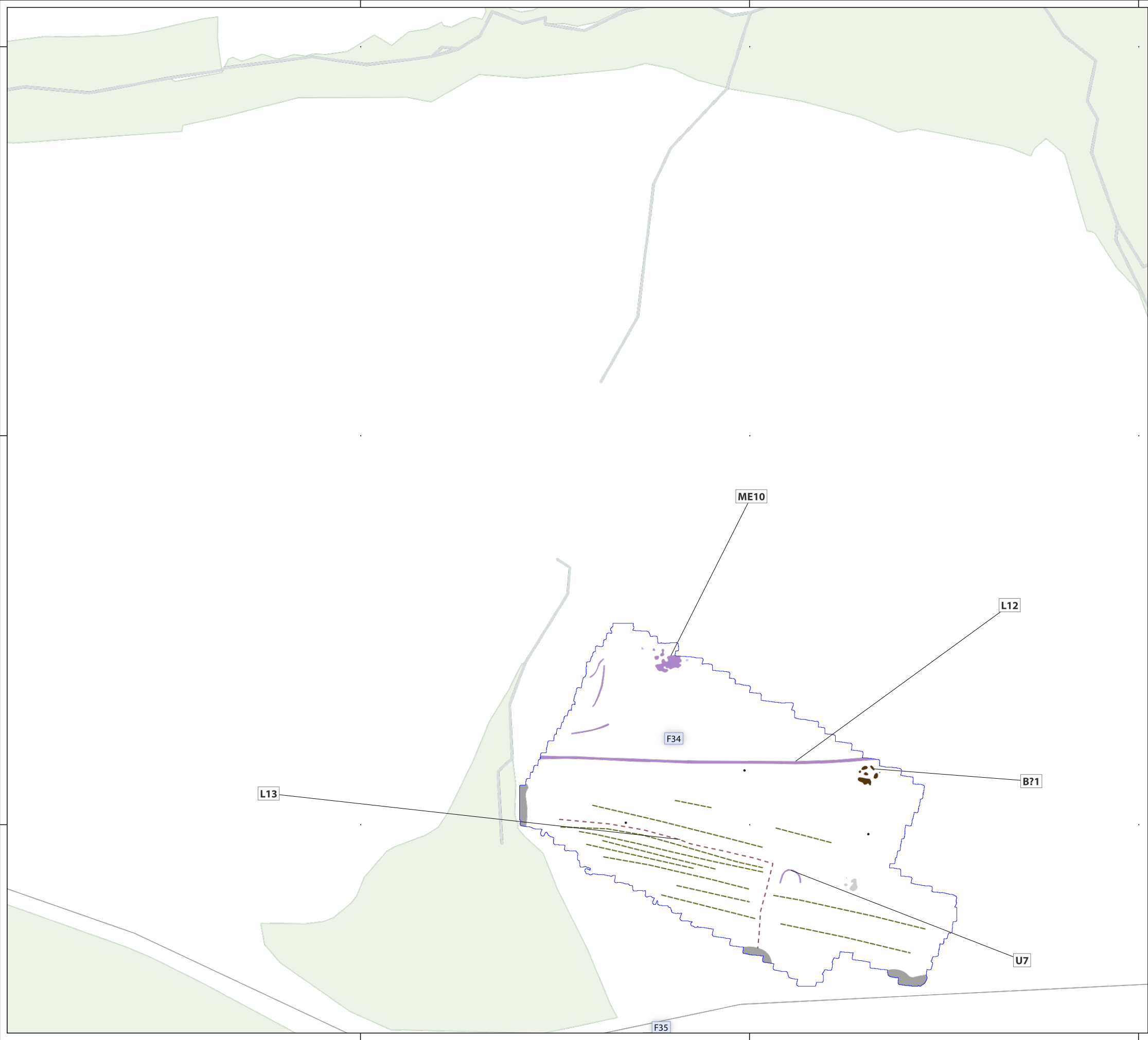
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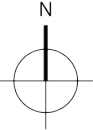


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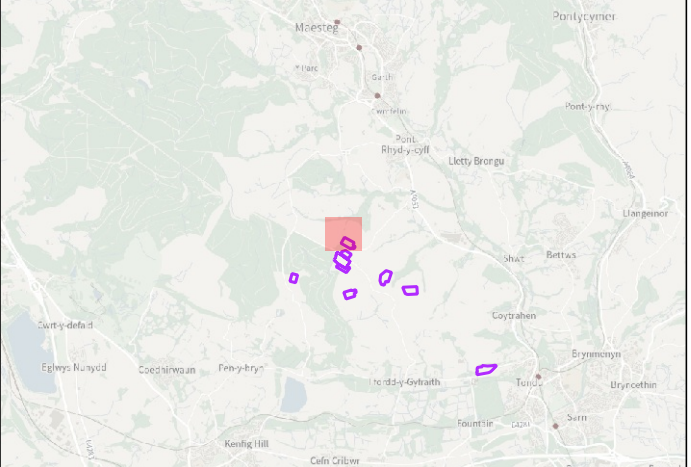
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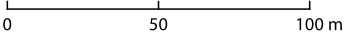
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Key

- Survey Extent
- Ferrous Objects
- Possible Field Boundary
- Ridge and Furrow
- Magnetic Disturbance (Above Ground)
- Magnetic Disturbance (Below Ground)
- Natural
- Uncertain
- Burning?

Abbreviation	
B?	Burning?
L	Linear
ME	Magnetic Enhancement
U	Uncertain

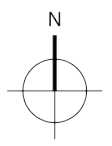


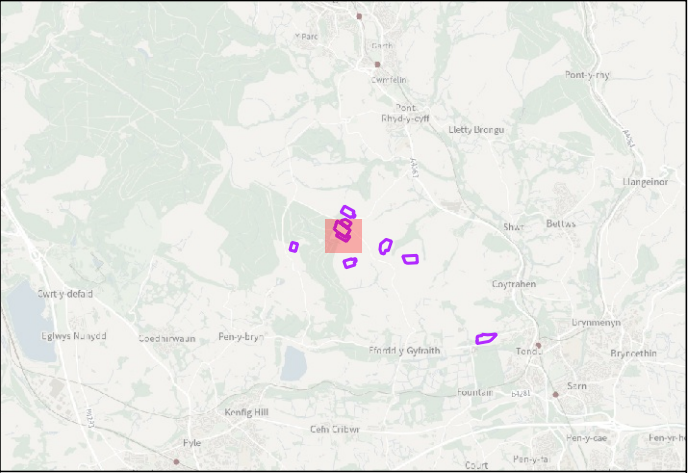
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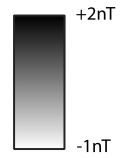
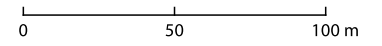






