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Geophysical Survey Report
Stowmarket Solar Farm, Middlewood Green
East of Stowmarket, Suffolk

For
Cotswold Archaeology

On Behalf of
DLP Planning Ltd

Magnitude Surveys Ref: MSTM1514

OASIS Number:magnitud1-513503

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Abstract

Magnitude Surveys was commissioned to assess the subsurface archaeological potential of a c. 35.6ha of land east of Stowmarket, Suffolk. A fluxgate gradiometer survey was successfully completed across the survey area with the exception of an area totalling c. 4.2ha, due to heavily waterlogged ground. No anomalies of significant archaeological interest were discovered, although anomalies of an undetermined origin were identified. Anomalies consistent with agricultural activities, including former field divisions and drainage systems have been identified. Two anomalies classed as 'Undetermined' were detected within the survey area and for which an archaeological origin cannot be excluded. Magnetic disturbance resultant from modern activities is limited to field edges and overhead cables and might obscure weaker anomalies should they be present.

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1. Introduction

- 1.1. Magnitude Surveys Ltd (MS) was commissioned by Cotswold Archaeology on behalf of DLP Planning Ltd to undertake a geophysical survey over a c. 35.6ha area of agricultural land east of Stowmarket, Suffolk (TM 08681 61380).
- 1.2. The geophysical survey comprised 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).
- 1.3. 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).
- 1.4. It was conducted in line with a WSI produced MS (Dolan, 2023).
- 1.5. The survey commenced on 13th March 2023 and took four 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 of GeoSIG (CIfA 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, 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. 4.1km northeast of the centre of Stowmarket (Figure 1). Gradiometer survey was undertaken across four fields under arable cultivation. The survey area lay between Larks Rise in the north and the A1120 to the south, and adjacent and to the west of Blacksmith's Lane. It was further surrounded by additional agricultural fields (Figure 2). An area of c. 4.2ha could not be surveyed due to heavily waterlogged ground.

4.2. Survey considerations:

Survey Area	Ground Conditions	Further Notes
1	The survey area consisted of a flat arable field.	The survey area was bordered by trees in the north and a ditch with occasional trees to the east. The southern and western borders consisted of a ditch with hedgerow and trees.
2	The survey area consisted of flat arable field.	The survey area was bordered by an open ditch to the north and east, the remaining boundaries consisted of ditches and hedgerows.
3	The survey area consisted of a flat arable field.	The survey area was bordered on all sides by a ditch with occasional trees along the western edge, except for a portion of the easternmost corner where there was no physical boundary.
4	The survey area consisted of a flat arable field.	The survey area was bordered by a ditch and trackway to the west and a treelined ditch to the east. An open ditch created the northern border and the south-eastern corner. There was no physical boundary in the south-eastern corner.

4.3. The underlying geology comprises sand of the Crag Group. Superficial deposits across the whole of the survey area consist of of Diamicton of the Lowestoft Formation (British Geological Survey, 2023).

4.4. The soils consist of slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils (Soilscapes,2023).

5. Archaeological Background

5.1. The following is a summary of a Desk-Based Assessment produced and provided by Cotswold Archaeology (Karpinski, 2023).

5.2. Prehistoric activity within the survey area is limited to a findspot of a Mesolithic tranchet axehead (MSF4219) found within the northeast of the survey area and a Bronze Age looped spearhead found by detectorists at an unspecified location within the south of the survey area.

5.3. Within the wider area, possible ring ditch cropmarks have been identified c. 130m to the south of the survey area through a search of historic Google Satellite imagery. Probable prehistoric burnt flints (MSF30605) were found during a watching brief undertaken c. 480m south of the survey area.

