

Parc Solar Caenewydd, Swansea

Geophysical Survey Report

Development of National Significance in the Renewable Energy Sector
Full Re-Consultation before Applying for Planning Permission





**magnitude
surveys**

**Geophysical Survey Report
for
Parc Solar, Caenewydd,
Llewitha, Swansea**

**For
Taiyo Power & Storage Ltd**

Magnitude Surveys Ref: MSSS1328

HER Event Number: TBC

OASIS Number: TBC

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Abstract

Magnitude Surveys was commissioned to assess the subsurface archaeological potential of a c. 55.3ha area of land off Swansea Road, Llewitha, Swansea. Areas totalling c. 1.2ha could not be surveyed due to waterlogged ground, steep terrain and overgrown vegetation. A fluxgate gradiometer survey was successfully completed across the survey area. Areas in the southeast of the survey area are magnetically enhanced due to subsurface materials, and therefore may obscure any weaker anomalies if they are present. Two areas of possible archaeological activity have been identified in the north of the survey area, within Areas 13 and 15, with linear anomalies forming right-angled anomalies suggestive of partial enclosures. Anomalies indicative of historical agricultural activity have been identified as former mapped and unmapped field boundaries and ridge and furrow cultivation. Anomalies identified as modern agricultural activity have also been identified in the form of modern ploughing regimes and drainage systems. Anomalies reflective of other former land uses have been identified as possible former mineshafts, an aqueduct and a mineral railway. Natural variations have been identified throughout the majority of the survey area and are indicative of the differing soils and superficial deposits present. A sinuous band located to the south of the survey area identifies a former river channel of the Afon Llan depicted on historical maps. Anomalies without a distinct morphology and/or lacking clear context have been identified throughout the survey area and are classified as 'undetermined', although an archaeological interpretation for these anomalies cannot be excluded. The impact of modern activity is limited to fencing, buried services and ferrous debris spreads which has limited the interpretation of weaker anomalies present within these affected areas.

Abstract

Comisiynwyd Magnitude Surveys i asesu potensial archaeolegol o dan yr wyneb tua 55.3ha o dir oddi ar Swansea Road, Llewitha, Abertawe. Ni ellid arolygu ardaloedd sydd â chyfanswm o tua 1.2ha oherwydd tir dwrlawn, tirwedd serth a llystyfiant sydd wedi gordyfu. Llwyddwyd i gynnal arolwg â theclyn mesur fflwcs magnetig (fluxgate gradiometer) ar draws ardal yr arolwg. Mae'r ardaloedd yn ne-ddwyrain ardal yr arolwg wedi'u gwella'n fagnetig oherwydd deunyddiau o dan yr wyneb, ac felly gallent guddio unrhyw anghysondebau gwannach os ydynt yn bresennol. Mae gweithgarwch archaeolegol posibl wedi'i nodi mewn dwy ardal yng ngogledd ardal yr arolwg, yn Ardaloedd 13 a 15, gydag anghysondebau llinol yn ffurfio anghysondebau sgwaronglog sy'n awgrymu amgaeadau rhannol. Mae anghysondebau sy'n dangos gweithgarwch amaethyddol hanesyddol wedi'u nodi fel hen ffiniau caeau wedi'u mapio a heb eu mapio, ac amaethu cefnen a rych. Mae anghysondebau a nodwyd fel gweithgarwch amaethyddol modern hefyd wedi'u nodi ar ffurf systemau aredig a systemau draenio modern. Mae anghysondebau sy'n adlewyrchu defnyddiau tir blaenorol eraill wedi'u nodi fel hen siafftau pwll, traphont ddŵr a rheilffordd fwynau. Mae amrywiadau naturiol wedi'u nodi drwy'r rhan fwyaf o ardal yr arolwg ac maen nhw'n dangos y priddoedd a'r dyddodion arwynebol gwahanol sy'n bresennol. Mae tro dolennog i'r de o ardal yr arolwg yn nodi hen sianel Afon Llan a ddangosir ar fapiau hanesyddol. Mae anghysondebau heb forffoleg benodol a/neu heb gyd-destun clir wedi'u nodi drwy ardal yr arolwg ac maen nhw'n cael eu trin fel rhai 'amhenodol', er na ellir eithrio dehongliad archaeolegol o'r anghysondebau hyn. Mae effaith gweithgarwch modern yn gyfyngedig i ffensys, cyfleustodau wedi'u claddu a gweddillion fferrus yn ymledu. Mae hynny wedi cyfyngu ar y dehongliad o'r anghysondebau gwannach sy'n bresennol yn yr ardaloedd hyn yr effeithir arnynt.

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1. Introduction

- 1.1. Magnitude Surveys has been appointed by Taiyo Power & Storage Limited (herein referred to as “the Applicant”) to undertake a Geophysical Survey Report for a proposed Non-EIA¹ utility-scale solar and battery storage facility on land fronting the A484 and Swansea Road (B4560) at Gowerton, Swansea. It will deliver a host of landscape, biodiversity, soil and hydrological enhancements, including measures to strengthen habitat connectivity through this part of the valley, the creation of green buffer zones and public right of ways improvements. The development is called ‘Parc Solar Caenewydd’.
- 1.2. This draft Geophysical Survey Report is being published to accompany a pre-application consultation carried out under Articles 8 and 9 of the Development of National Significance (Procedure) (Wales) Order 2016.
- 1.3. Magnitude Surveys Ltd (MS) was commissioned by Taiyo Power & Storage Ltd to undertake a geophysical survey over a c. 55.3ha area of land off Swansea Road, Llewitha, Swansea (SS60342 97186).
- 1.4. The geophysical survey comprised of a quad-towed and hand-carried GNSS-positioned fluxgate gradiometer survey. Magnetic survey is the standard primary geophysical method for archaeological applications in the UK due to its ability to detect a range of different features. The technique is particularly suited for detecting fired or magnetically enhanced features, such as ditches, pits, kilns, sunken featured buildings (SFBs) and industrial activity (David *et al.*, 2008).
- 1.5. The survey was conducted in line with the current best practice guidelines produced by Historic England (David *et al.*, 2008), the Chartered Institute for Archaeologists (CifA, 2020) and the European Archaeological Council (Schmidt *et al.*, 2015).
- 1.6. It was conducted in line with a WSI produced by MS (Terry 2022) and submitted and accepted by GGAT.
- 1.7. The survey was undertaken over two deployments; The first commenced on 11/7/2022 and took three days to complete. The second deployment commenced on 14/11/2022 and took 3 days to complete.

2. Quality Assurance

- 2.1. Magnitude Surveys is a Registered Organisation of the Chartered Institute for Archaeologists (CifA), the chartered UK body for archaeologists, and a corporate member of ISAP (International Society for Archaeological Prospection).
- 2.2. The directors of MS are involved in cutting edge research and the development of guidance/policy. Specifically, Dr Chrys Harris has a PhD in archaeological geophysics from the University of Bradford, is a Member of CifA and has served as the Vice-Chair of the International Society for Archaeological Prospection (ISAP); Finnegan Pope-Carter has an MSc in archaeological geophysics and is a Fellow of the London Geological Society, as well as a member

¹ On 17 August 2022, Planning & Environmental Decision Wales adopted its Environmental Impact Assessment (EIA) Screening Direction. The Welsh Ministers direct that the development is not EIA development within the meaning of the Regulations

of GeoSIG (ClfA Geophysics Special Interest Group); Dr Paul Johnson has a PhD in archaeology from the University of Southampton, is a Fellow of the Society of Antiquaries of London and a Member of ClfA, has been a member of the ISAP Management Committee since 2015, and is currently the Chair of the Archaeological Prospection Community of the European Archaeological Association.

- 2.3. All MS managers, field and office staff have degree qualifications relevant to archaeology or geophysics and/or field experience.

3. Objectives

- 3.1. The objective of this geophysical survey was to assess the subsurface archaeological potential of the survey area.

4. Geographic Background

- 4.1. The survey area was located c. 420m northeast of Tre-gwyr (Figure 1). A Gradiometer survey was undertaken across a mixture of pasture and arable fields. The survey area was bordered to the north and east by the B4620, by Stafford common and Kingsbridge Cemetery to the northwest, to the south by a river and an industrial estate, and to the west by a water treatment works (Figure 2). Approximately 1.2ha of land in the north and south could not be surveyed due to steep terrain, overgrown vegetation and waterlogged ground.

- 4.2. Survey considerations:

Survey Area	Ground Conditions	Further Notes
1	The area consisted of pasture sloping down from the north.	The field continued beyond the survey area to the north and southwest and was bordered to the east, south and west by hedges.
2	The area consisted of pasture sloping down from the north	The field continued beyond the survey area to the north, south and west and was bordered to the east by hedges.
3	The area consisted of pasture sloping down from the north.	The field continued beyond the survey area to the north and west and was bordered to the east by hedges and to the south by wire fencing.
4	The area consisted of pasture sloping down from the northeast.	The field continued beyond the survey area to the north, east and west and was bordered to the south by hedges and trees.
5	The area consisted of pasture gently sloping down from the north.	The area was bordered to the north, east and south by hedges and to the west by hedges and a wire fence. A gravel path was identified within the centre of the survey area running down to a small pool within the south.
51	The area consisted of pasture gently sloping down from the north.	The area was bordered to the north, south and west by hedges and to the east by trees.
6	The area consisted of pasture sloping down from the north.	The area was bordered to the north and east by hedges and trees and continued beyond the survey area to the south and west.

601	The area consisted of pasture sloping down from the north.	The area was bordered to the north by hedges, trees and metal fencing, by hedges and trees to the northeast, southeast and south, by overgrown vegetation to the east and continued beyond the survey area to the west.
70	The area consisted of pasture sloping down from the north.	The field continued in all directions beyond the survey area.
71	The area consisted of pasture sloping down from the east.	The field continued to the north, east and south beyond the survey area and was bordered by overgrown vegetation to the west.
8	The area consisted of pasture sloping down from the east.	The area was bordered to the north, east and south by hedges. The field continued to the west beyond the survey extent.
91	The area consisted of pasture sloping down from the north.	The field continued in all directions beyond the survey area. Tracks were identified running across the north of the survey area in an east-west orientation.
92	The area consisted of flat pasture.	The field continued in all directions beyond the survey area. Tracks were identified running across the north of the survey area in an east-west orientation.
10	The area consisted of pasture sloping down from the northeast.	The area was bordered to the north, east and west by hedges, trees and wire fencing and the field continued beyond the survey area to the south.
11	The area consisted of mostly flat pasture, with a small slope present within the east sloping down from the west.	The area was bordered to the north, east, south and southwest by hedges and to the northwest by a wire fence. A feeding trough and tractor was identified within the west of the survey area.
12	The area consisted of pasture sloping down from the east.	The area was bordered to the north and south by hedges and continued beyond the survey extent to the east and south.
13	The area consisted of pasture sloping down from the east to the west. Two small areas within the north and south of the survey area could not be surveyed due to overgrown vegetation.	The area was bordered to the north, east and west by hedges and to the south by hedges and a stream.
14	The area consisted of a flat pasture field	The area was bordered to the north and west by wire fencing, hedges and trees and to the east and south by wire fencing.
15	The area consisted of pasture gently sloping down from the south.	The field continued to the north and west beyond the survey area and was bordered to the east by wire fencing, hedges and trees and to the south by wire fencing. Hedges and trees, a quarry, farming equipment and a trough were located within the south.
16	The area consisted of pasture gently sloping down from the northeast. The south of the	The area was bordered to the north and east fences and hedges and to the south and west by

	survey area could not be surveyed due to the steep terrain and overgrown vegetation.	wire fencing. Housing was located adjacent to the north of the survey area.
17	The area consisted of pasture sloping down from the west. The east of the survey area could not be surveyed due to the steep terrain.	The area was surrounded by trees and a metal fence. A water treatment plant was identified adjacent to the southeast of the survey area.
1801	The area consisted of an arable field with pumpkins in, sloping down to the southwest and east.	The area was bordered by hedges and trees to the north, east and west, with the field continuing to the south. A farmyard was located adjacent to the area on the east, along with a metal gate. Overhead cables ran from north to south in the south-western corner.
1802	The area consisted of a flat arable field with pumpkins.	The area was bordered by hedges and trees on to the east, south and west, with the field continuing to the north. An area of tyres was located in the south-western corner.
19	The area consisted of arable field with pumpkins sloping down to the west from the northeast corner.	The area was bordered by hedges and trees to the northwest and south and by a ditch to the north. A farmyard was located adjacent to the north of the survey area. Telephone poles and associated overhead cables ran along the south and west borders.
20	The area consisted of mostly flat arable field with pumpkins, with a small slope within the east of the survey area sloping down to the west. The eastern edge of the survey area could not be surveyed due to overgrown vegetation.	The area was surrounded by hedges on all sides.
21	The area consisted of a pasture field sloping down to the southwest.	The area was surrounded by hedges and trees, with a metal gate and metal wire fencing present on the southern border. Overhead cables ran along the northern border.
2201	The area consisted of an arable field with pumpkins, sloping steeply down to the southwest. Areas of flood water in the southwest could not be surveyed.	The area was bordered by hedges, trees and a ditch in the north, east and west. The field continued to the south. Telephone poles and their associated cables ran along the southern border.
2202	The area consisted of an arable field with pumpkins sloping steeply down to the southwest. Areas of flood water in the west could not be surveyed.	The area was bordered to the south by a river and to the east by trees and hedges. The field continued to the west and north.
23	The area consisted of flat pasture.	The field continued beyond the survey area in all directions. A river was located adjacent to the

		field to the north and two service covers were identified within the north of the survey area.
24	The area consisted of flat pasture. A small section of the survey area to the north could not be surveyed due to overgrown vegetation.	The field continued beyond the survey area to the north, south and west and was bordered to the east by hedges. Farming equipment was located within the east of the survey area.
25	The area consisted of a small pasture field.	The area was bordered by wire fencing to the east and by a road to the south. The field continued in all other directions. Telephone poles and associated overhead cables ran along the southern border.
26	The area consisted of a small pasture field.	The area was bordered by trees and hedges to the west and continued in all other directions.
27	The area consisted of a small pasture field.	The area was bordered by trees and hedges to the north, south and east. The field continued to the west.
28	The area consisted of a small pasture field.	The area was bordered by trees and hedges to the northwest and southwest. The field continued east.
29	The area consisted of a small flat pasture field.	The area was bordered by hedges and a trackway to the east. The field continued in all other directions.
30	The area consisted of a small flat pasture field.	The area was bordered by trees and hedges to the west and continued in all other directions. A farmyard was located immediately west of the survey area.
31	The area consisted of a small flat pasture field.	The area was bordered by trees and hedges to the west and south and continued in all other directions. Overhead cables ran north to south in the eastern corner of the area.
32	The area consisted of a small flat pasture field.	The area was bordered by trees and hedges to the west and south. The field continued in all other directions.