Key

- 2024 Survey Extent
- Survey Extent



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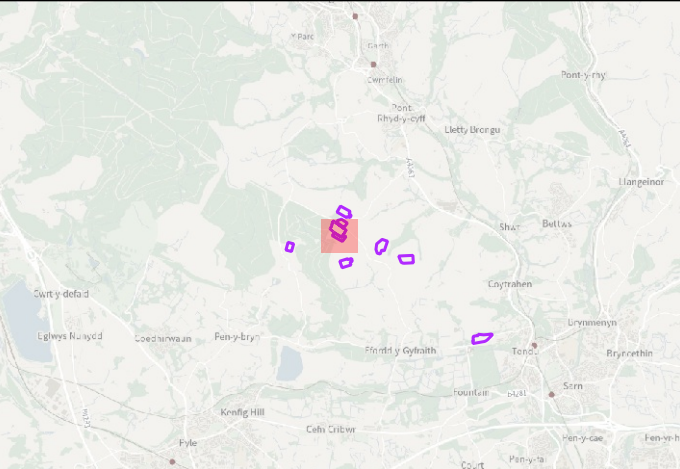
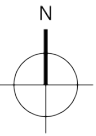
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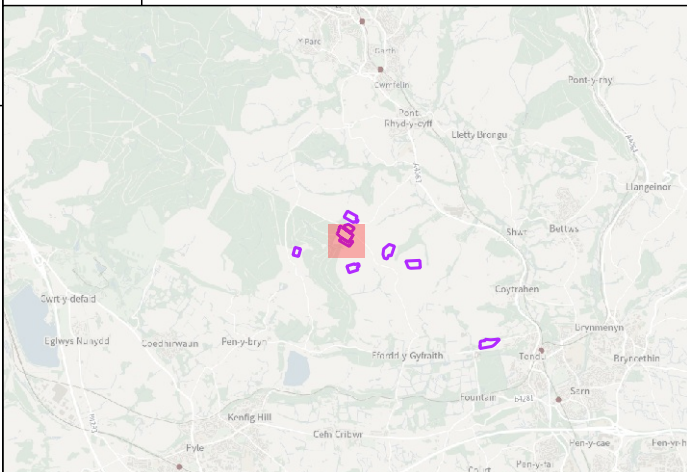
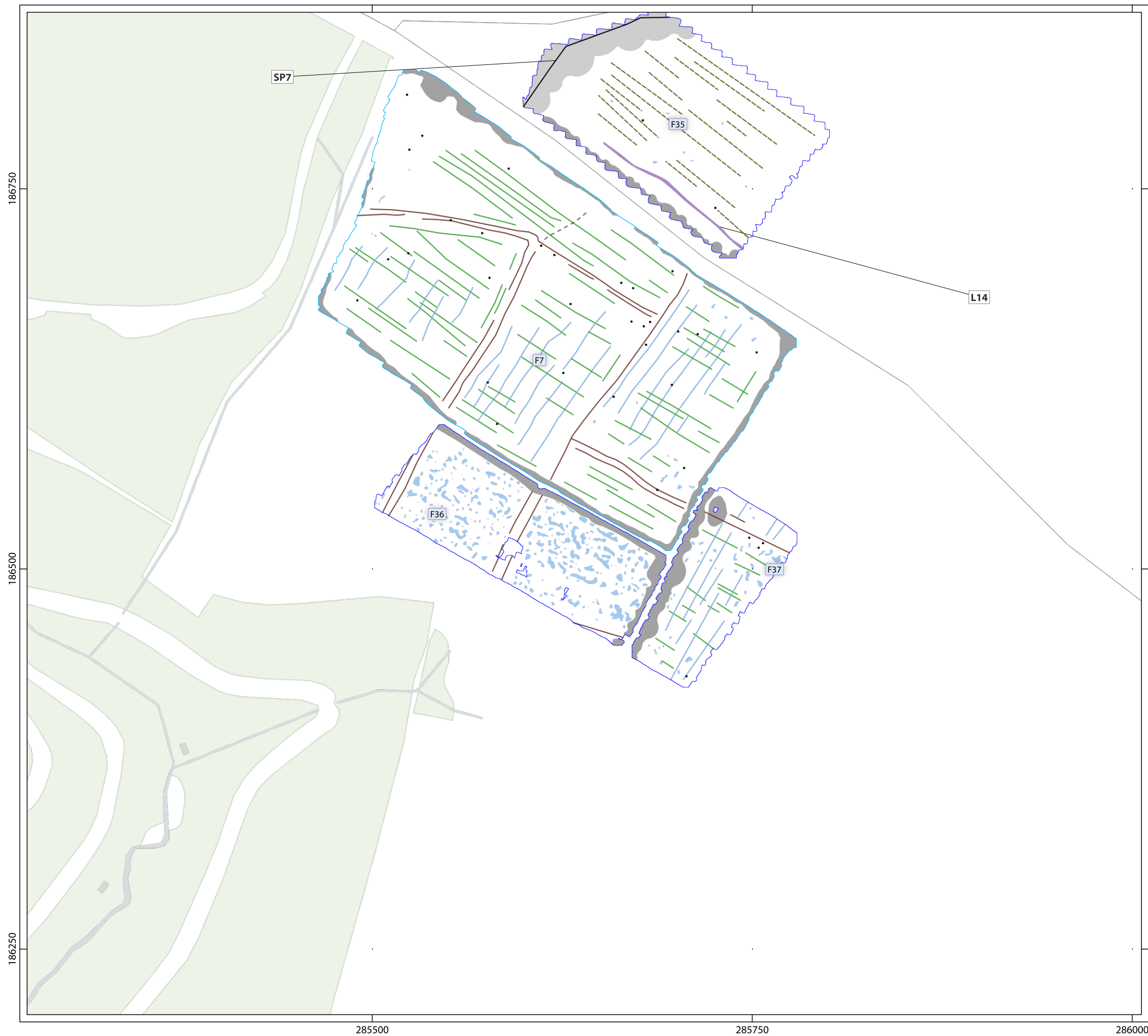


- Key
- 2024 Survey Extent
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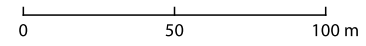
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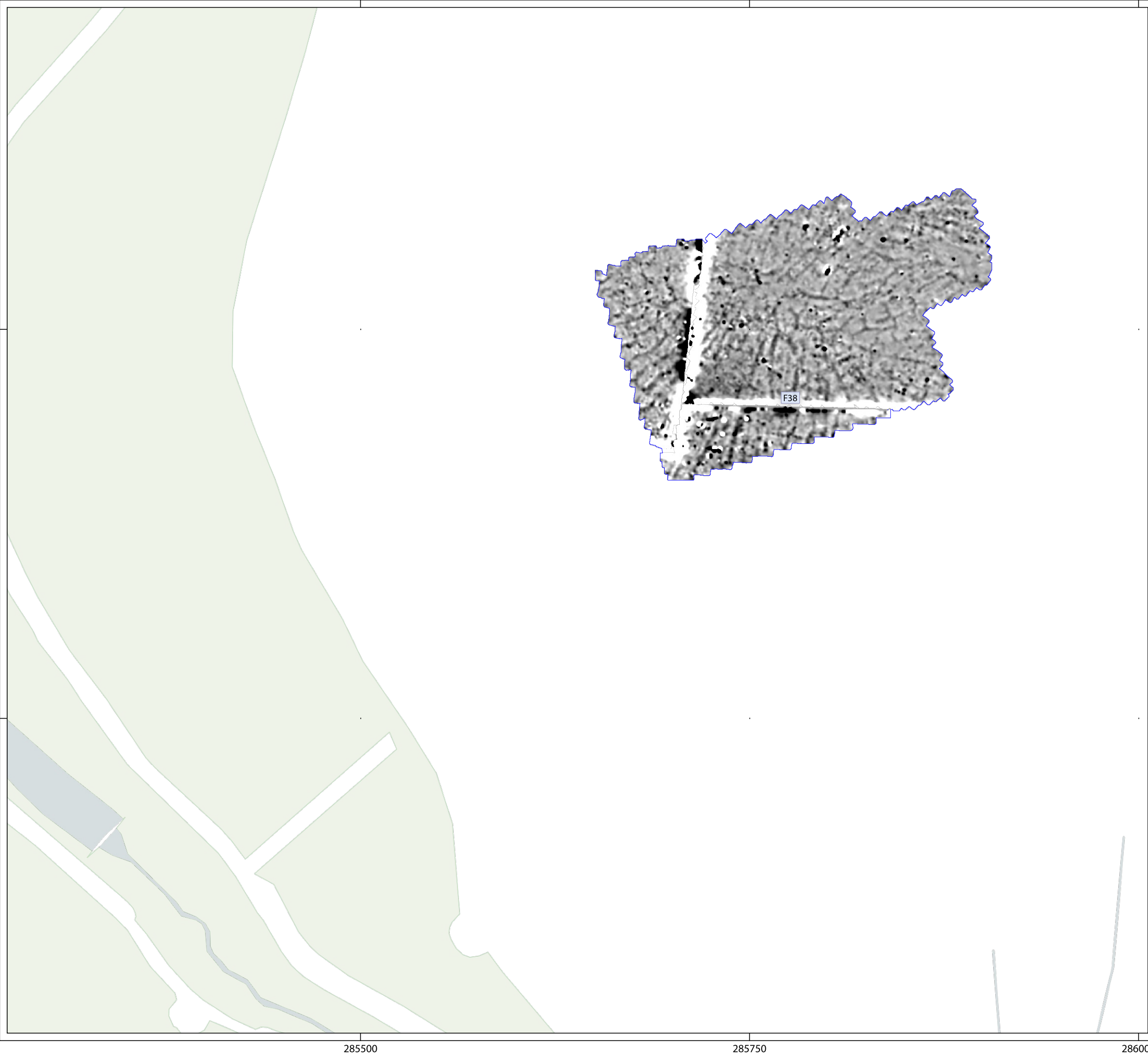
Key		Abbreviation	
	2024 Survey Extent	L	Linear
	Survey Extent	SP	Service Pipe
•	Ferrous Objects		
	Agriculture		
	Field Boundary		
	Possible Field Boundary		
	Natural		
	Service		
	Ridge and Furrow		
	Magnetic Disturbance (Above Ground)		
	Magnetic Disturbance (Below Ground)		
	Natural		
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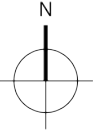