- 5.4. Roman activity has been identified in the wider environs. An excavation undertaken in 1987 by Suffolk Archaeological Unit revealed features including a ditch, a small pit, and other finds of Roman date c. 190m south of the site (MSF11596). Cropmarks indicating possible rectilinear enclosures were observed c. 215m south of the survey area and could possibly be associated with the finds detailed above. Further Roman findspots of pottery and coins have been identified in the wider area (MSF7455, MSF4216, MSF5382) at c.365m south, c. 815m southeast and c. 475m west of the survey area respectively, indicating further possibility of Roman activity within the wider area.
- 5.5. Medieval activity has been identified within the wider area, including close to the survey area boundary. Adjacent to the survey boundary, there is cropmark evidence from aerial imagery indicating an L-shaped cropmark (1582914) abutting the survey area to the west. This is found in close proximity to an early medieval pottery scatter c. 15m west of the site (MSF5381). Further finds to the west include further pottery scatters c. 40m (MSF5379), c. 220m (MSF5380) and c. 540m (MSF5375) away, further supporting the evidence of a wider medieval landscape to the west of the survey area.
- 5.6. Further medieval activity is located within the wider environs. A medieval moated site (MSF4217) is located c. 920m to the northeast of the survey area. A medieval ditch (1471386) was recorded c. 580m southeast of the survey area during a watching brief.

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 hand-carried GNSS-positioned system].
- 6.1.4.1. MS' hand-carried system was 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 (Figures 7, 10, 13, 16 & 19), as well as the total field data from the lower sensors (Figures 3 & 5). 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). 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).
- 7.2.2. The geophysical survey was completed across the majority of the survey area, with c. 4.2ha unable to be surveyed due to waterlogged ground. The fluxgate gradiometer survey has responded well to the environment of the survey area, and identified anomalies of agricultural, natural and modern origins. Modern interference was generally limited to field edges and overhead cables.
- 7.2.3. The geophysical results primarily reflect historical and modern agricultural activity, in the form of mapped former field boundaries, modern ploughing trends and drainage systems. Anomalies of natural origin have also been identified, in the form of weak, amorphous anomalies, likely resulting from changes in the underlying geology.
- 7.2.4. Anomalies of undetermined origin have also been identified. These lack contextual and morphological evidence for a more definitive interpretation. They may be of agricultural, natural or modern origin, but an archaeological origin cannot be ruled out.

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. **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.
- 7.3.1.4. **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. **Agricultural (Weak)** – Within Areas 2, 3 and 4 multiple linear and curvilinear anomalies have been identified (Figures 11, 14, 17 & 20). The anomalies correspond with mapped former field boundaries visible on historical OS mapping (Figures 4 & 6) and some can be seen as cropmarks in satellite imagery. In addition to the cartographic evidence, the strength and morphology of the magnetic signal is characteristic of past field boundaries and can be confidently interpreted as evidence of past field divisions.
- 7.3.2.2. **Drainage Feature (Trend)** – Multiple linear anomalies have been identified across most of the survey area, running on varying orientations (Figures 11, 14, 17 & 20). The weak dipolar signal visible in the XY Trace Plot (Figures 12, 15, 18 & 21) and morphology of these anomalies are characteristic of a field drainage system. The varying magnetic enhancements of these anomalies are reflective of the different types and composition of the drains.
- 7.3.2.3. **Natural (Weak and Spread)** – Several areas of slightly magnetically enhanced material have been identified and are best seen in the total field data (Figures 3 & 5). The amorphous nature and weak positive magnetic signal indicate that they are resultant from natural processes, possibly pedological silting consistent with the microtopography of the area.
- 7.3.2.4. **Undetermined** – In the northern part of Area 2 an incomplete penannular anomaly has been identified (Figure 17). The anomaly measures c. 20m in diameter and c. 1m wide. A further weak curvilinear anomaly was identified in the central part of Area 3 (Figures 11 & 14). They are not consistent with

agricultural regimes or natural variations within the survey area. Although of evident circular or penannular morphology, the lack of distinctive signal or contextual evidence prevents a more robust interpretation. They may be resultant from natural processes, or possibly agricultural or modern activities but an archaeological origin cannot be excluded without further investigation.