4.3. The geology underlying the majority of the survey area mainly consists of mudstone, siltstone and sandstone of the Grovesend Formation, with bands of sandstone of the Grovesend Formation identified within Areas 4, 5, 51, 61, 8, 11, 12, 17, 1801 and 1802. The superficial deposits within the majority of the survey area comprise diamicton consisting of Devensian Till, with deposits in Areas 20 (south), 23, 24, 25 (south), 26 (south), 27, 28, 29, 30 (north) and 31 (west) consisting of alluvium comprising of clay, silt, sand and gravel (British Geological Survey, 2023).

4.4. The majority of the soils consist of slowly permeable, seasonally wet, acidic, loamy and clayey soils. However, the soils under Areas 20, 23, 24, 27, 28, 29, 30, 31 and 32 consist of loamy and clayey floodplain soils with naturally high groundwater (Soilscapes, 2023).

5. Archaeological Background

- 5.1. The following is a summary of a Desk-Based Assessment produced by Pegasus Group (Pratt 2022) and provided by Low Carbon Alliance.
- 5.2. Evidence of later prehistorical activity has been recorded c. 850m north of the survey area identified by two Bronze Age burial cairns and two cremation urns.
- 5.3. Swansea Road, abutting the northern boundary of the survey area has its origins in a Roman road linking forts at Loughor and Neath. The earthwork and buried remains of two Roman practice camps are located at Carn Goch Common c. 100m north and at Stafford Common c. 370m west of the survey area. A Roman coin hoard is recorded c. 820m southwest of the survey area.
- 5.4. Adjacent to Areas 11, 13, 14 and 15 is Pen-Y-Fodau-Fawr, which the HER and RCAHMW describe as a farmstead of a loose courtyard plan type with a 19th-century symmetrically-fronted farmhouse. There may have been localised small-scale quarrying and mining activity within the coal-rich areas subject to commercial exploitation in the 19th century, but there are no known documentary records or surface traces of this.

6. Methodology

6.1. Data Collection

6.1.1. Magnetometer surveys are generally the most cost effective and suitable geophysical technique for the detection of archaeology in England. Therefore, a magnetometer survey should be the preferred geophysical technique unless its use is precluded by any specific survey objectives or the site environment. For this site, no factors precluded the recommendation of a standard magnetometer survey. Geophysical survey therefore comprised the magnetic method as described in the following section.

6.1.2. Geophysical prospection comprised the magnetic method as described in the following table.

6.1.3. Table of survey strategies:

Method	Instrument	Traverse Interval	Sample Interval
Magnetic	Bartington Instruments Grad-13 Digital Three-Axis Gradiometer	1m	200Hz reprojected to 0.125m

6.1.4. The magnetic data were collected using MS' bespoke quad-towed cart system and hand-carried GNSS-positioned system.

6.1.4.1. MS' cart and hand carried systems were comprised of Bartington Instruments Grad 13 Digital Three-Axis Gradiometers. Positional referencing was through a multi-channel, multi-constellation GNSS Smart Antenna RTK GPS outputting in NMEA mode to ensure high positional accuracy of collected measurements. The RTK GPS is accurate to 0.008m + 1ppm in the horizontal and 0.015m + 1ppm in the vertical.

- 6.1.4.2. Magnetic and GPS data were stored on an SD card within MS' bespoke datalogger. The datalogger was continuously synced, via an in-field Wi-Fi unit, to servers within MS' offices. This allowed for data collection, processing and visualisation to be monitored in real-time as fieldwork was ongoing.
- 6.1.4.3. A navigation system was integrated with the RTK GPS, which was used to guide the surveyor. Data were collected by traversing the survey area along the longest possible lines, ensuring efficient collection and processing.

6.2. Data Processing

- 6.2.1. Magnetic data were processed in bespoke in-house software produced by MS. Processing steps conform to the EAC and Historic England guidelines for 'minimally enhanced data' (see Section 3.8 in Schmidt *et al.*, 2015: 33 and Section IV.2 in David *et al.*, 2008: 11).

Sensor Calibration – The sensors were calibrated using a bespoke in-house algorithm, which conforms to Olsen *et al.* (2003).

Zero Median Traverse – The median of each sensor traverse is calculated within a specified range and subtracted from the collected data. This removes striping effects caused by small variations in sensor electronics.

Projection to a Regular Grid – Data collected using RTK GPS positioning requires a uniform grid projection to visualise data. Data are rotated to best fit an orthogonal grid projection and are resampled onto the grid using an inverse distance-weighting algorithm.

Interpolation to Square Pixels – Data are interpolated using a bicubic algorithm to increase the pixel density between sensor traverses. This produces images with square pixels for ease of visualisation.

6.3. Data Visualisation and Interpretation

- 6.3.1. This report presents the gradient of the sensors' total field data as greyscale images, as well as the total field data from the lower sensors. The gradient of the sensors minimises external interferences and reduces the blown-out responses from ferrous and other high contrast material. However, the contrast of weak or ephemeral anomalies can be reduced through the process of calculating the gradient. Consequently, some features can be clearer in the respective gradient or total field datasets. Multiple greyscale images of the gradient and total field at different plotting ranges have been used for data interpretation. Greyscale images should be viewed alongside the XY trace plot (Figures 9, 12, 15, 18, 21, 24 and 27). XY trace plots visualise the magnitude and form of the geophysical response, aiding anomaly interpretation.
- 6.3.2. Geophysical results have been interpreted using greyscale images and XY traces in a layered environment, overlaid against open street maps, satellite imagery, historical maps, LiDAR data, and soil and geology maps. Google Earth (2023) was also consulted, to compare the results with recent land use.

- 6.3.3. Geodetic position of results – All vector and raster data have been projected into OSGB36 (ESPG27700) and can be provided upon request in ESRI Shapefile (.SHP) and Geotiff (.TIF) respectively. Figures are provided with raster and vector data projected against OS Open Data.



7. Results

7.1. Qualification

7.1.1. Geophysical results are not a map of the ground and are instead a direct measurement of subsurface properties. Detecting and mapping features requires that said features have properties that can be measured by the chosen technique(s) and that these properties have sufficient contrast with the background to be identifiable. The interpretation of any identified anomalies is inherently subjective. While the scrutiny of the results is undertaken by qualified, experienced individuals and rigorously checked for quality and consistency, it is often not possible to classify all anomaly sources. Where possible, an anomaly source will be identified along with the certainty of the interpretation. The only way to improve the interpretation of results is through a process of comparing excavated results with the geophysical reports. MS actively seek feedback on their reports, as well as reports from further work, in order to constantly improve our knowledge and service.

7.2. Discussion

7.2.1. The geophysical results are presented in combination with satellite imagery and historical maps (Figures 4, 6 and 8).

7.2.2. The fluxgate gradiometer survey has mostly responded well to the environment of the survey area. The geophysical survey has detected a wide variety of anomalies related to possible archaeological activity, historical agricultural and modern agricultural activity, other former land uses such as mines, a railway, and an aqueduct and natural variations. The presence of magnetic disturbance produced by metal fencing and buried services as well as spreads of ferrous material across much of the survey area may have masked weaker more ephemeral anomalies, if any were present and has limited the interpretation of detected anomalies within these affected areas.

7.2.3. Possible archaeology has been identified within Areas 13 and 15 as a series of linear anomalies forming right angled morphologies indicative of partial enclosures (Figures 10 & 13). However, both series of anomalies are masked by a spread of ferrous material within Area 15 and an area of natural enhancement within Area 13. Thus, a 'possible' characterisation has been ascribed as it cannot be certain that these anomalies are reflective of archaeological activity.

7.2.4. Evidence of former agricultural activity has been detected throughout most of the survey area in the form of former mapped and unmapped field boundaries and ridge and furrow cultivation. The mapped boundaries align with former field boundaries visible in historical OS maps (Figures 4, 6 and 8). Modern agricultural activity has also been identified as drainage systems and ploughing regimes, many of which are visible on satellite imagery (Figures 4, 6 and 8).

7.2.5. Evidence of possible mining activity has been identified within Areas 5, 6, 90 and 92 (Figures 28 & 31). These anomalies consist of zones of magnetically enhanced material with clearly defined edges, with those in Area 5 correlating with terrain deformations visible on satellite imagery (Figure 6). Further features related to the historical land use

of the survey area includes a former mineral railway running through the south of Area 3 and north of Area 24 and an aqueduct running through the centre of Area 24 which are both visible in historical OS mapping (Figures 4, 6, 14 & 25).

7.2.6. Across the majority of the survey area sinuous bands, amorphous anomalies and spreads of weakly enhanced anomalies have been identified. These are reflective of the natural variations of the soils and superficial deposits within the survey area. A strong sinuous anomaly within Area 23 identifies a former channel for the Afon Llan depicted on historical OS maps (Figure 4).

7.2.7. Throughout most of the survey area anomalies that have been classified as 'undetermined' have been identified. These generally present strong and weak curvilinear and linear anomalies. These have limited context or lack any clear pattern or morphology to enable a confident interpretation. Several 'undetermined' anomalies have also been identified within spreads of ferrous material or enhanced magnetic backgrounds which has limited the interpretation of these anomalies. Nevertheless, a potential archaeological origin cannot be excluded.

7.3. Interpretation

7.3.1. General Statements

- 7.3.1.1. Geophysical anomalies will be discussed broadly as classification types across the survey area. Only anomalies that are distinctive or unusual will be discussed individually.
- 7.3.1.2. **Ferrous (Spike)** – Discrete dipolar anomalies are likely to be the result of isolated pieces of modern ferrous debris on or near the ground surface.
- 7.3.1.3. **Ferrous/Debris (Spread)** – A ferrous/debris spread refers to a concentration of multiple discrete, dipolar anomalies usually resulting from highly magnetic material such as rubble containing ceramic building materials and ferrous rubbish.
- 7.3.1.4. **Magnetic Disturbance** – The strong anomalies produced by extant metallic structures, typically including fencing, pylons, vehicles and service pipes, have been classified as 'Magnetic Disturbance'. These magnetic 'haloes' will obscure weaker anomalies relating to nearby features, should they be present, often over a greater footprint than the structure causing them.
- 7.3.1.5. **Undetermined** – Anomalies are classified as Undetermined when the origin of the geophysical anomaly is ambiguous and there is no supporting contextual evidence to justify a more certain classification. These anomalies are likely to be the result of geological, pedological or agricultural processes, although an archaeological origin cannot be entirely ruled out. Undetermined anomalies are generally distinct from those caused by ferrous sources.