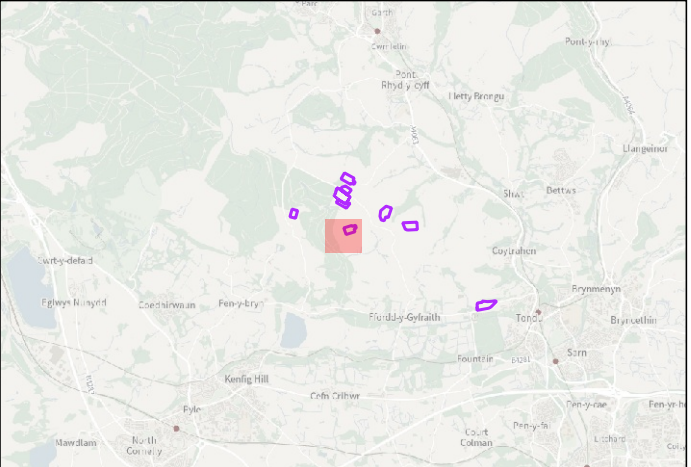
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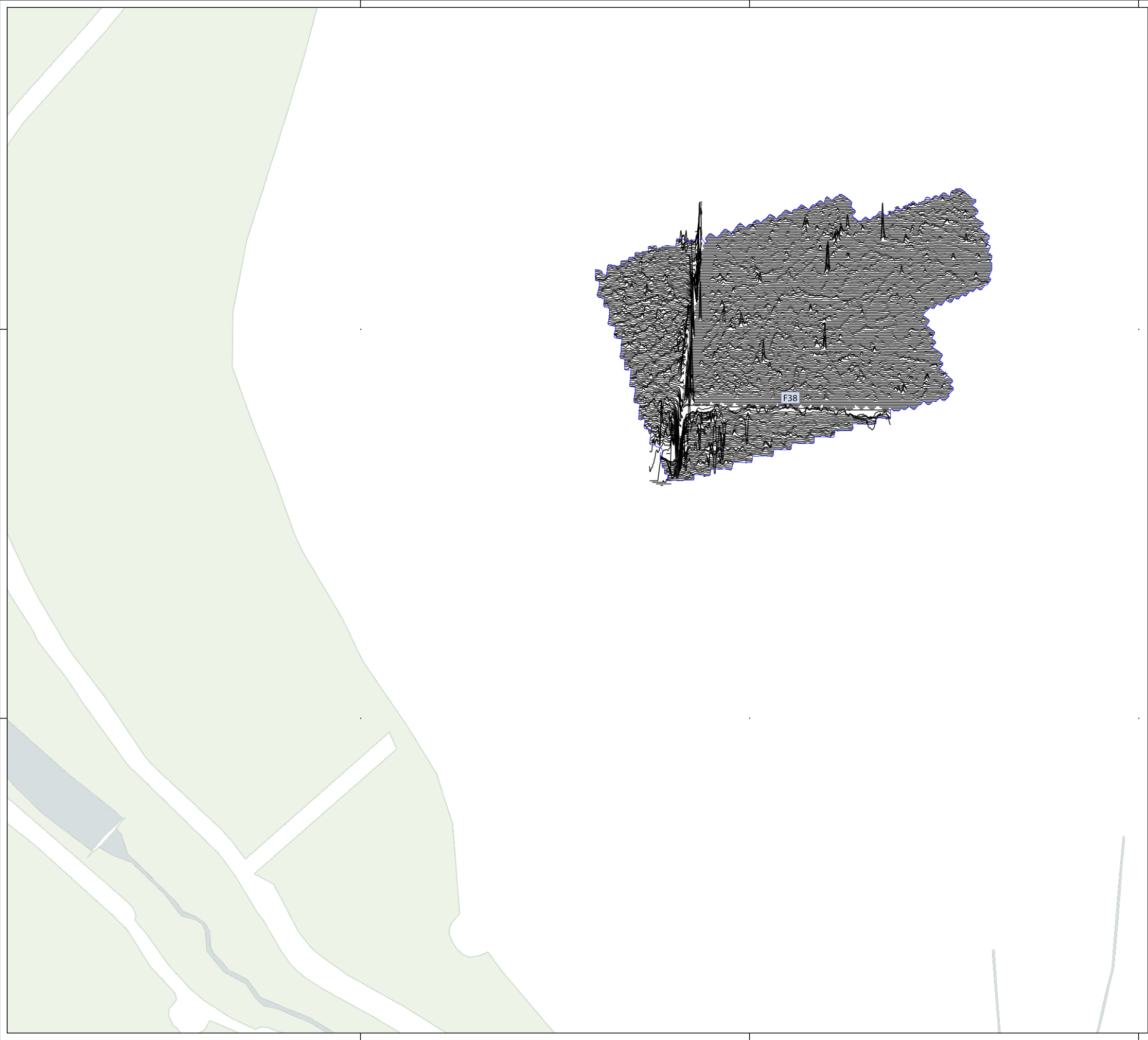