8. Conclusions

- 8.1. A fluxgate gradiometer survey was successfully completed across c. 31.4ha of the survey area. An area of c. 4.2ha could not be surveyed due to heavily waterlogged ground. The impact of modern disturbance on the data is limited to the edges of the survey area.
- 8.2. The geophysical results reflect the long-term agricultural use of the area evidenced by multiple mapped field boundaries and extensive drainage systems.
- 8.3. Natural variations consistent with changes in the natural geology and likely resultant from localised colluvial deposition have been identified across the survey area.
- 8.4. Some anomalies have been classed as undetermined because it has not been possible to definitively determine whether they are a consequence 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.

10. Copyright

- 10.1. Copyright and intellectual property pertaining to all reports, figures and datasets produced by Magnitude Services Ltd is retained by MS. The client is given full licence to use such material for their own purposes. Permission must be sought by any third party wishing to use or reproduce any IP owned by MS.

11. References

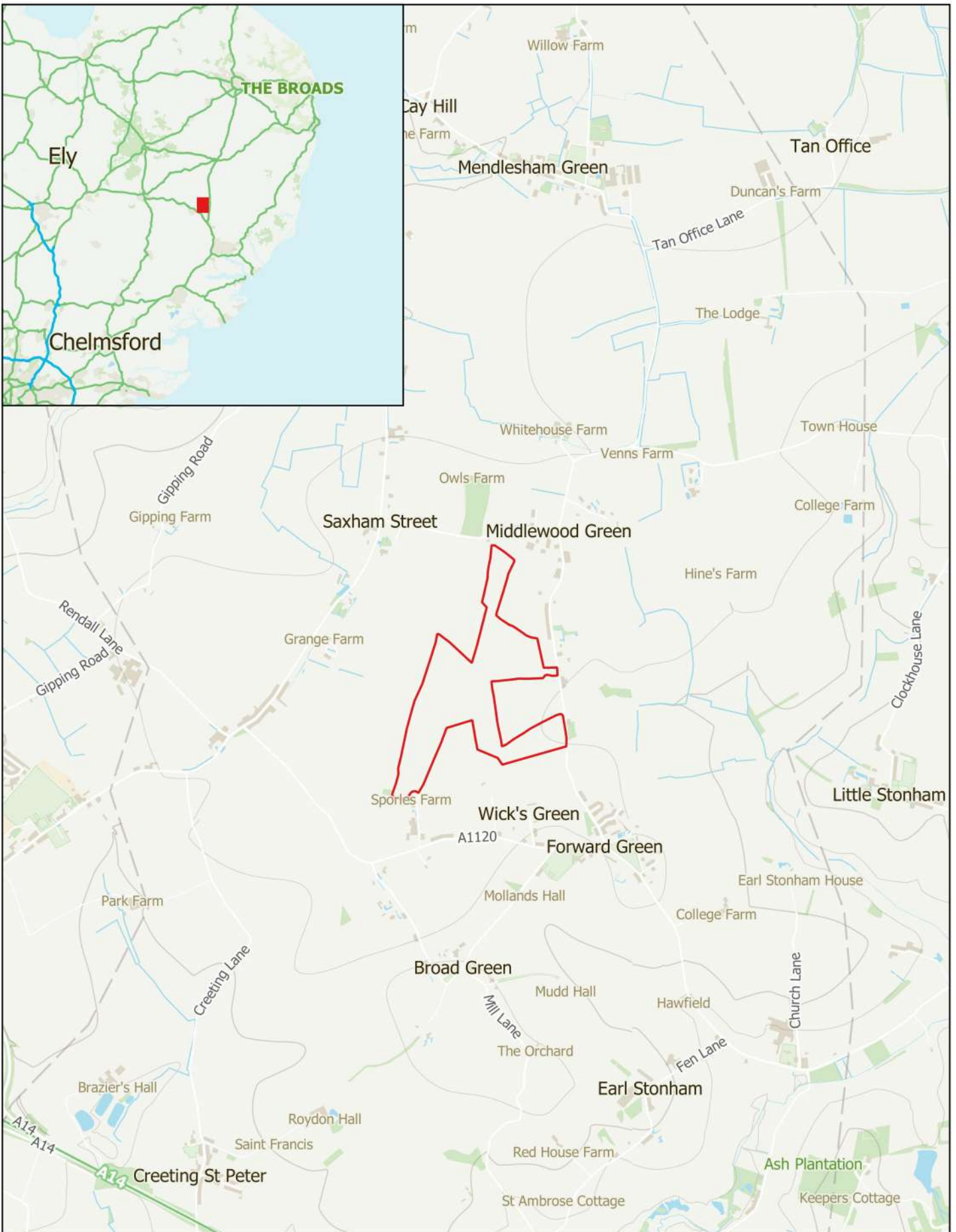
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12. Project Metadata