7.3.2. Magnetic Results - Specific Anomalies

- 7.3.2.1. **Possible Archaeology (Weak)**– Weak rectilinear and curvilinear anomalies have been detected in Areas 13 and 15 (Figures 8 and 12). The morphology and magnetic signal of these anomalies are characteristic of anthropogenic features, in particular possible partial enclosures; however, the anomalies are somewhat obscured by natural background enhancement in Area 15 and by modern interference in Area 13. The anomalies have therefore been categorised as Possible Archaeology.
- 7.3.2.2. **Agricultural (Strong/Weak)** – Throughout the survey area strong and weak, linear anomalies have been identified and categorised as ‘agricultural’ in origin. Several of these anomalies correlate with former field boundaries depicted on historical OS maps [1a] [2a] [3a] [5a] [6a] [8a] [2202a] [23a] [26a] (Figures 4, 6 and 8). The majority of the anomalies categorised as ‘agricultural’ do not correspond with any features depicted on historical mapping. However, these anomalies share similar morphologies and strengths to the former field boundaries. Thus, these may relate to former field boundaries not depicted on historical maps. In Area 2202, a strong agricultural linear anomaly has been identified (Figure 28). This does not correlate exactly with the pathway recorded on historical maps, however this has been interpreted as an extension or additional agricultural pathway (Figure 4).
- 7.3.2.3. **Agricultural (Trend)** – A multitude of weakly positive, linear anomalies have been identified running roughly northeast to southwest in Areas 4, 90, 12 and 20 and running roughly east to west in Areas 16 and 20 (Figures 8, 11, 20 & 23). The close spacing between these anomalies (c. 2m) is indicative of modern ploughing regimes, some of which are identifiable on satellite imagery (Figures 4 and 6).
- 7.3.2.4. **Ridge and Furrow** – Broad, weakly enhanced, linear anomalies have been identified within the west of Area 15 and northeast of Area 61 (Figures 19 and 31). Although these anomalies share a similar morphology to the previously discussed modern ploughing trends, these anomalies are broader and are spread further apart (c.8-10m) which are typical of ridge and furrow cultivation.
- 7.3.2.5. **Drainage Systems** – Strong linear anomalies have been identified as probable drainage systems within Areas 2, 4, 13, 14, 17, 1802, 21 and 2201 (Figures 4 and 6). The majority of these drains exhibit a strong, positive magnetic enhancement indicative of ditch drains. However, drains within Areas 2 and 4 exhibit a strong dipolar magnetic enhancement indicative of clay/brick drains (Figures 14 & 17).
- 7.3.2.6. **Natural (Strong/Weak/Spread)** – Weakly positive, sinuous bands and/or spreads of weak discrete anomalies have been identified throughout the majority of the survey area (Figures 3 and 5). These anomalies likely reflect the variations of superficial deposits and soils (See Sections 4.3 and 4.4). A sinuous

band of strongly positive anomalies has been identified within the north of Area 23 (Figure 25). This band correlates with the Afon Llan depicted on historical maps and is characteristic of a former river channel (Figure 4).

- 7.3.2.7. **Possible Mining Activity** – Clusters of ferrous anomalies have been detected in Areas 5, 90 and 92 (Figures 28 and 31), these consist of zones containing magnetically enhanced material with clearly defined edges relatively characteristic of former mineshafts (See Section 5.5). This is particularly evident within Area 5 as the anomalies correspond with terrain deformation visible through satellite imagery (Figure 6).
- 7.3.2.8. **Industrial/Modern (Strong)** – A strong dipolar band has been identified within the south of Area 3 and northeast of Area 24 [3a] [24a] (Figures 25 and 31). These anomalies correlate with a mineral railway depicted on historical maps (Figures 4 and 6). A strong linear anomaly has also been detected within the centre of Area 24 running northeast to southwest [24b] (Figure 26), which correlates with an aqueduct depicted on historical OS mapping (Figure 4).
- 7.3.2.9. **Services** – Two sets of parallel, linear, strong dipolar anomalies have been identified within Areas 23 and 24 (Figure 26). The distinct morphology and strengths of these anomalies are typical of buried services.
- 7.3.2.10. **Undetermined (Strong/Weak)** – Throughout the majority of the survey areas, linear and curvilinear, strong and weak anomalies have been identified (Figures 8, 11, 14, 17, 20, 23, 26). These anomalies are likely representative of ditches containing magnetically enhanced infill. However, due to the lack of distinct morphologies and masking by ferrous debris spreads in Areas 6, 61, 70, 71, 14 and 23, a confident classification cannot be ascribed. Thus, while these anomalies may be agricultural or natural in origin, an archaeological origin cannot be completely ruled out.

8. Conclusions

- 8.1. A fluxgate gradiometer survey was successfully completed across the c. 55.3ha survey area. A total of c. 1.2ha of land could not be surveyed due to steep terrain, overgrown vegetation and waterlogged ground. Magnetic disturbance was limited to haloes caused by fencing, ferrous spreads and buried services. Areas in the southeast of the survey area are magnetically enhanced due to subsurface materials, and therefore may obscure any weaker anomalies if they are present. Anomalies resulting from natural processes have been identified a former channel for the Afon Llan and variations within the superficial deposits and soils.
- 8.2. Areas of extensive magnetic interference were identified along the cable route in the southwest, with a large quantity of highly ferrous 'green waste' detected, which has potentially obscured any weaker, more ephemeral anomalies, if they were present. Several stronger anomalies were able to be identified through the disturbance, however.

- 8.3. Anomalies of a possible archaeological origin have been detected within two areas in the north of the survey area (Areas 13 & 15). These consist of several strong and weak linear anomalies possibly indicative of partial enclosures.
- 8.4. The geophysical results primarily reflect the long-term agricultural use of the survey area in the form of mapped and unmapped former field boundaries, ridge and furrow cultivation, modern ploughing regimes and drainage systems.
- 8.5. Anomalies indicative of possible mining activities have been identified within the southeast of the survey area, which largely correlate with terrain deformations visible on satellite imagery. Remnants of an aqueduct within the southwest and a mineral railway within the southwest and southeast have been detected and correlate with historical maps.
- 8.6. Numerous anomalies throughout the survey area have been classified as undetermined as it has not been possible to definitively determine whether these anomalies are the result of archaeological, agricultural or natural processes.



9. Archiving

- 9.1. MS maintains an in-house digital archive, which is based on Schmidt and Ernenwein (2013). This stores the collected measurements, minimally processed data, georeferenced and un-georeferenced images, XY traces and a copy of the final report.
- 9.2. MS contributes reports to the ADS Grey Literature Library upon permission from the client, subject to any dictated time embargoes.

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11. References

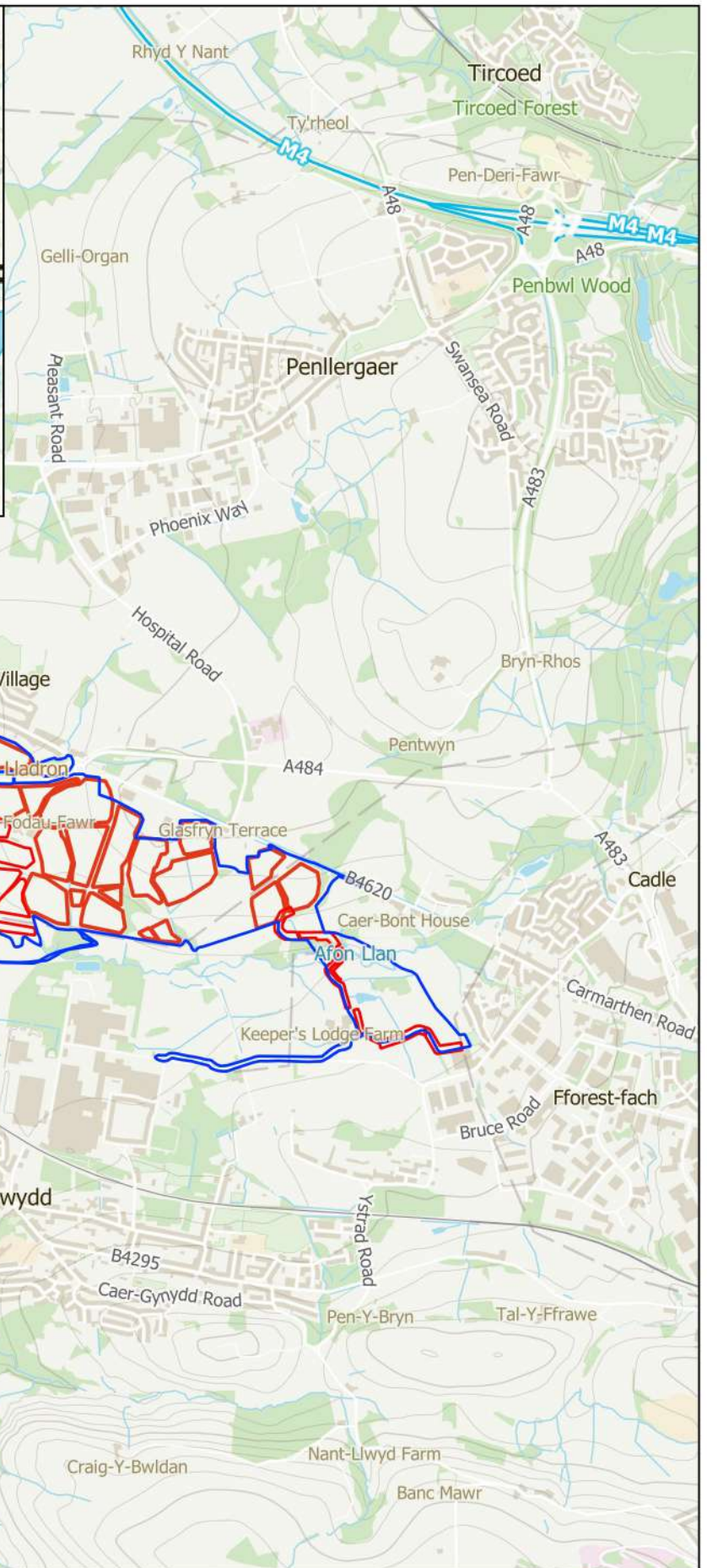
- British Geological Survey, 2023. Geology of Britain. Llewitha, Swansea.
[<http://mapapps.bgs.ac.uk/geologyofbritain/home.html/>]. Accessed 18/07/2023.
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12. Project Metadata

MS Job Code	MSSS1328
Project Name	Parc Solar, Caenewydd
Client	Taiyo Power & Storage Ltd
Grid Reference	SS60342 97186
Survey Techniques	Magnetometry
Survey Size (ha)	43ha (Magnetometry)
Survey Dates	2022-07-11 to 2022-07-13
Project Lead	Alison Langston BA PCIfA
Project Officer	Alison Langston BA PCIfA
HER Event No	TBC
OASIS No	TBC
S42 Licence No	N/A
Report Version	1.2

13. Document History

Version	Comments	Author	Checked By	Date
0.1	Initial draft for Project Lead to Review	DW	AL	25 July 2022
0.2	Corrections from Project Lead, Report issued as Draft	IT	PSJ	28 July 2022
0.3	Corrections from Client	AL	AL	21 September 2022
0.4	Changes to the abstract after meeting with client	IC	IC	22 September 2022
0.5	Addition of second deployment	ED	PSJ	24 November 2022
1.0	Client Corrections, Report Issued as Final	AL	AL	24 November 2022
1.1	Change to redline, and addition of text supplied by client	AL	AL	25 January 2023
1.2	Corrections from Client	AL	AL	16 March 2023





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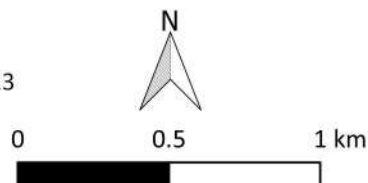
Figure 1 - Site Location

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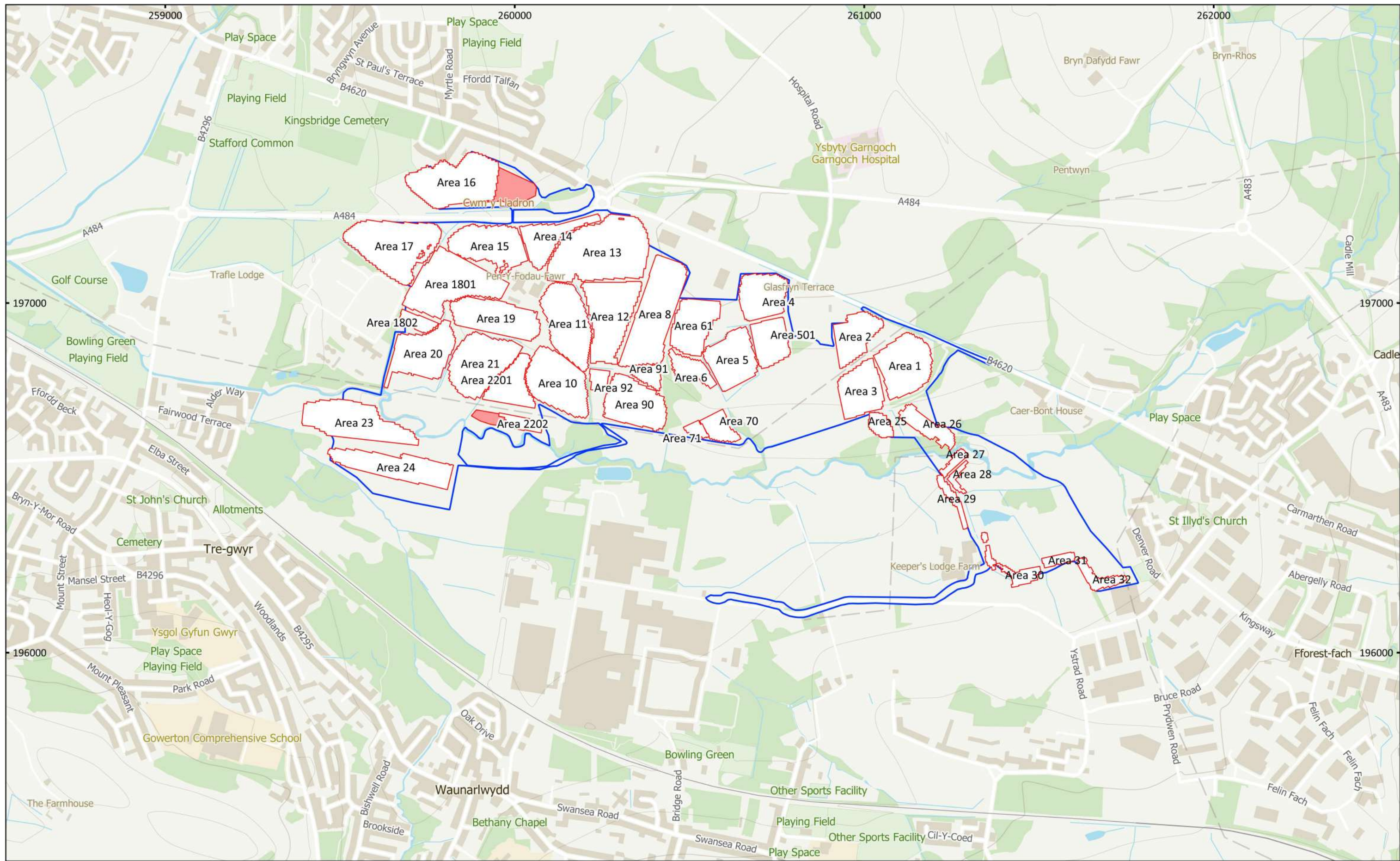
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-  Site Boundary
-  Geophysical Survey Extent