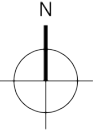
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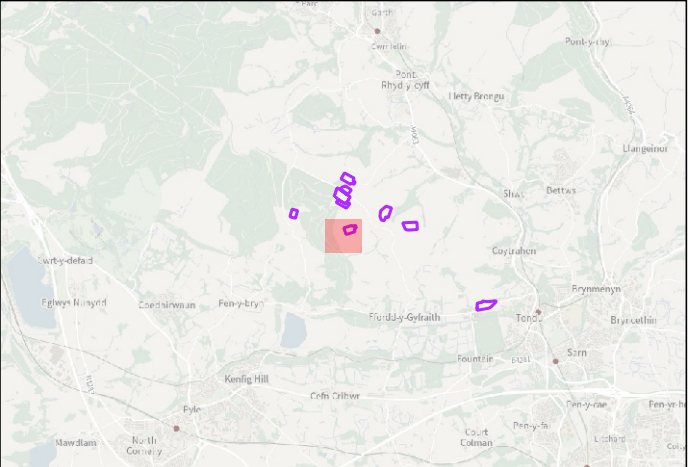
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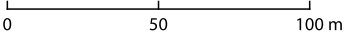






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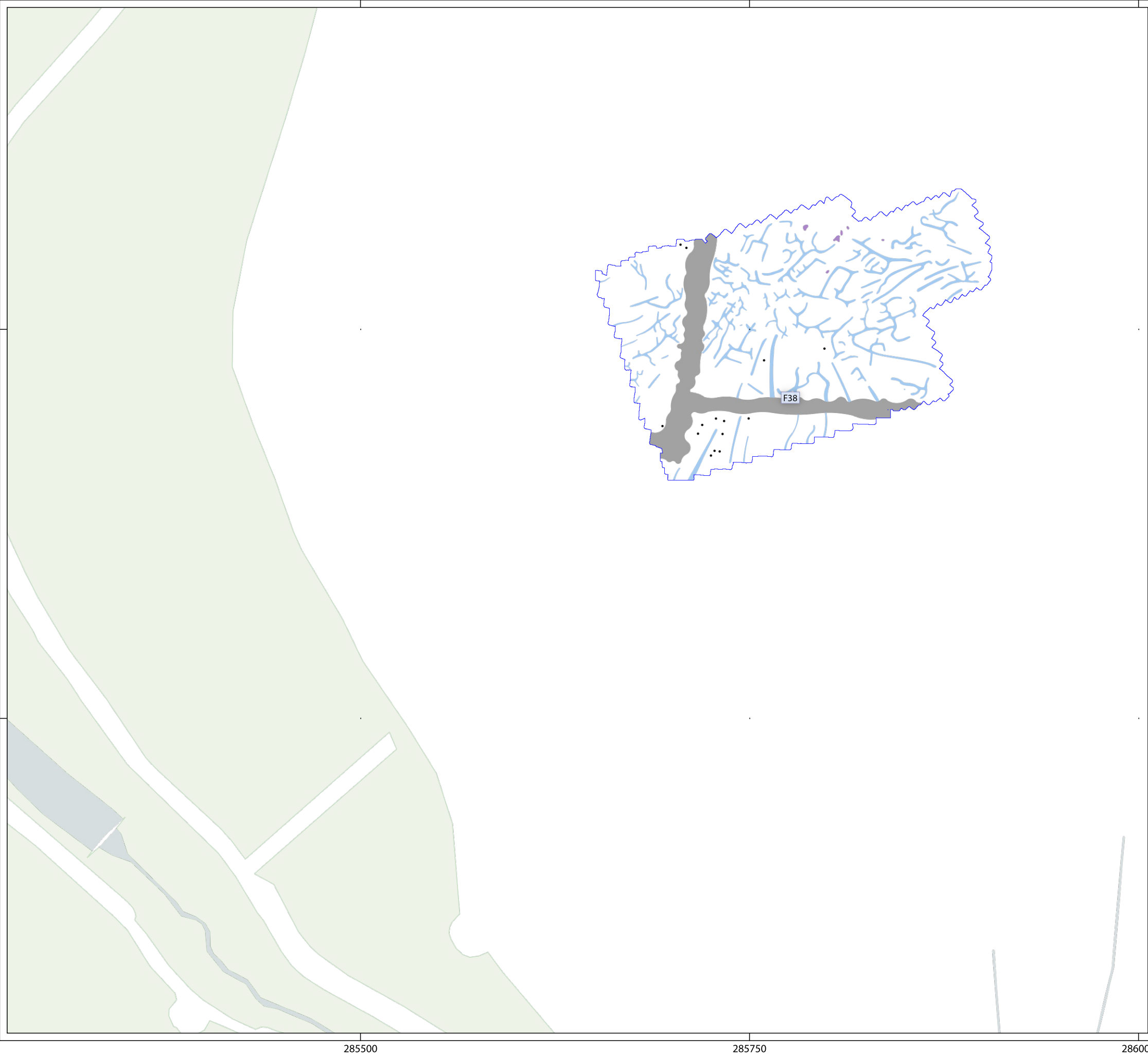
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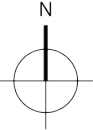


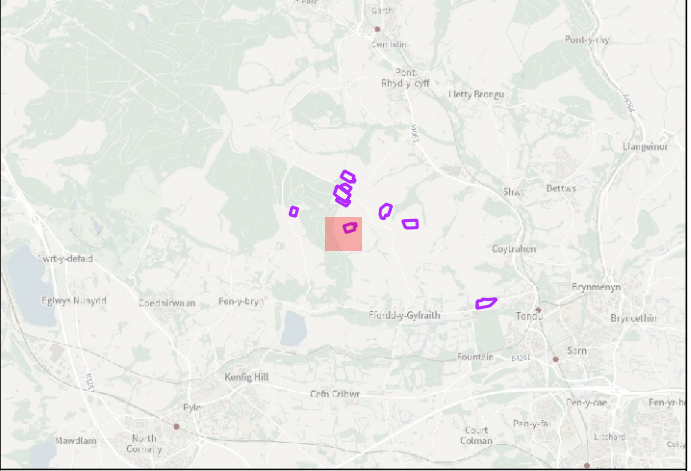
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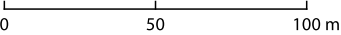