MS Job Code	MSTM1514
Project Name	Stowmarket Solar Farm, Middlewood Green, East of Stowmarket, Suffolk
Client	Cotswold Archaeology
Grid Reference	TM 08681 61380
Survey Techniques	Magnetometry
Survey Size (ha)	35.6ha
Survey Dates	2023-13-03 – 2023-16-03
Project Lead	J. Dolan BSC FGS
Project Officer	J. Dolan BSc FGS
HER Event No	Pending Application Result
OASIS No	magnitud1-513503
S42 Licence No	N/A
Report Version	0.3

13. Document History

Version	Comments	Author	Checked By	Date
0.1	Initial draft for Project Lead to Review	DT	AL	13 April 2023
0.2	Corrections from Project Officer	AL, BH	PSJ	14 April 2023
0.3	Addition of archaeological background and client corrections	JD	-	18 April 2023



MSTM1514 - Stowmarket Solar Farm, Middlewood Green, East of Stowmarket, Suffolk

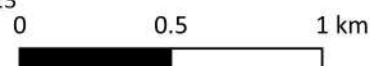
Figure 1 - Site Location

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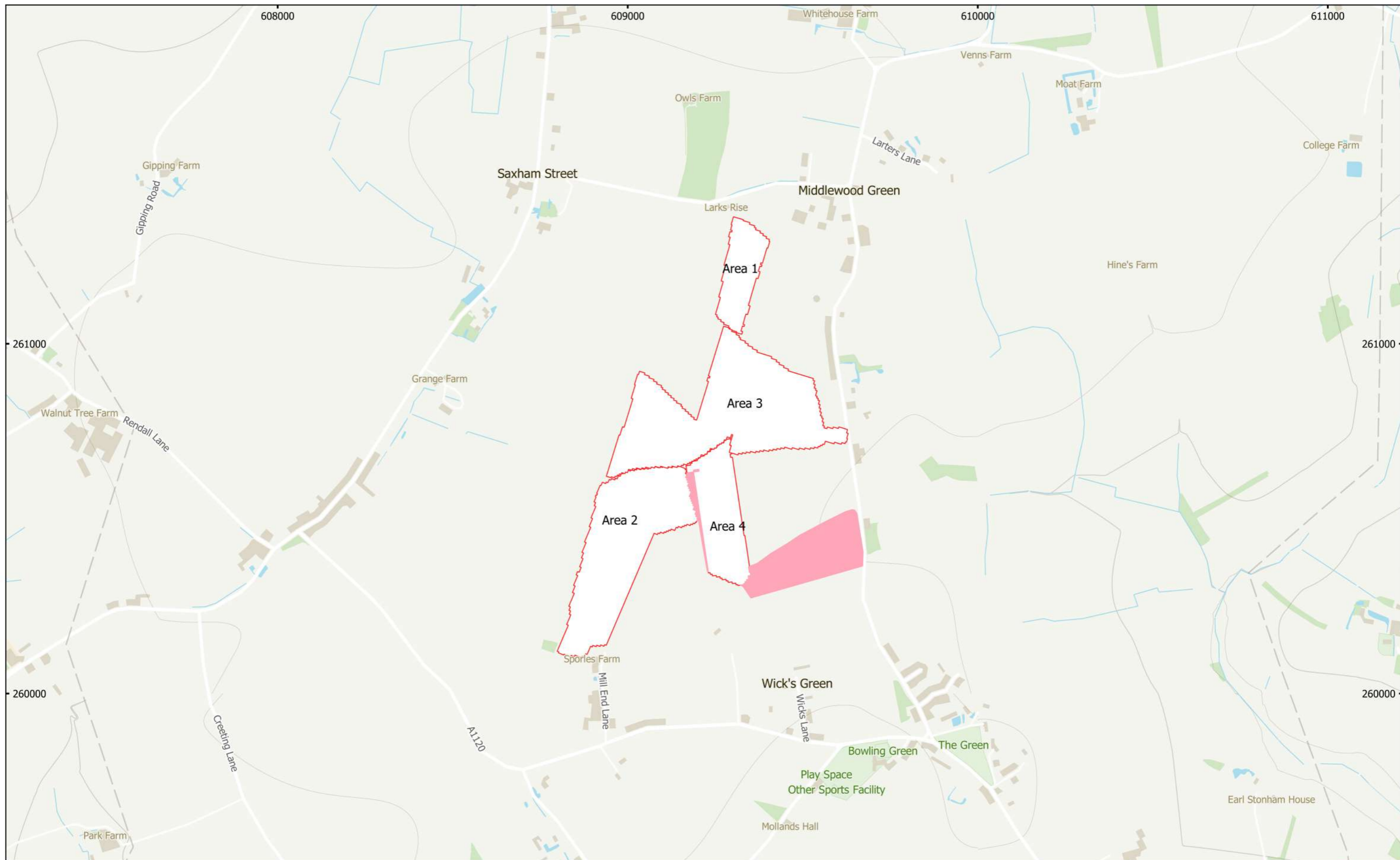
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 Site Boundary

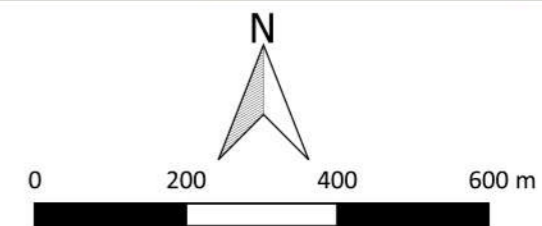


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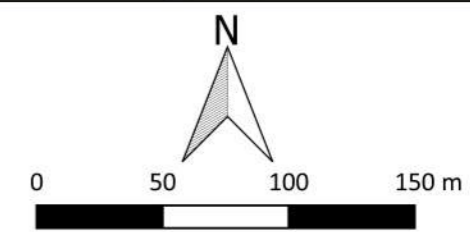
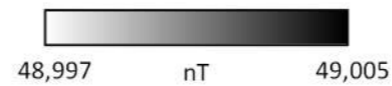
MSTM1514 - Stowmarket Solar Farm, Middlewood Green, East of Stowmarket, Suffolk
 Figure 2 - Location of Survey Areas
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- Survey Extent
- Unable to Survey