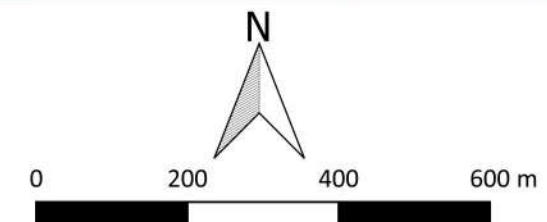


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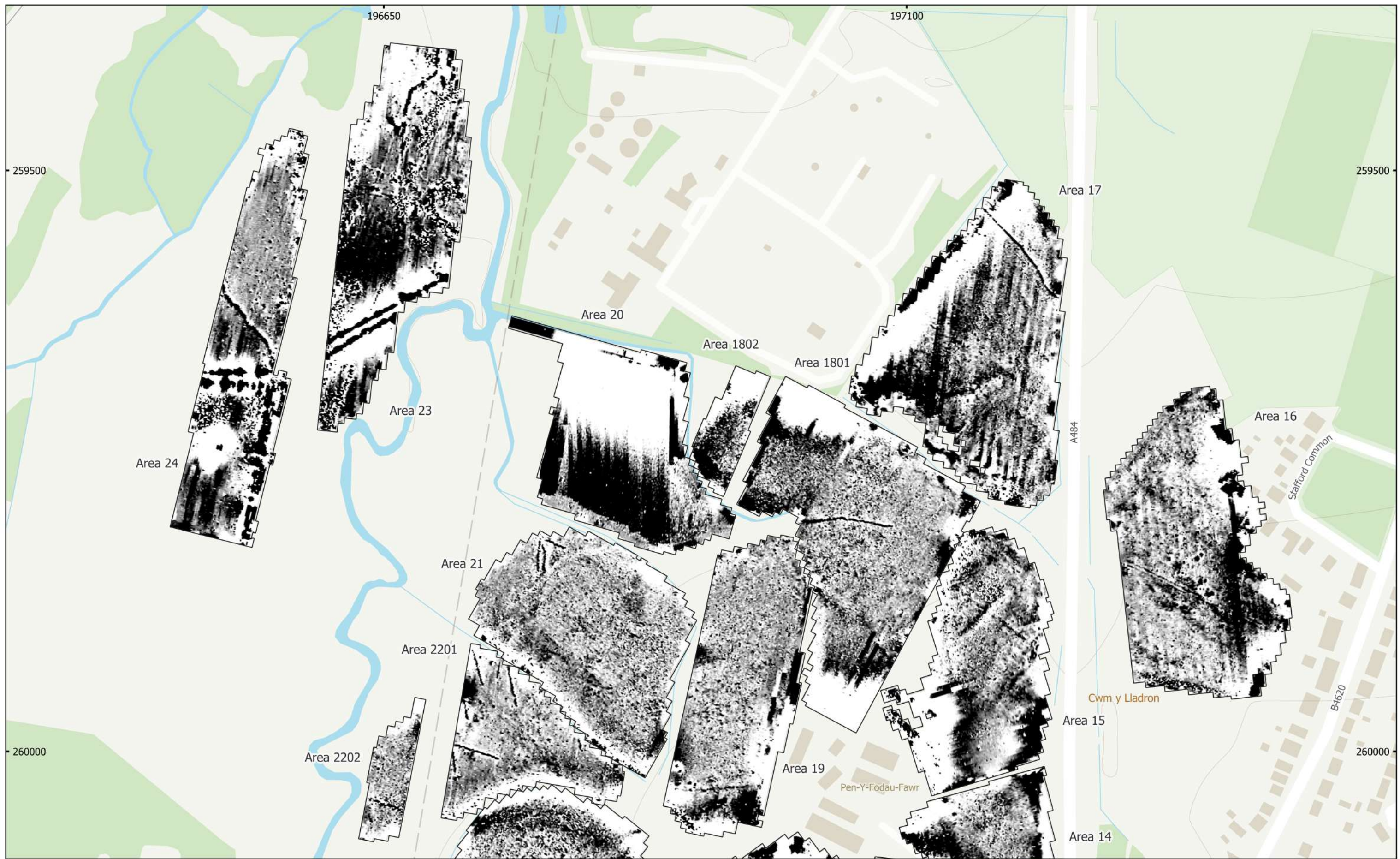


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 Figure 2 - Location of Survey Areas
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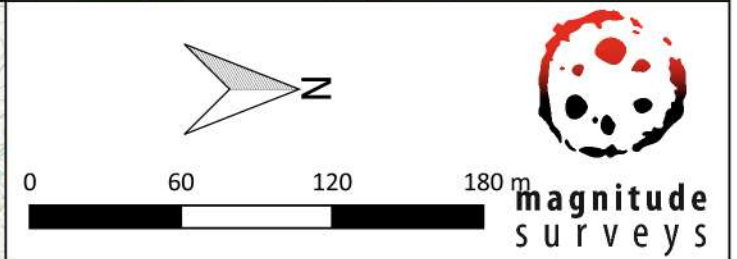
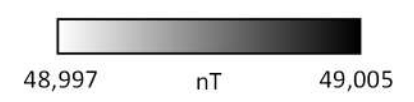
-  Site Boundary
-  Geophysical Survey Extent
-  Areas unable to be surveyed



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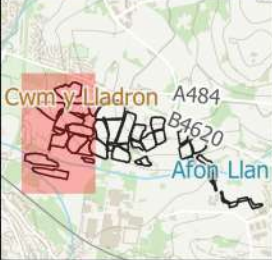
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 Figure 3 - Magnetic Total Field (West) (Overview)
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 Figure 4 - Magnetic Interpretation over Historical Mapping and Satellite Imagery (West) (Overview)
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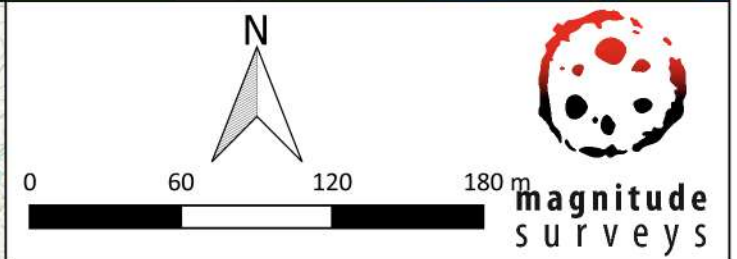
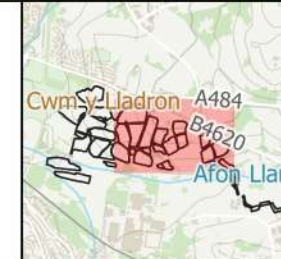
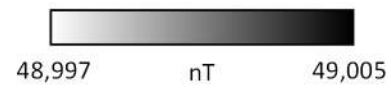
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| Agricultural (Weak) | Natural (Strong) | Service |
| Archaeology Possible (Strong) | Natural (Weak) | Ridge and Furrow (Trend) |
| Archaeology Possible (Weak) | Undetermined (Strong) | Drainage Feature |
| Magnetic Disturbance | Undetermined (Weak) | Ferrous (Spike) |
| Ferrous/Debris (Spread) | Industrial/Modern | |



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 Figure 5 - Magnetic Total Field (Centre) (Overview)
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 Figure 6 - Magnetic Interpretation over Historical Mapping and Satellite Imagery (Centre) (Overview)
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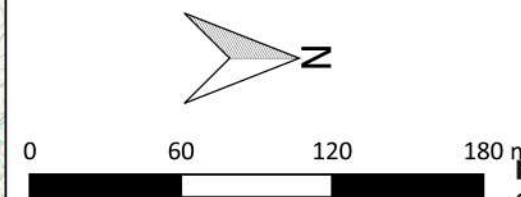
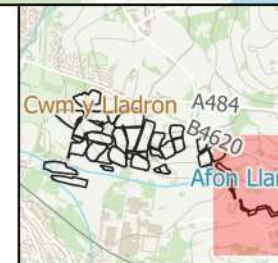
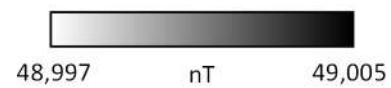
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	Agricultural (Weak)		Natural (Weak)		Service
	Archaeology Possible (Weak)		Possible Mining Activity		Ridge and Furrow (Trend)
	Magnetic Disturbance		Undetermined (Strong)		Drainage Feature
	Ferrous/Debris (Spread)		Undetermined (Weak)		Ferrous (Spike)
	Natural (Spread)		Industrial/Modern		



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 Figure 7 - Magnetic Total Field (Southeast) (Overview)
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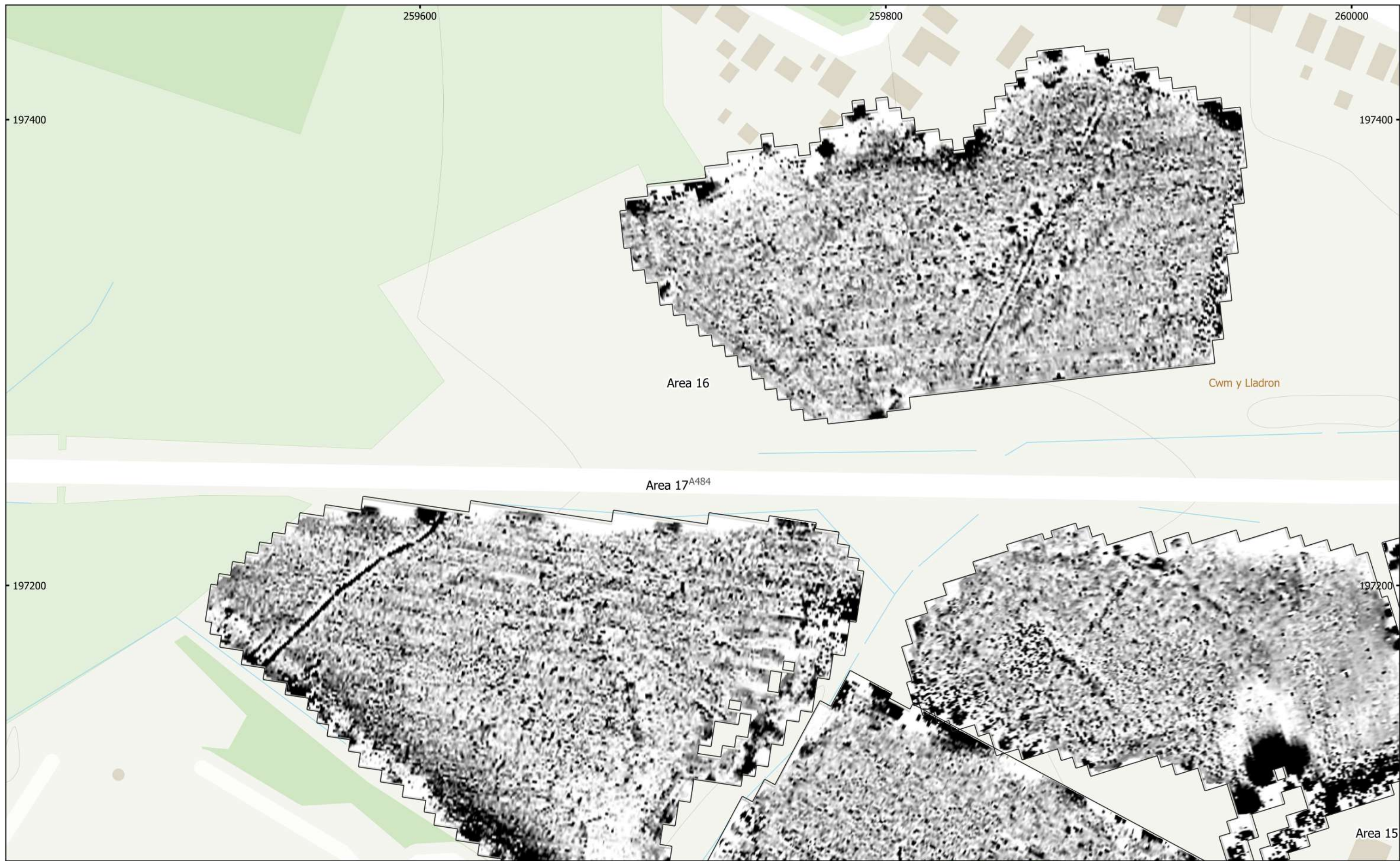