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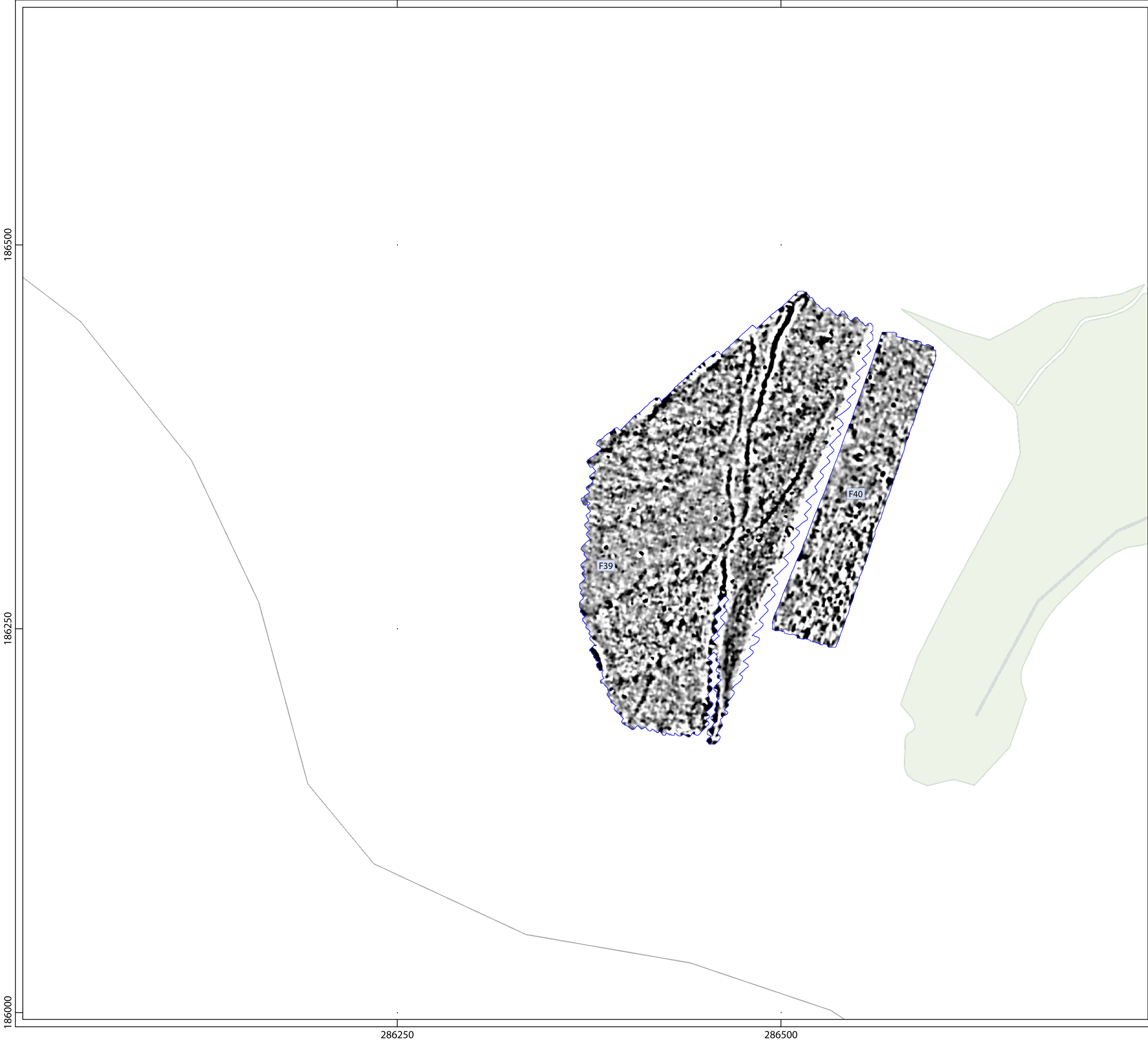
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-  Ferrous Objects
-  Magnetic Disturbance (Above Ground)
-  Natural
-  Uncertain

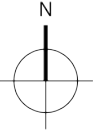


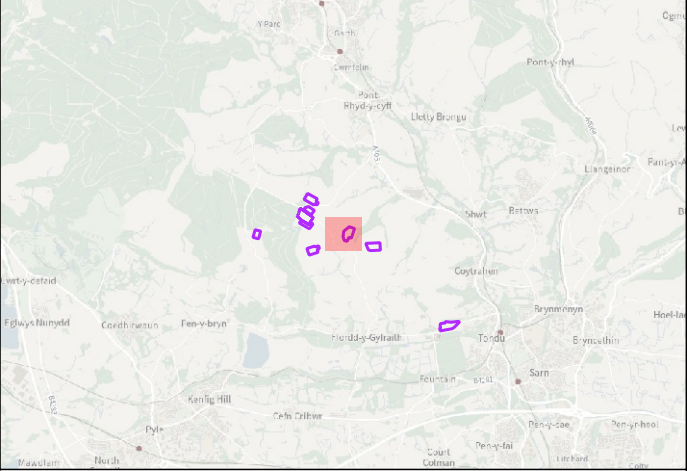
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Key

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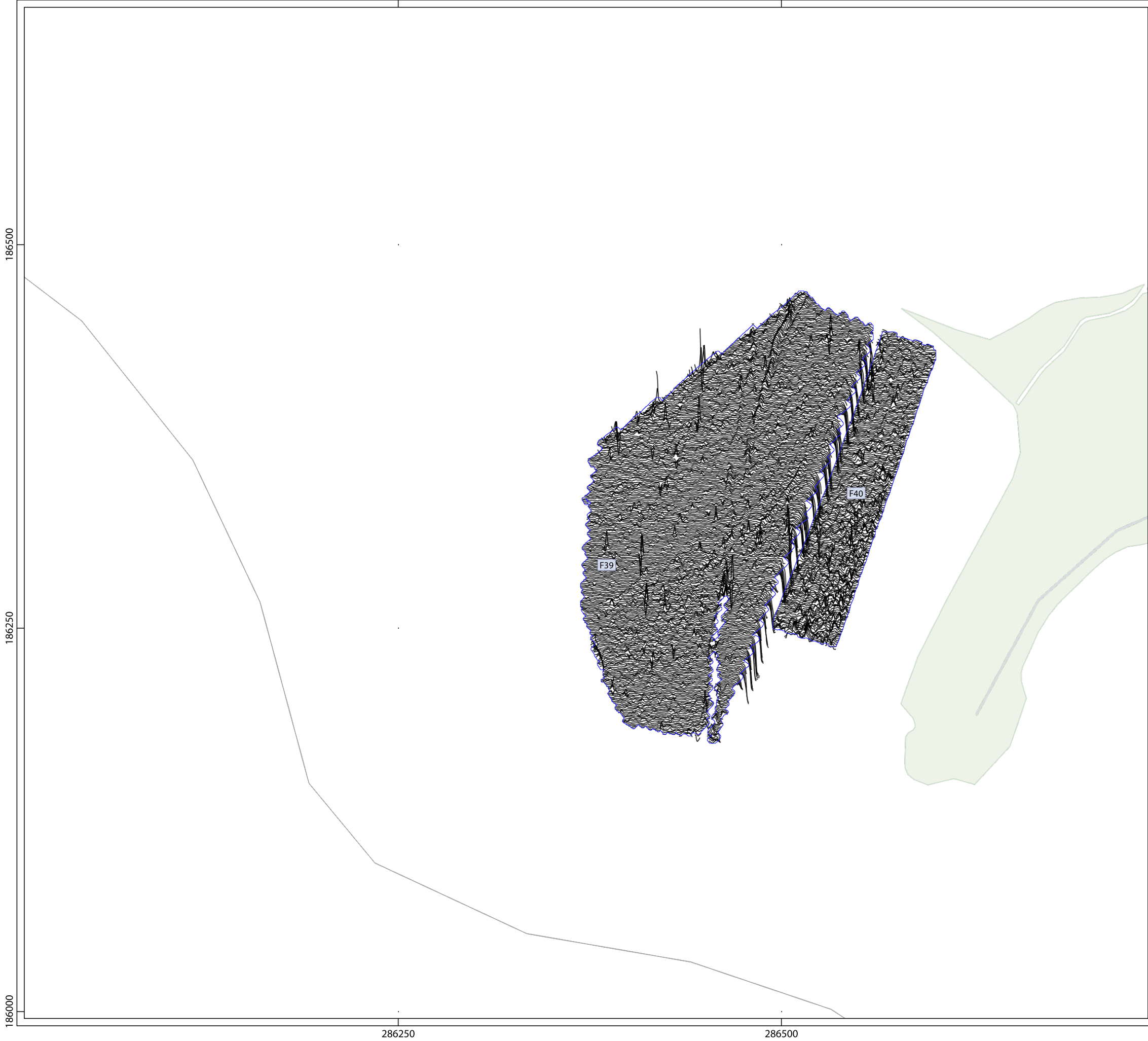


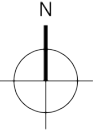
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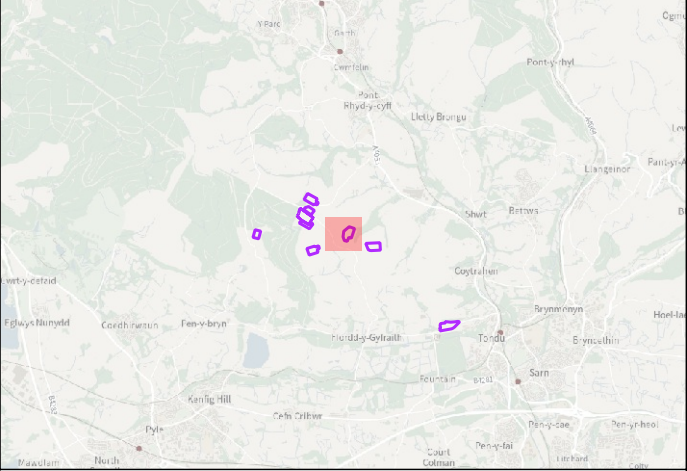
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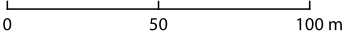




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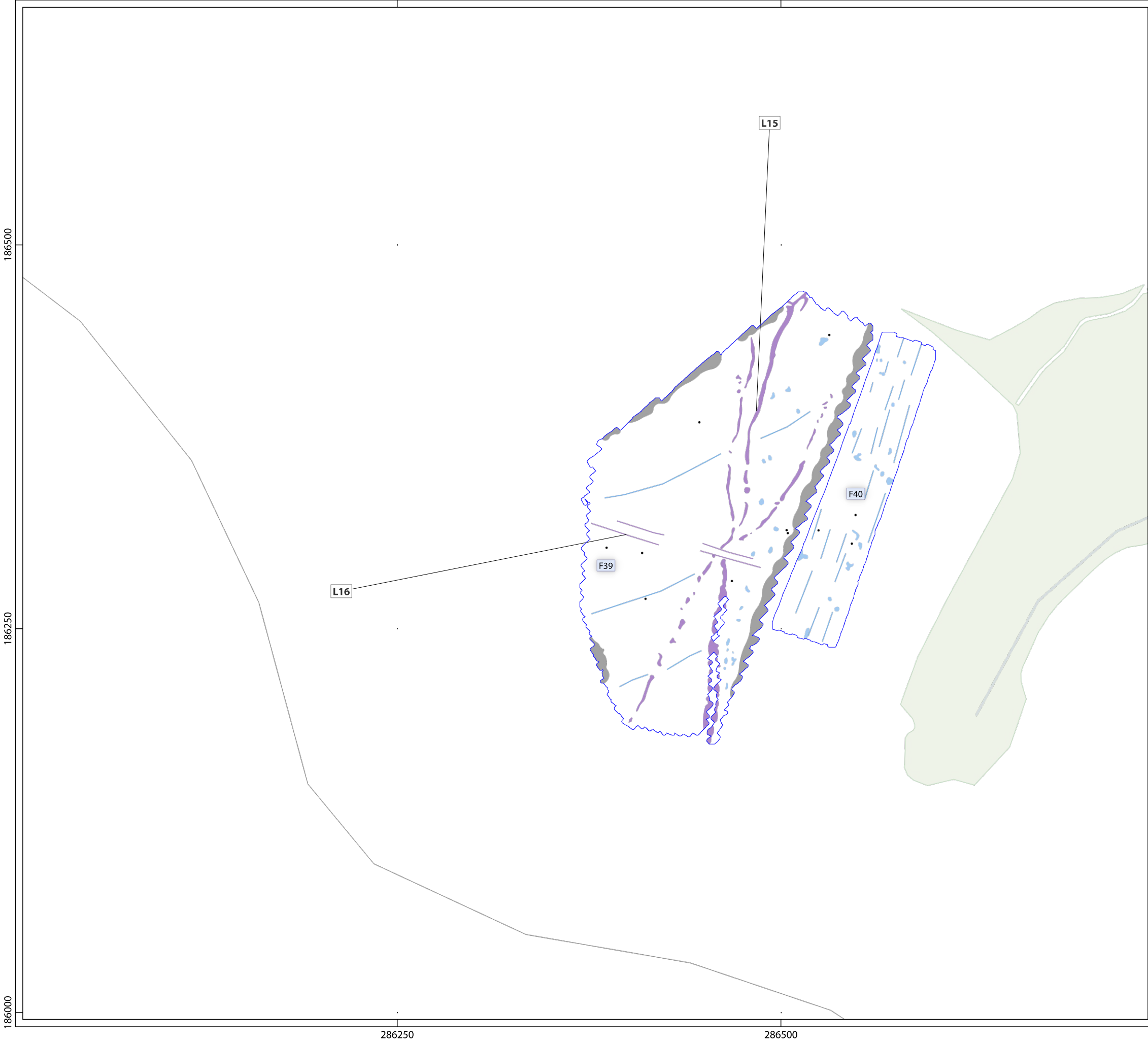
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 Survey Extent
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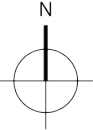


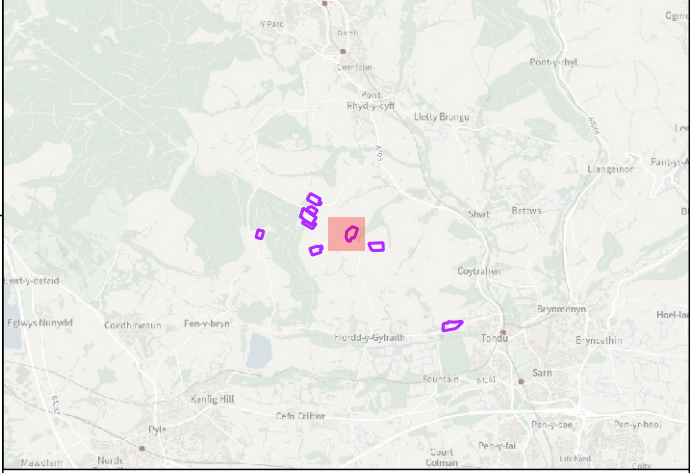
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Key

-  Survey Extent
-  Ferrous Objects
-  Natural
-  Uncertain
-  Magnetic Disturbance (Above Ground)
-  Natural
-  Uncertain

Abbreviation	
L	Linear

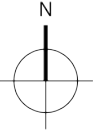
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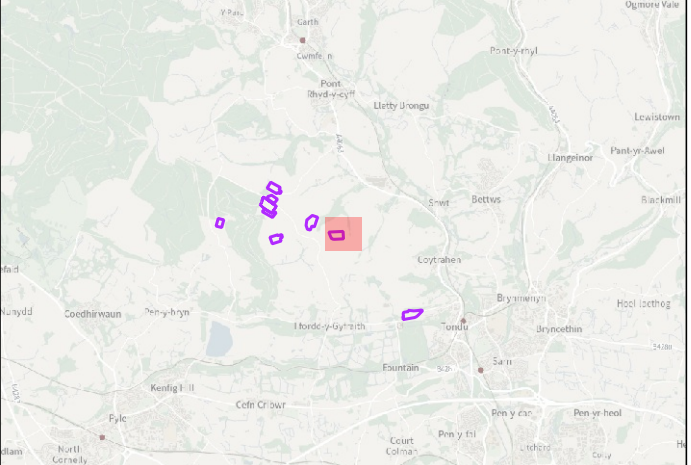
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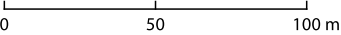