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 Figure 8 - Magnetic Interpretation over Historical Mapping and Satellite Imagery (Southeast) (Overview)
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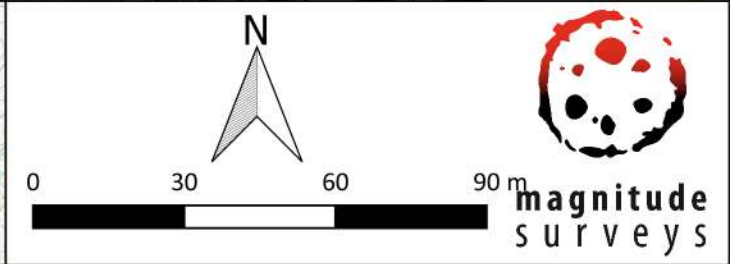
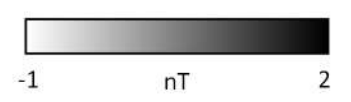
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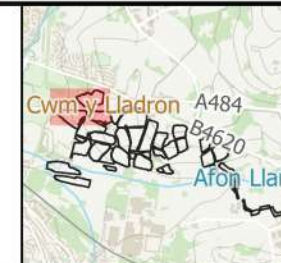
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 Figure 9 - Magnetic Gradient (Areas 15, 16, 17 and 1801)
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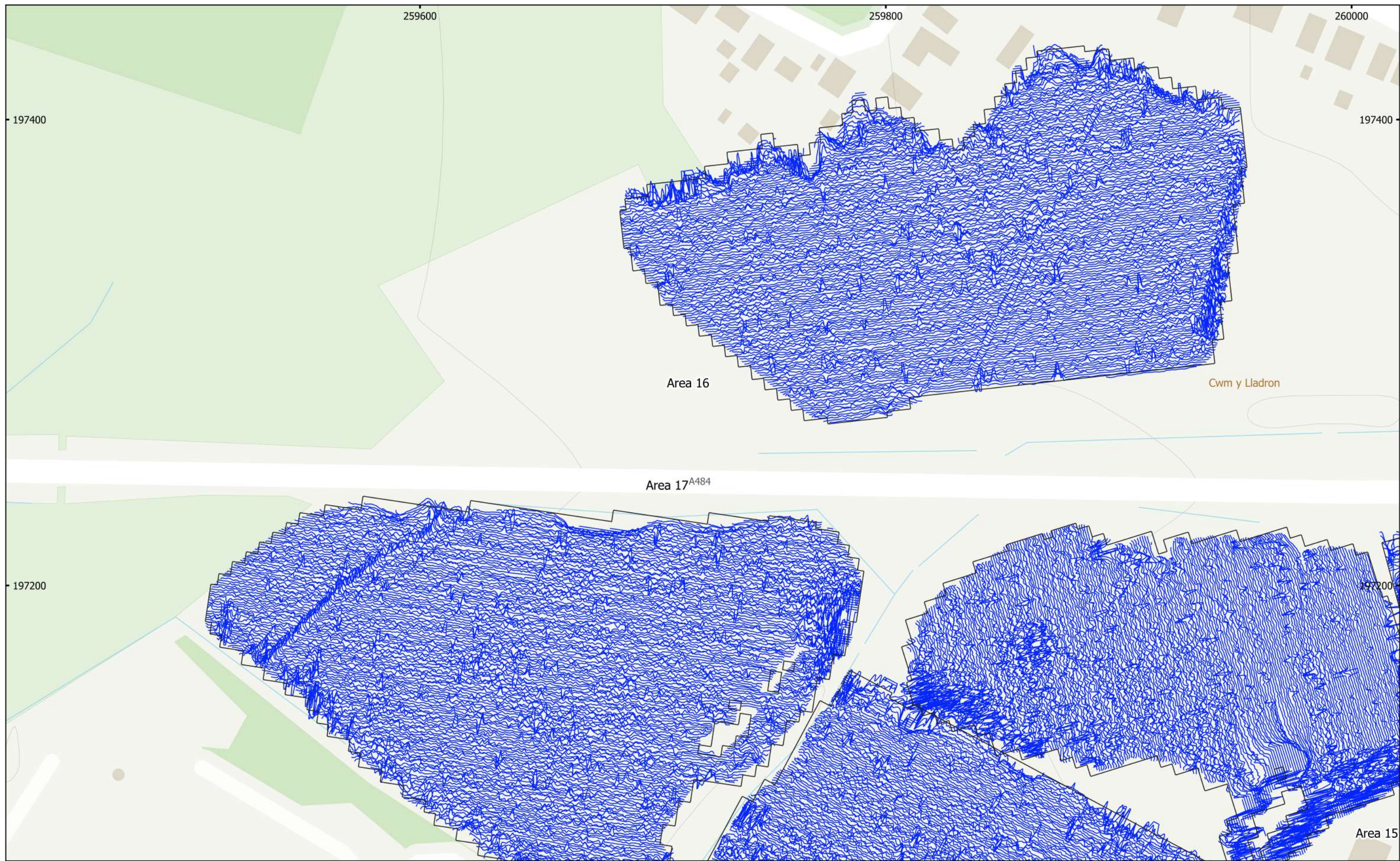
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 Figure 10 - Magnetic Interpretation (Areas 15, 16, 17 and 1801)
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|-------------------------------|-------------------------|--------------------------|
| Agricultural (Strong) | Ferrous/Debris (Spread) | Undetermined (Weak) |
| Agricultural (Weak) | Natural (Spread) | Agricultural (Trend) |
| Archaeology Possible (Strong) | Natural (Strong) | Ridge and Furrow (Trend) |
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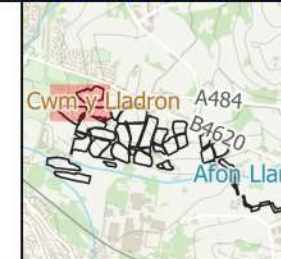


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 Figure 11 - XY Trace Plot (Areas 15, 16, 17 and 1801)
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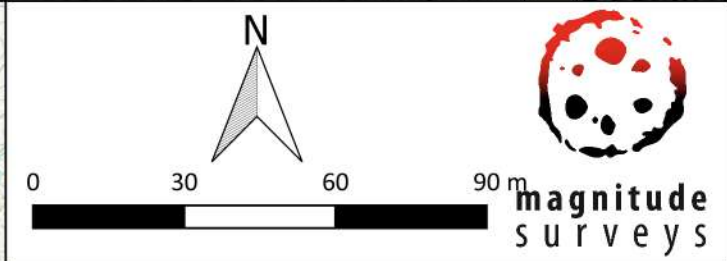
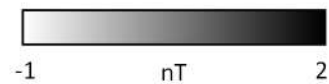


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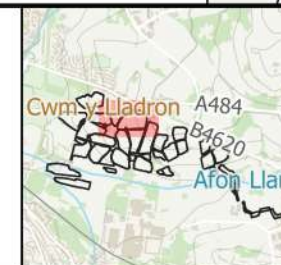
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 Figure 12 - Magnetic Gradient (Areas 8, 11, 12, 13, 14, 15 and 1801)
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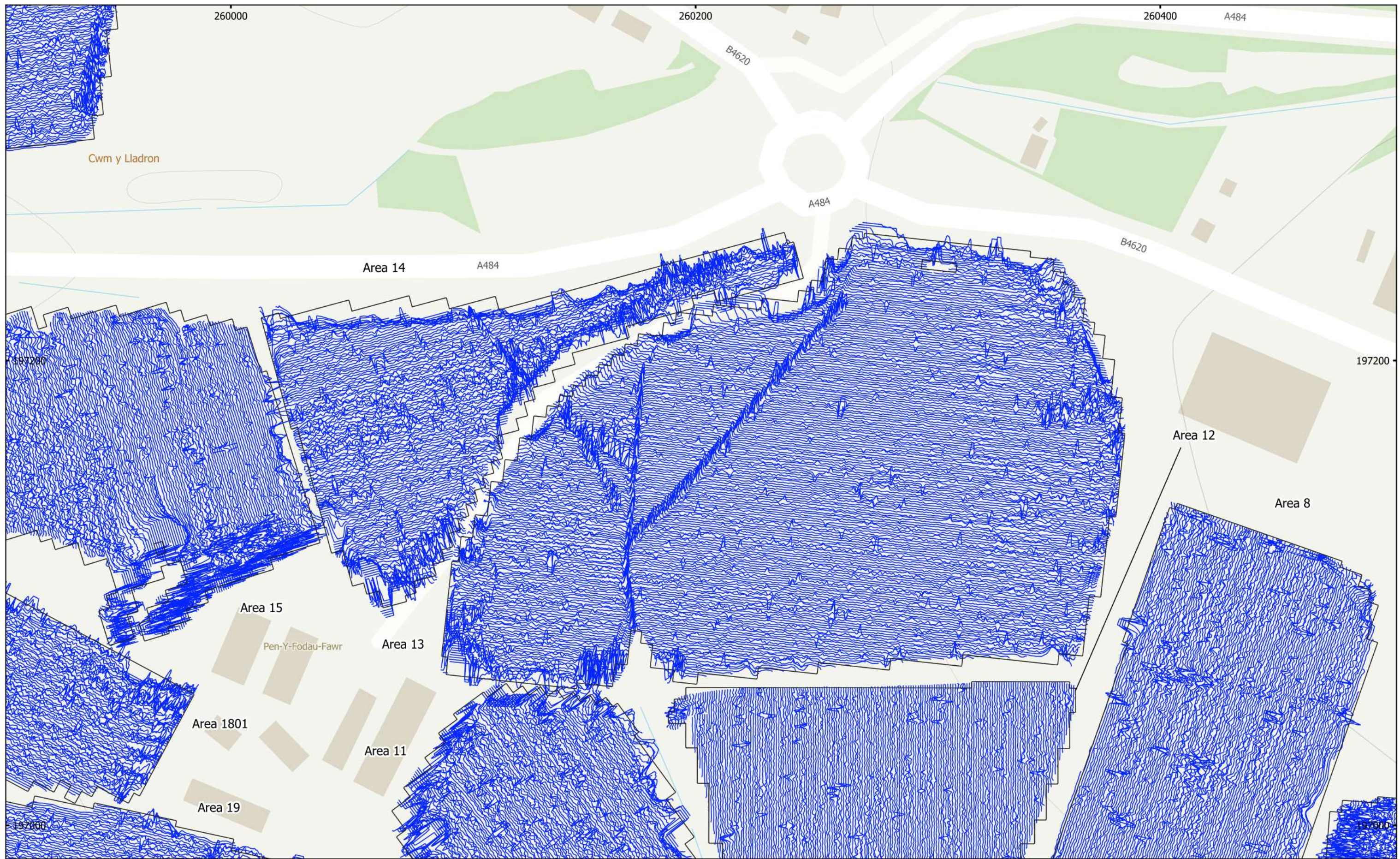


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 Figure 13 - Magnetic Interpretation (Areas 8, 11, 12, 13, 14, 15 and 1801)
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|-------------------------------|-------------------------|--------------------------|
| Agricultural (Strong) | Ferrous/Debris (Spread) | Agricultural (Trend) |
| Agricultural (Weak) | Natural (Spread) | Ridge and Furrow (Trend) |
| Archaeology Possible (Strong) | Natural (Strong) | Drainage Feature |
| Archaeology Possible (Weak) | Natural (Weak) | Ferrous (Spike) |
| Magnetic Disturbance | Undetermined (Weak) | |



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 Figure 14 - XY Trace Plot (Areas 8, 11, 12, 13, 14, 15 and 1801)
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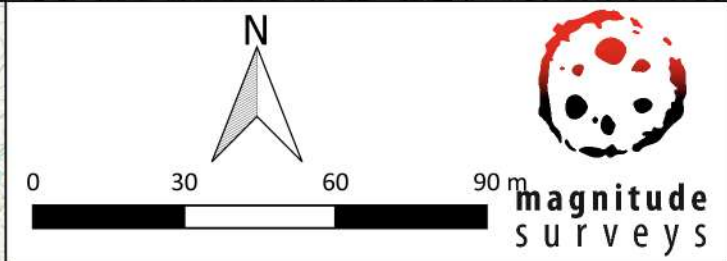
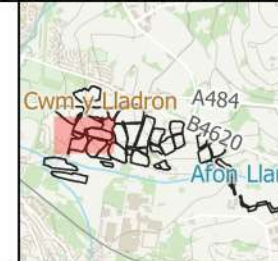
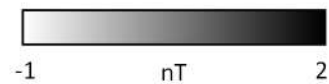


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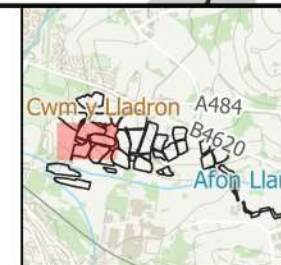
MSSS1328 - Parc Solar Caenewydd
 Figure 15 - Magnetic Gradient (Areas 1801, 1802, 19, 21, 22 and 2201)
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 Figure 16 - Magnetic Interpretation (Areas 1801, 1802, 19, 21, 22 and 2201)
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|-------------------------|-----------------------|----------------------|
| Agricultural (Strong) | Natural (Spread) | Undetermined (Weak) |
| Agricultural (Weak) | Natural (Strong) | Agricultural (Trend) |
| Magnetic Disturbance | Natural (Weak) | Drainage Feature |
| Ferrous/Debris (Spread) | Undetermined (Strong) | Ferrous (Spike) |