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Key
 Survey Extent



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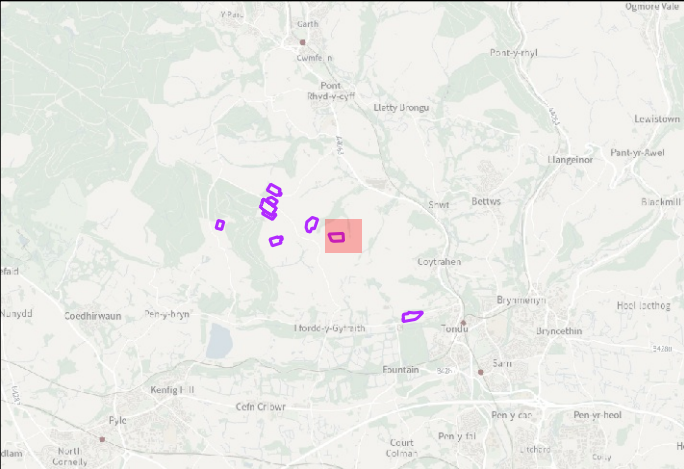
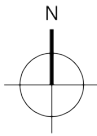
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186000

286750

287000

287250



Key
Survey Extent
XY Trace (25nT/cm)

0 50 100 m

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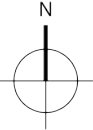
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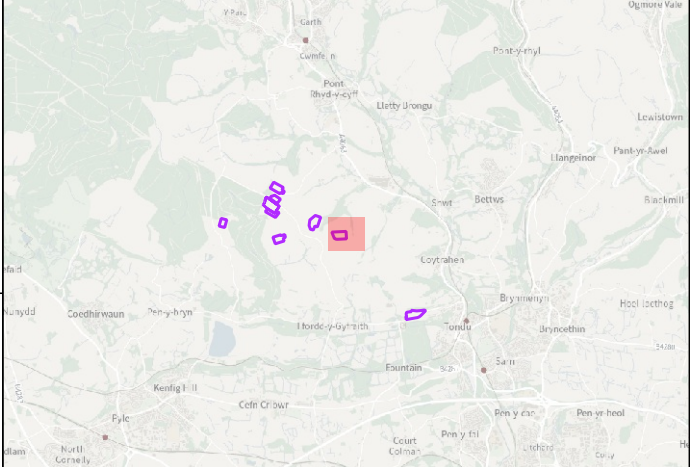
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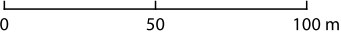


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Key

-  Survey Extent
-  Ferrous Objects
-  Magnetic Disturbance (Above Ground)
-  Burning?
-  Green Waste

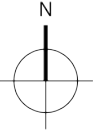


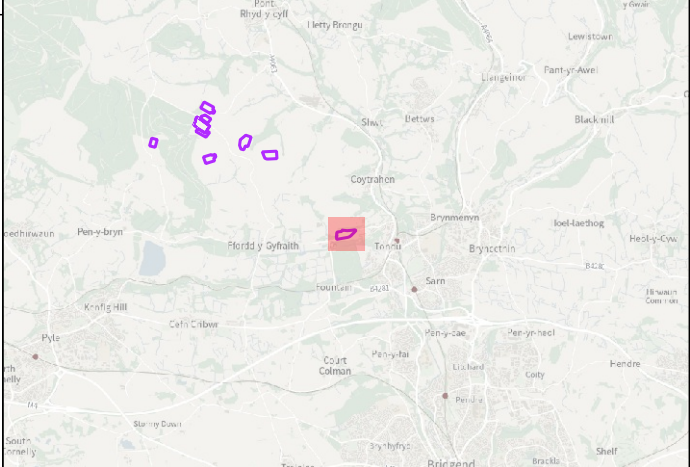
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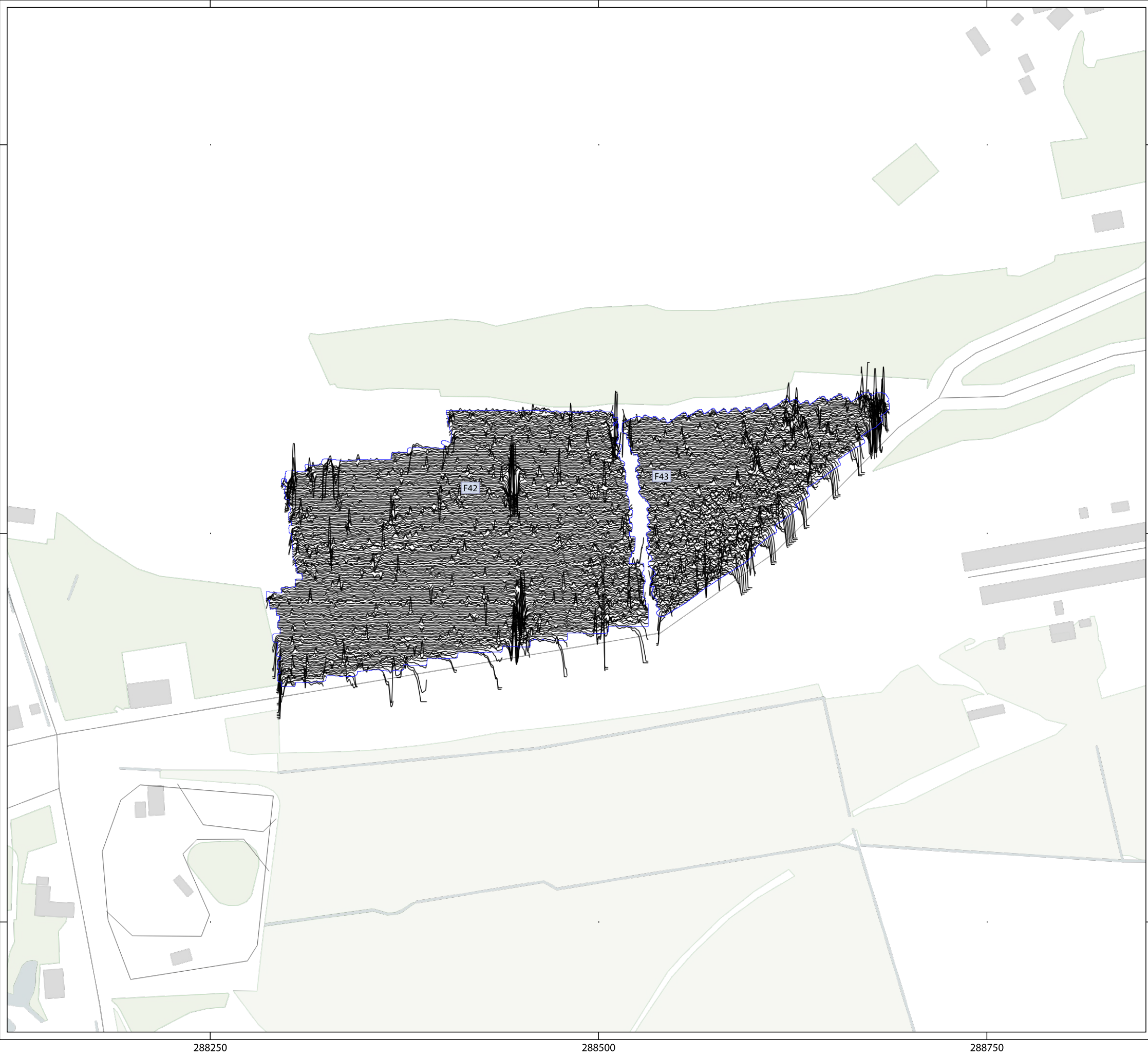


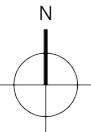
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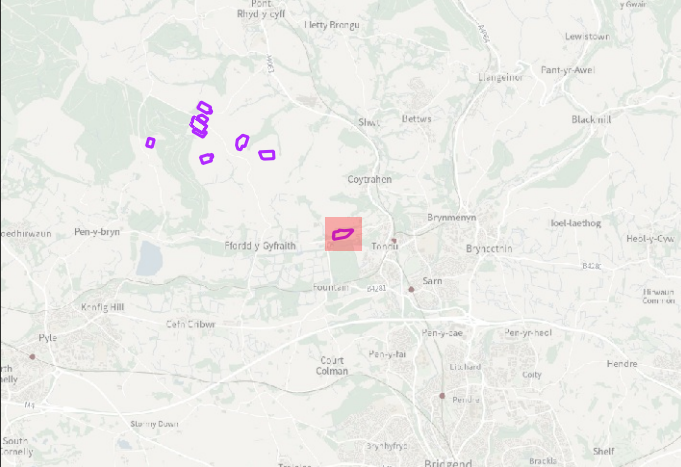
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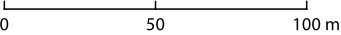


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Key

-  Survey Extent
-  XY Trace (25nT/cm)

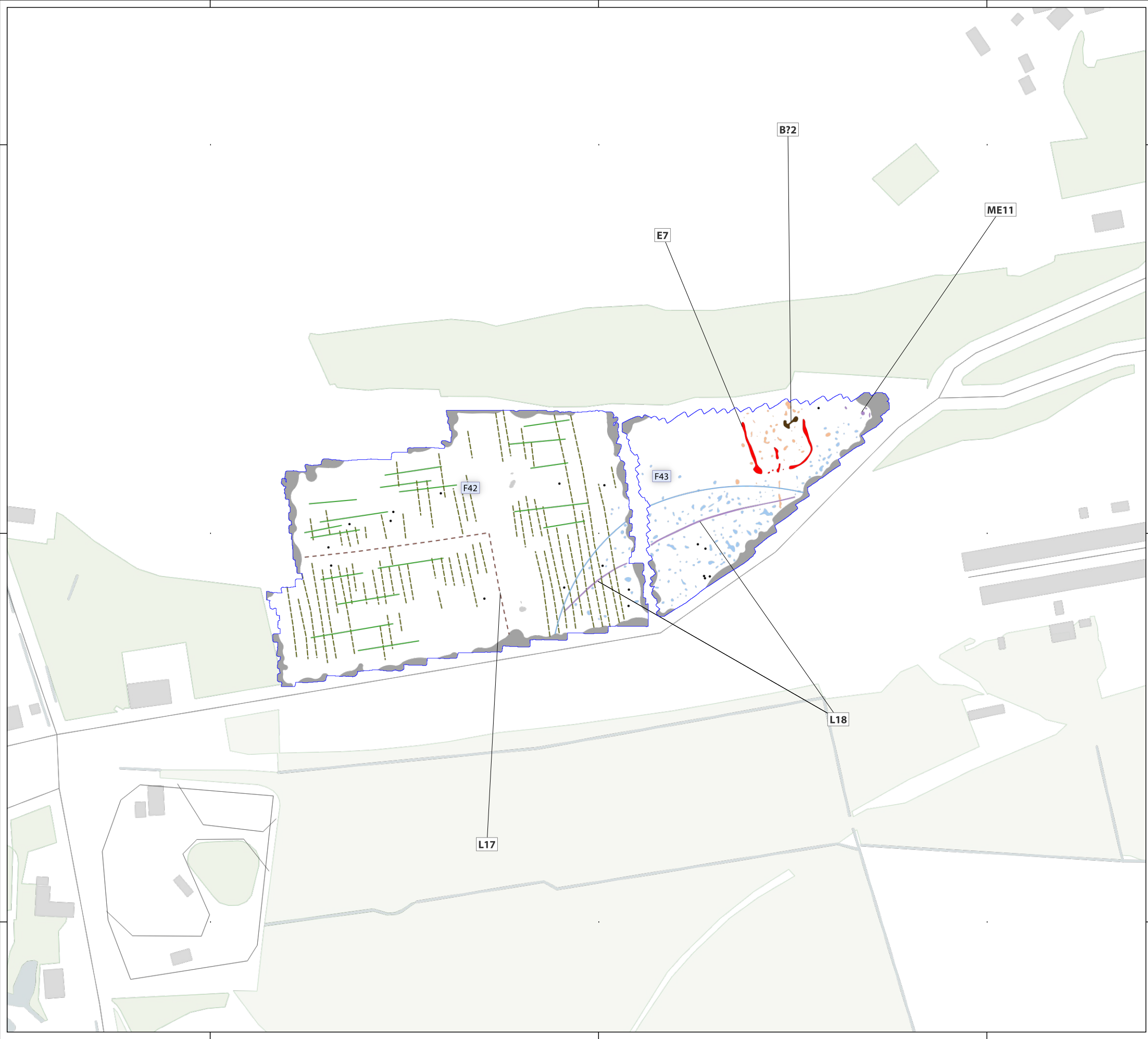


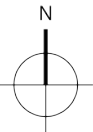
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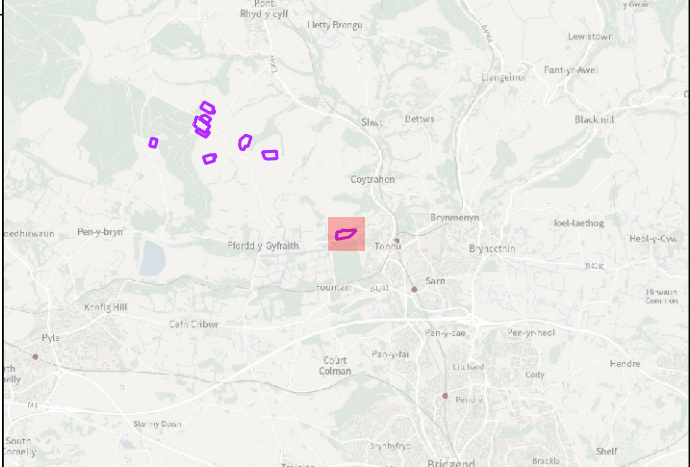
Illus - 28 XY trace plot of minimally processed magnetometer data; Sector 7







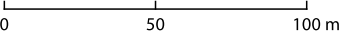
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Key

- Survey Extent
- Ferrous Objects
- Agriculture
- Possible Field Boundary
- Natural
- Ridge and Furrow
- Archaeology
- Magnetic Disturbance (Above Ground)
- Magnetic Disturbance (Below Ground)
- Natural
- Possible Archaeology
- Uncertain
- Burning?

Abbreviation	
B?	Burning?
E	Enclosure
L	Linear
ME	Magnetic Enhancement



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7. APPENDICES

APPENDIX 1 MAGNETOMETER SURVEY

Magnetic susceptibility and soil magnetism

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

In general, it is the contrast between the magnetic susceptibility of deposits filling cut features, such as ditches or pits, and the magnetic susceptibility of the topsoil, subsoil, and rock, 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 most 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 introduced into the topsoil during 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 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

The magnetometer data was georeferenced using a Trimble RTK differential Global Positioning

System (Trimble R12 model). 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 associated world file, and a PDF of the report.

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

APPENDIX 4 DATA PROCESSING

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)

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.