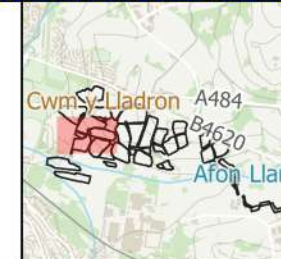


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 Figure 17 - XY Trace Plot (Areas 1801, 1802, 19, 21, 22 and 2201)
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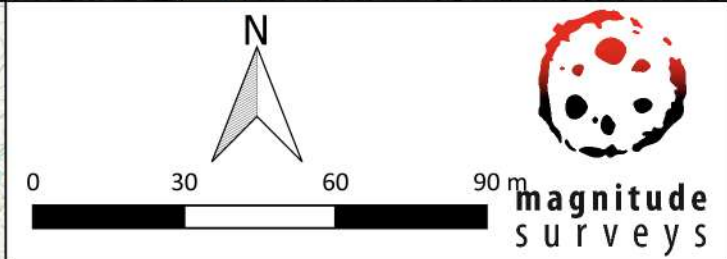
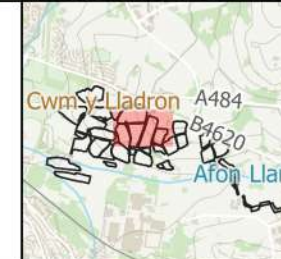
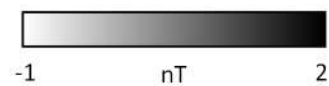


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 Figure 18 - Magnetic Gradient (Areas 8, 11, 12, 13, 14 and 61)
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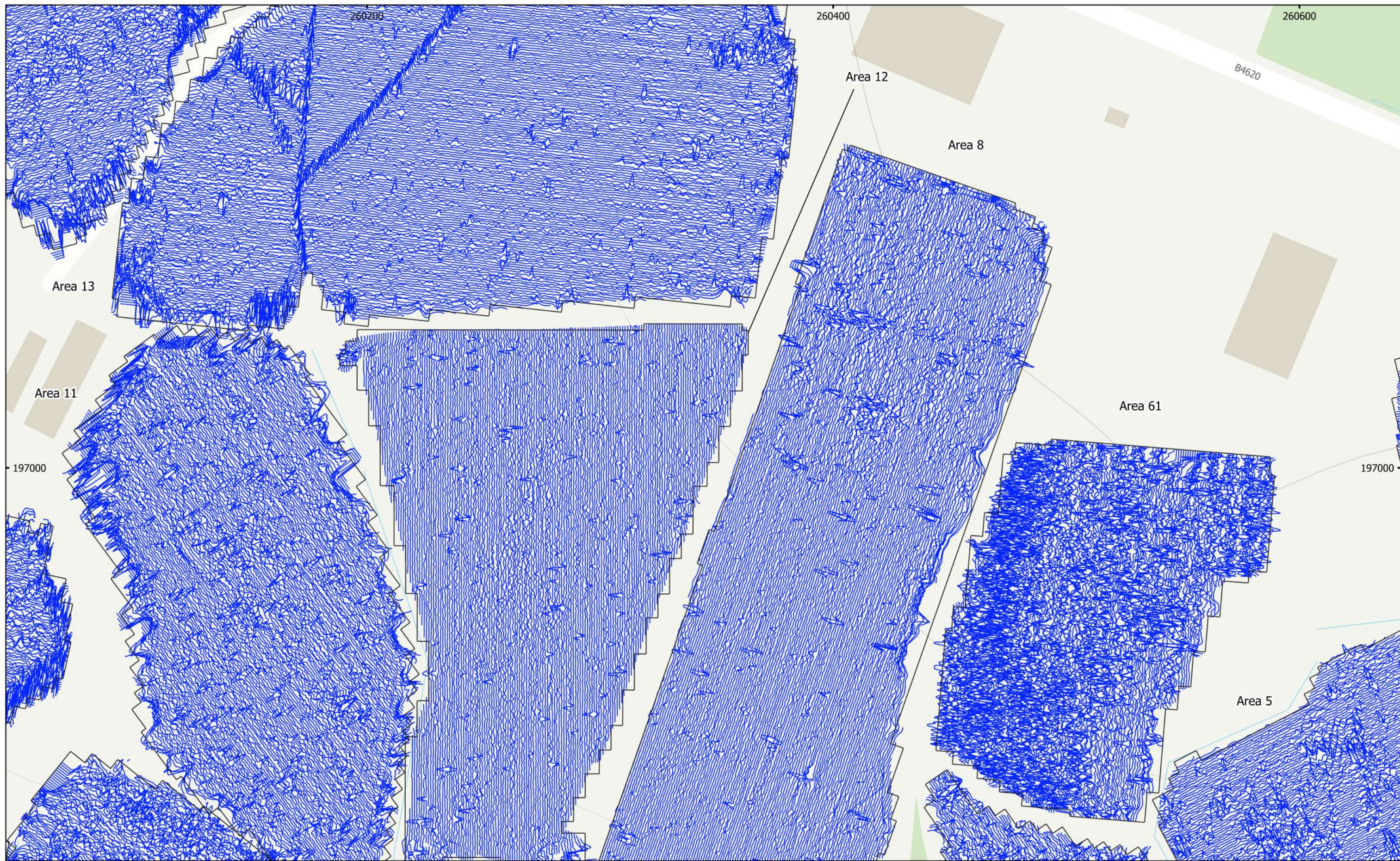
MSSS1328 - Parc Solar Caenewydd
 Figure 19 - Magnetic Interpretation (Areas 8, 11, 12, 13, 14 and 61)
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|-------------------------|--------------------------|--------------------------|
| Agricultural (Strong) | Natural (Spread) | Agricultural (Trend) |
| Agricultural (Weak) | Natural (Strong) | Ridge and Furrow (Trend) |
| Magnetic Disturbance | Natural (Weak) | Drainage Feature |
| Ferrous/Debris (Spread) | Possible Mining Activity | Ferrous (Spike) |
| Undetermined (Weak) | | |

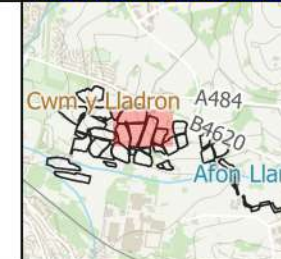


0 30 60 90 m

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 Figure 20 - XY Trace Plot (Areas 8, 11, 12, 13, 14 and 61)
 30nT/cm at 1:1,500 @ A3
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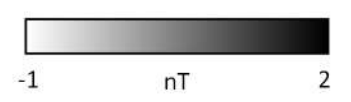


0 30 60 90 m

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MSSS1328 - Parc Solar Caenewydd
 Figure 21 - Magnetic Gradient (Areas 1, 2, 3, 4, 5 and 501)
 1:1,500 @ A3
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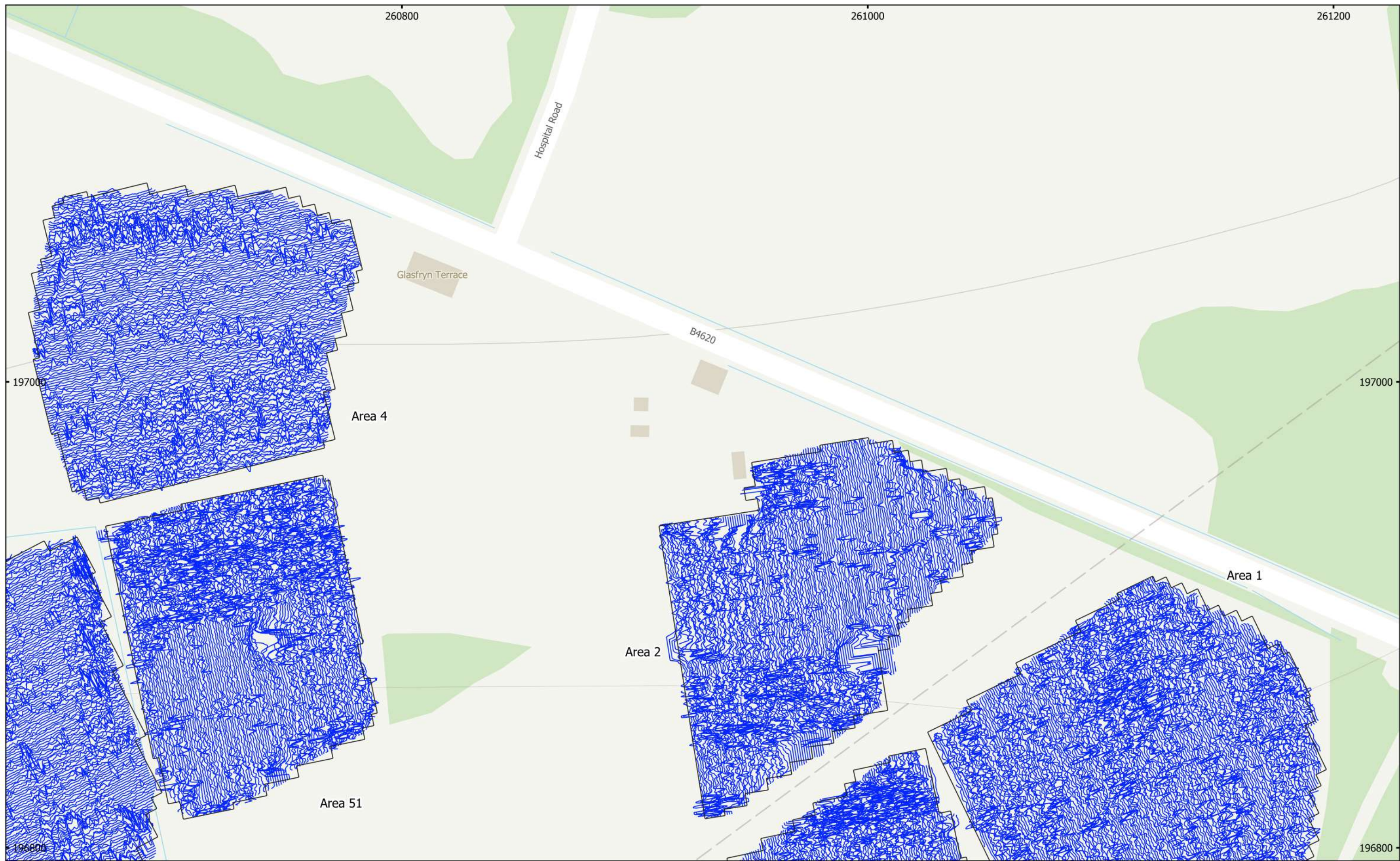


MSSS1328 - Parc Solar Caenewydd
 Figure 22 - Magnetic Interpretation (Areas 1, 2, 3, 4, 5 and 501)
 1:1,500 @ A3
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- | | | |
|-------------------------|--------------------------|----------------------|
| Agricultural (Weak) | Natural (Weak) | Agricultural (Trend) |
| Magnetic Disturbance | Possible Mining Activity | Drainage Feature |
| Ferrous/Debris (Spread) | Undetermined (Strong) | Ferrous (Spike) |
| | Undetermined (Weak) | |



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MSSS1328 - Parc Solar Caenewydd
 Figure 23 - XY Trace Plot (Areas 1, 2, 3, 4, 5 and 501)
 30nT/cm at 1:1,500 @ A3
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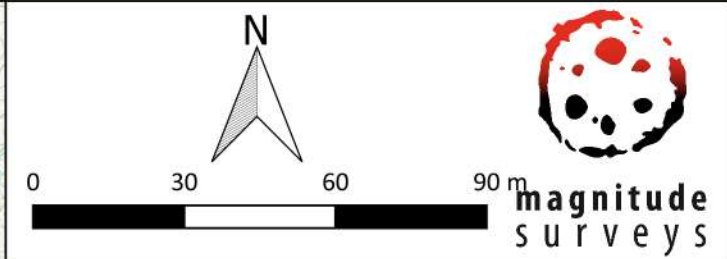
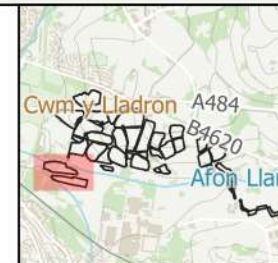
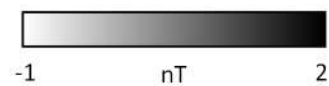


0 30 60 90 m

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surveys



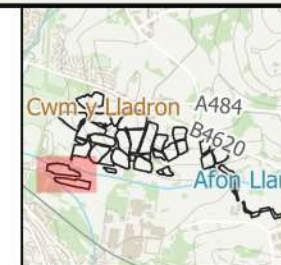
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 Figure 24 - Magnetic Gradient (Areas 23 and 24)
 1:1,500 @ A3
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 Figure 25 - Magnetic Interpretation (Areas 23 and 24)
 1:1,500 @ A3
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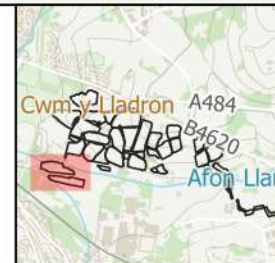
- | | | |
|-------------------------|-----------------------|----------------------|
| Agricultural (Strong) | Natural (Spread) | Agricultural (Trend) |
| Agricultural (Weak) | Natural (Strong) | Service |
| Magnetic Disturbance | Undetermined (Strong) | Drainage Feature |
| Ferrous/Debris (Spread) | Undetermined (Weak) | Ferrous (Spike) |
| | Industrial/Modern | |



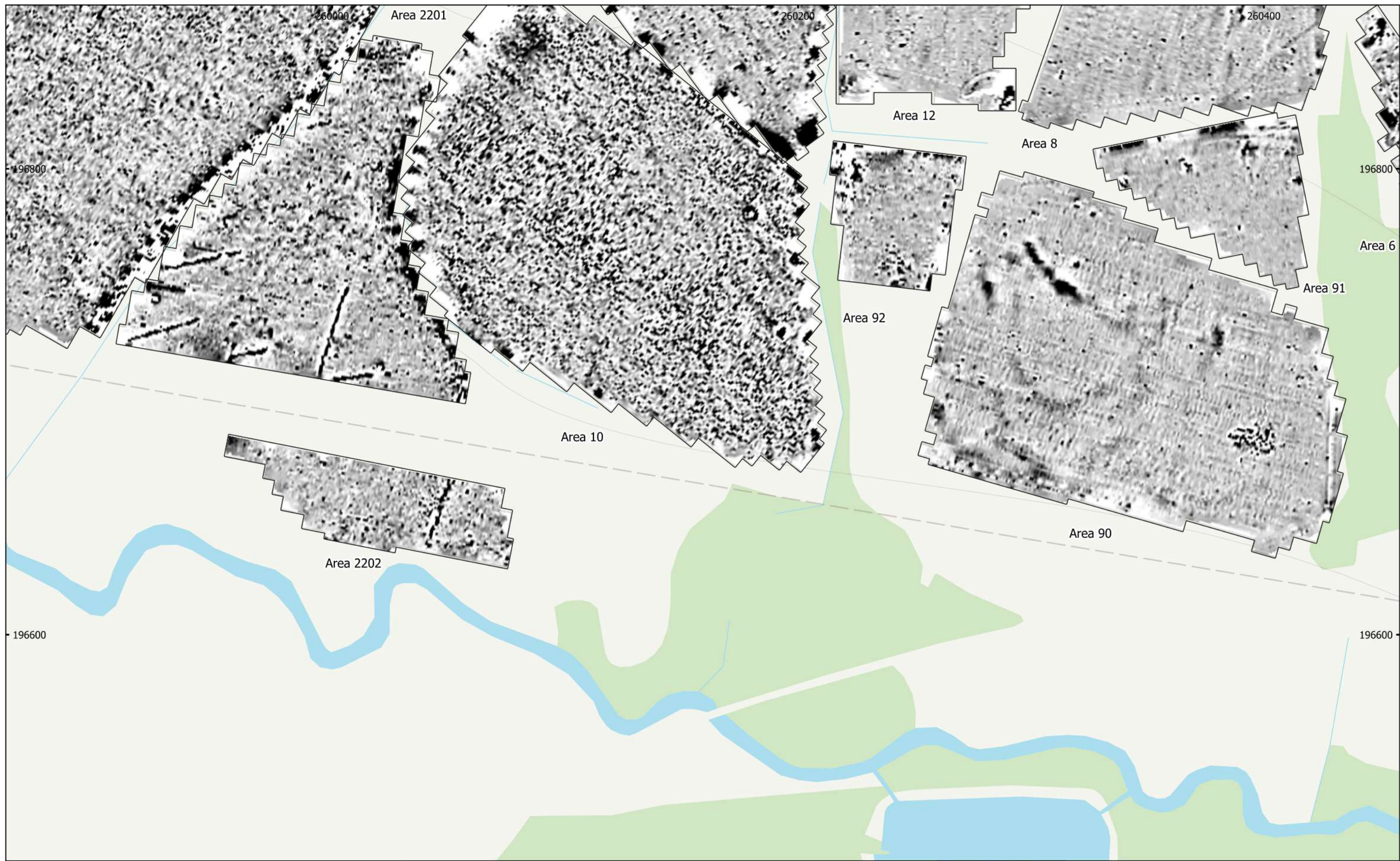
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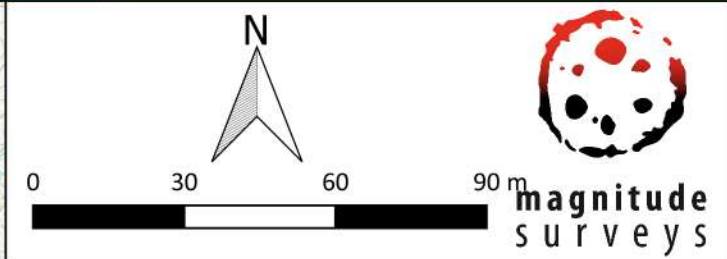
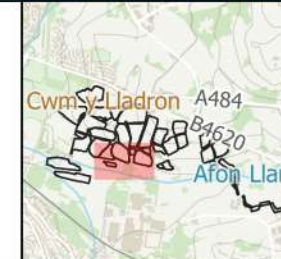
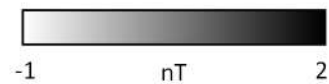
MSSS1328 - Parc Solar Caenewydd
 Figure 26 - XY Trace Plot (Areas 23 and 24)
 30nT/cm at 1:1,500 @ A3
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0 30 60 90 m
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 Figure 27 - Magnetic Gradient (Areas 10, 21, 2201, 2202, 90, 91 and 92)
 1:1,500 @ A3
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 Figure 28 - Magnetic Interpretation (Areas 10, 21, 2201, 2202, 90, 91 and 92)
 1:1,500 @ A3
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- | | | |
|-------------------------|--------------------------|----------------------|
| Agricultural (Strong) | Natural (Strong) | Undetermined (Weak) |
| Agricultural (Weak) | Natural (Weak) | Agricultural (Trend) |
| Magnetic Disturbance | Possible Mining Activity | Drainage Feature |
| Ferrous/Debris (Spread) | Undetermined (Strong) | Ferrous (Spike) |

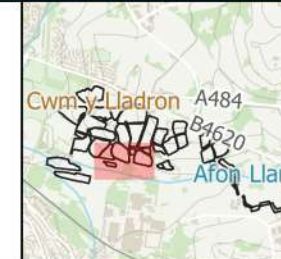


0 30 60 90 m

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MSSS1328 - Parc Solar Caenewydd
 Figure 29 - XY Trace Plot (Areas 10, 21, 2201, 2202, 90, 91 and 92)
 30nT/cm at 1:1,500 @ A3
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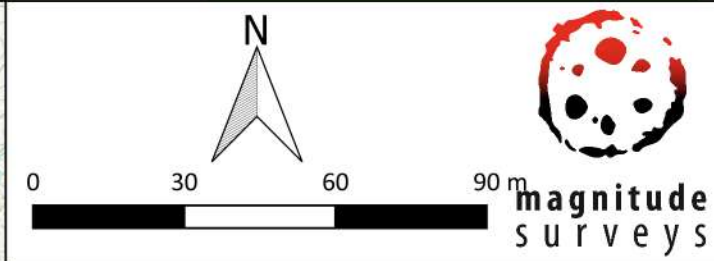
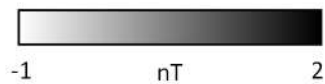


A north arrow pointing upwards and a scale bar showing 0, 30, 60, and 90 meters.





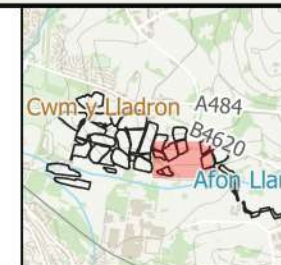
MSSS1328 - Parc Solar Caenewydd
 Figure 30 - Magnetic Gradient (Areas 2, 3, 5, 51, 6, 61, 70 and 71)
 1:1,500 @ A3
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MSSS1328 - Parc Solar Caenewydd
 Figure 31 - Magnetic Interpretation (Areas 2, 3, 5, 51, 6, 61, 70 and 71)
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- | | | |
|-------------------------|--------------------------|--------------------------|
| Agricultural (Strong) | Natural (Weak) | Industrial/Modern |
| Agricultural (Weak) | Possible Mining Activity | Ridge and Furrow (Trend) |
| Magnetic Disturbance | Undetermined (Strong) | Drainage Feature |
| Ferrous/Debris (Spread) | Undetermined (Weak) | Ferrous (Spike) |



0 30 60 90 m

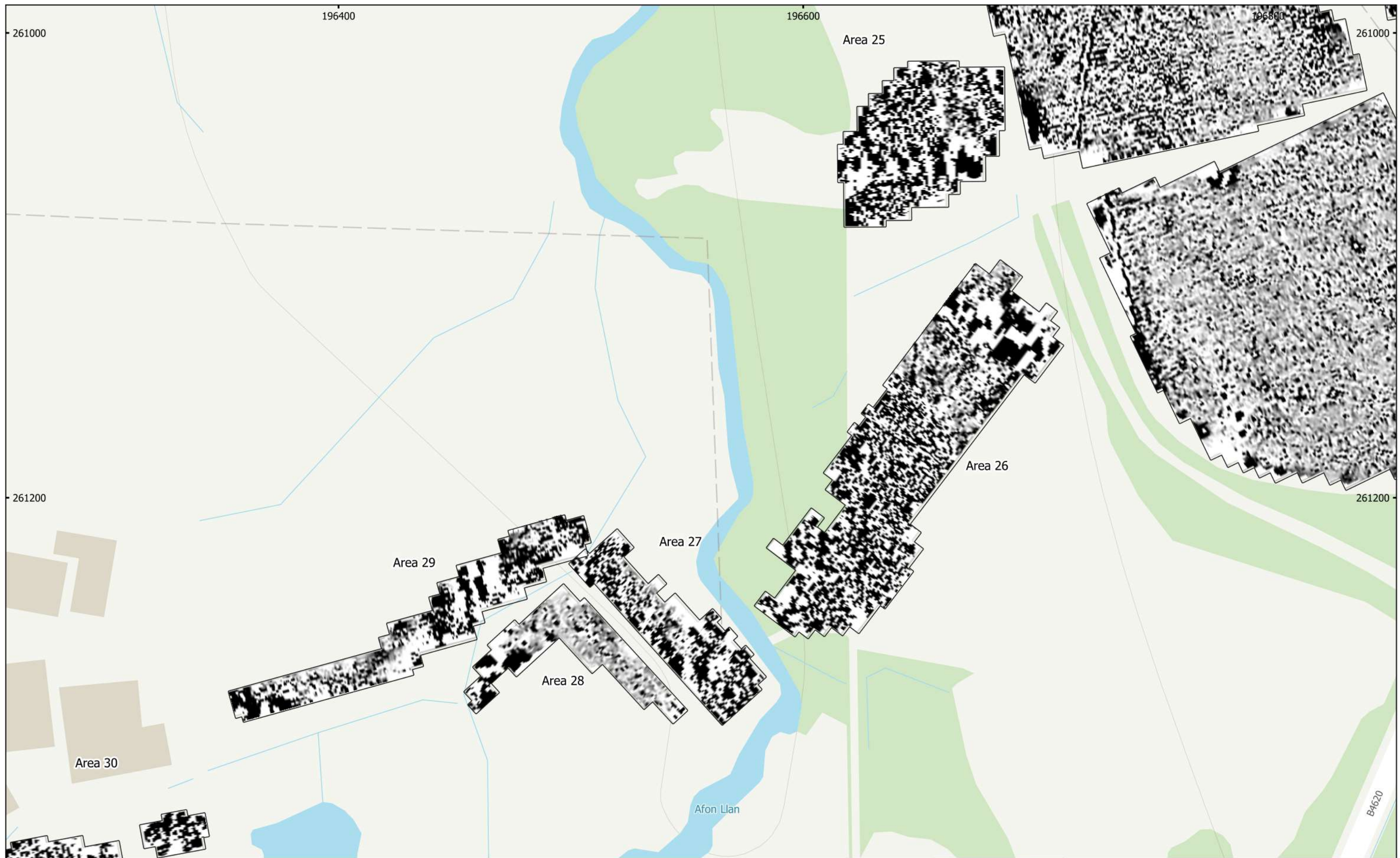
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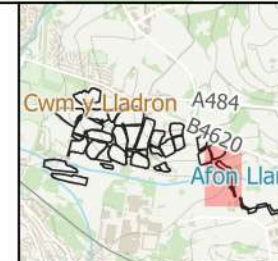
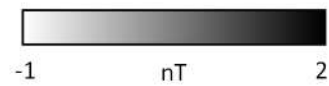
MSSS1328 - Parc Solar Caenewydd
 Figure 32 - XY Trace Plot (Areas 2, 3, 5, 51, 6, 61, 70 and 71)
 30nT/cm at 1:1,500 @ A3
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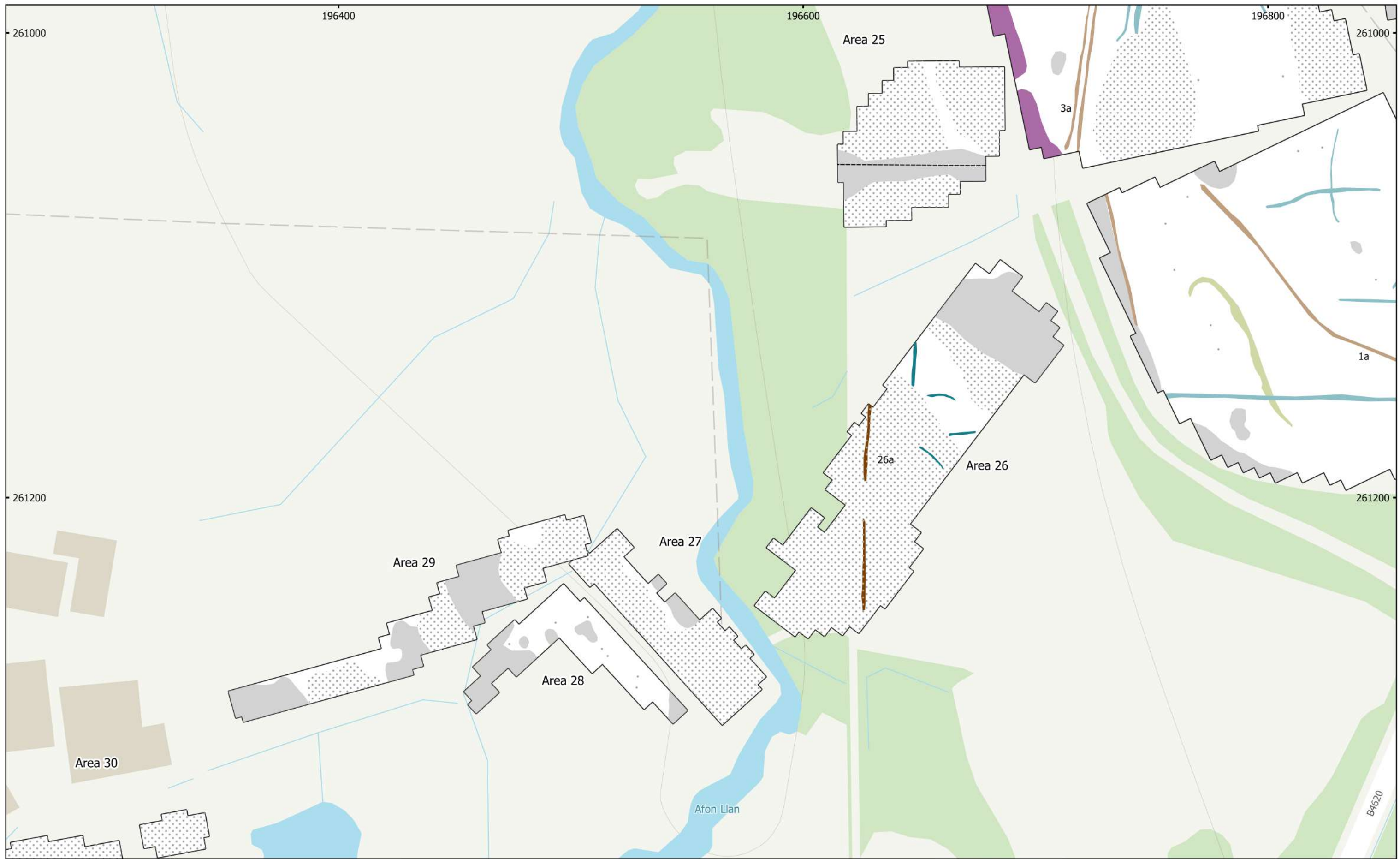
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 Figure 33 - Magnetic Gradient (Areas 24, 25, 26, 27 and 28)
 1:1,500 @ A3
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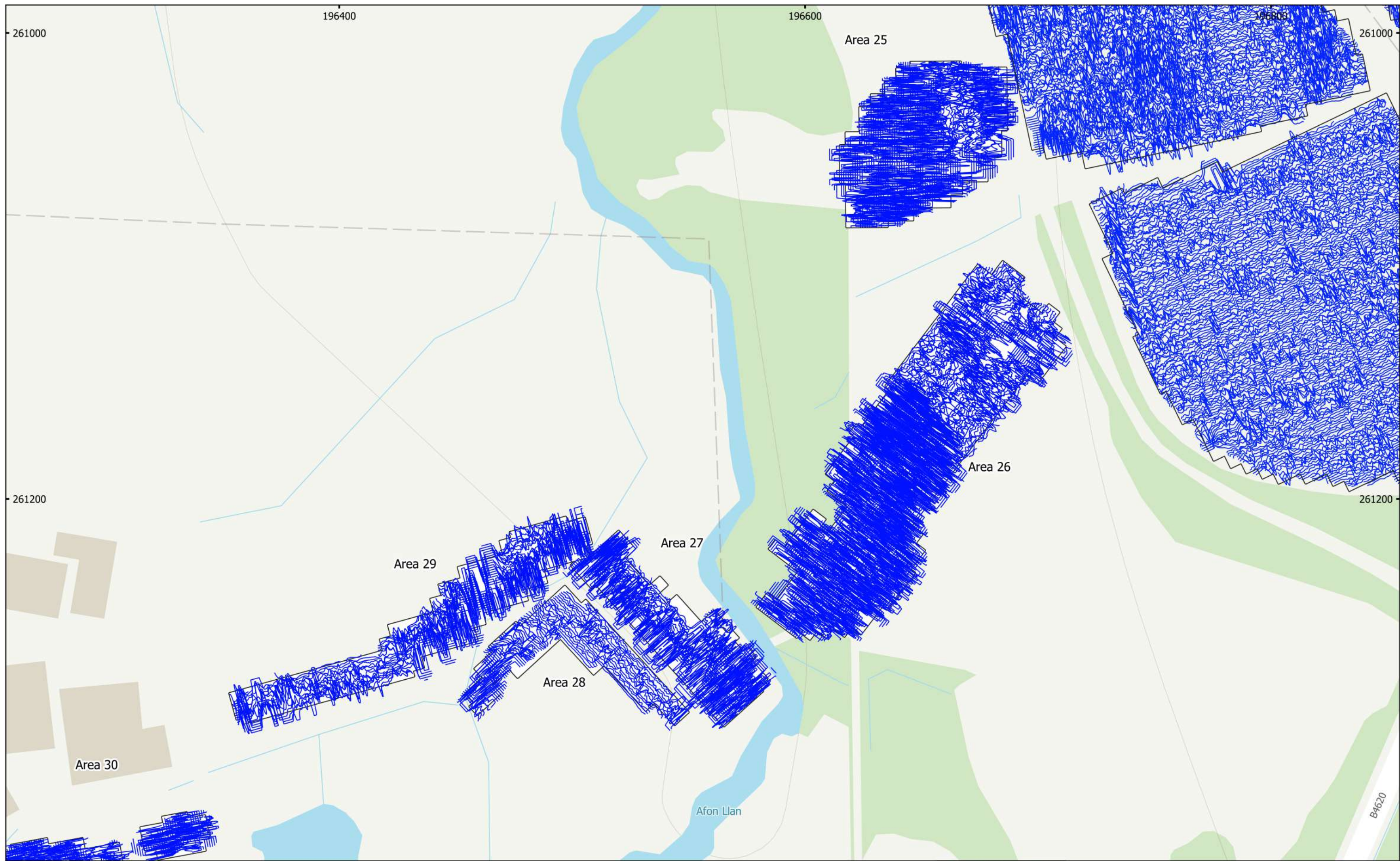


MSSS1328 - Parc Solar Caenewydd
 Figure 34 - Magnetic Interpretation (Areas 24, 25, 26, 27 and 28)
 1:1,500 @ A3
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- | | | |
|-----------------------|-------------------------|-------------------|
| Agricultural (Strong) | Ferrous/Debris (Spread) | Industrial/Modern |
| Agricultural (Weak) | Undetermined (Strong) | Service |
| Magnetic Disturbance | Undetermined (Weak) | Ferrous (Spike) |



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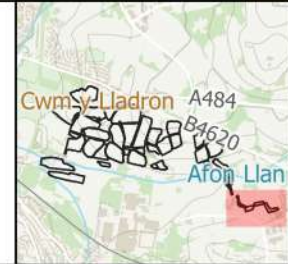
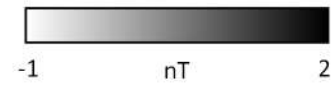
MSSS1328 - Parc Solar Caenewydd
 Figure 35 - XY Trace Plot (Areas 24, 25, 26, 27 and 28)
 30nT/cm at 1:1,500 @ A3
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The complex block contains a north arrow pointing towards the top right, a scale bar showing 0, 30, 60, and 90 meters, and the logo for 'magnitude surveys'.



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 Figure 36 - Magnetic Gradient (Areas 28, 29, 30 and 31)
 1:1,500 @ A3
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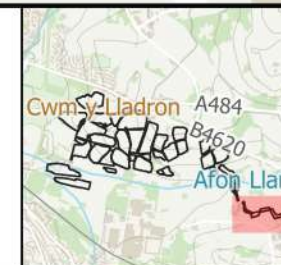


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MSSS1328 - Parc Solar Caenewydd
 Figure 37 - Magnetic Interpretation (Areas 28, 29, 30 and 31)
 1:1,500 @ A3
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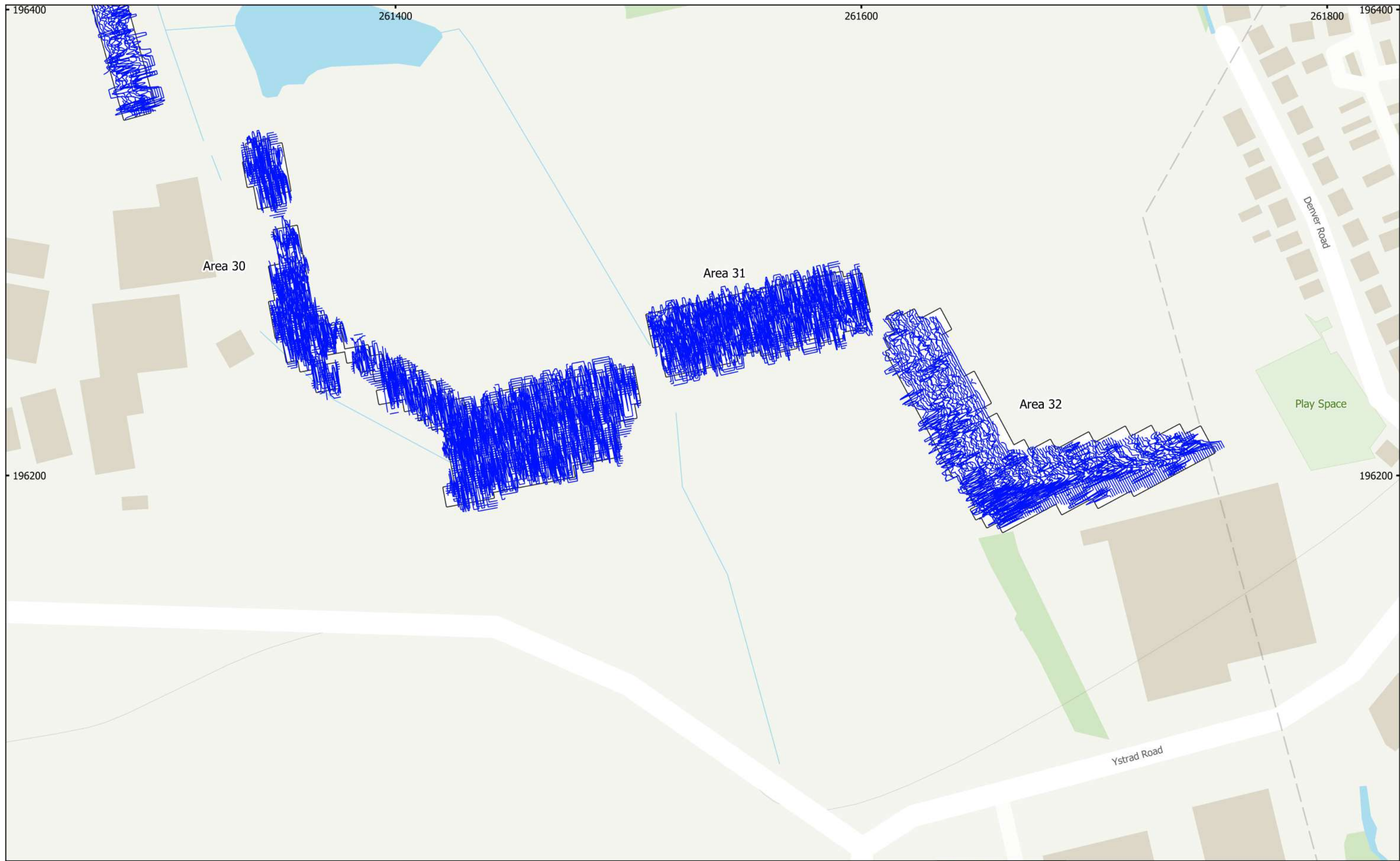
- Magnetic Disturbance
- Ferrous/Debris (Spread)
- Undetermined (Weak)
- Undetermined (Strong)



N

0 30 60 90 m

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MSSS1328 - Parc Solar Caenewydd
 Figure 38 - XY Trace Plot (Areas 28, 29, 30 and 31)
 30nT/cm at 1:1,500 @ A3
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A north arrow pointing upwards and a scale bar below it. The scale bar is marked with 0, 30, 60, and 90 meters. To the right of the scale bar is the logo for 'magnitude surveys', which consists of a stylized globe icon and the text 'magnitude surveys'.