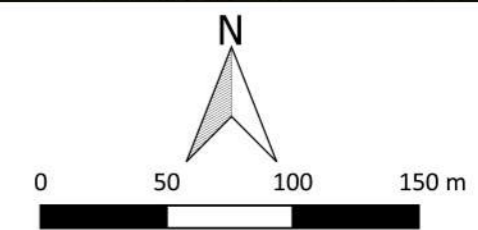
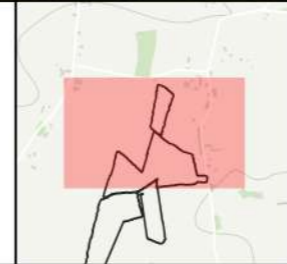
MSTM1514 - Stowmarket Solar Farm, Middlewood Green, East of Stowmarket, Suffolk
 Figure 3 - Magnetic Total Field (Lower Sensor) (Overview) (Areas 1 & 3 (North))
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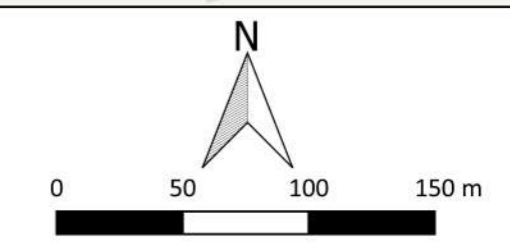
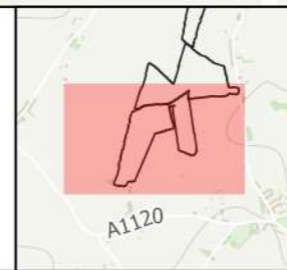
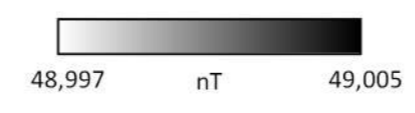
MSTM1514 - Stowmarket Solar Farm, Middlewood Green, East of Stowmarket, Suffolk
 Figure 4 - Magnetic Interpretation Over Historical Maps (Overview) (Areas 1 & 3 (North))
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- Agricultural (Weak)
- Undetermined (Weak)
- Natural (Spread)
- Magnetic Disturbance
- Natural (Weak)
- Drainage Feature
- Ferrous (Spike)





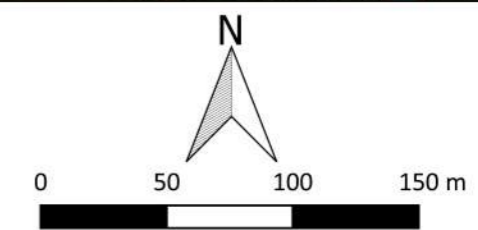
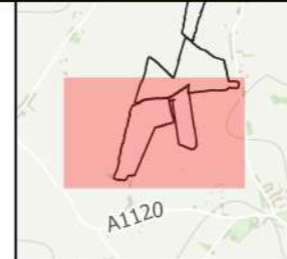
MSTM1514 - Stowmarket Solar Farm, Middlewood Green, East of Stowmarket, Suffolk
 Figure 5 - Magnetic Total Field (Lower Sensor) (Overview) (Areas 2, 3 & 4 (South))
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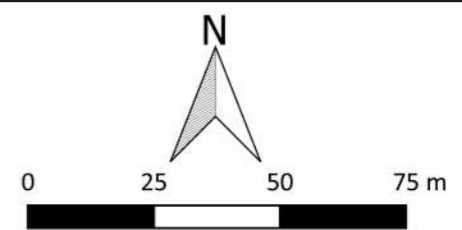
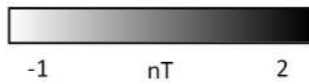
MSTM1514 - Stowmarket Solar Farm, Middlewood Green, East of Stowmarket, Suffolk
 Figure 6 - Magnetic Interpretation Over Historical Maps (Overview) (Areas 2, 3 & 4 (South))
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- Agricultural (Weak)
- Undetermined (Weak)
- Drainage Feature
- Magnetic Disturbance
- Ferrous (Spike)
- Natural (Spread)





MSTM1514 - Stowmarket Solar Farm, Middlewood Green, East of Stowmarket, Suffolk
Figure 7 - Magnetic Gradient (Area 1)
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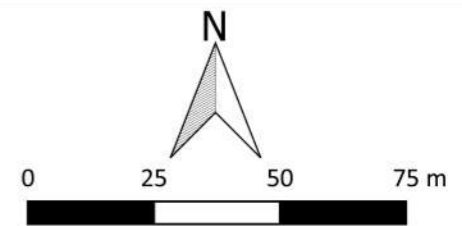


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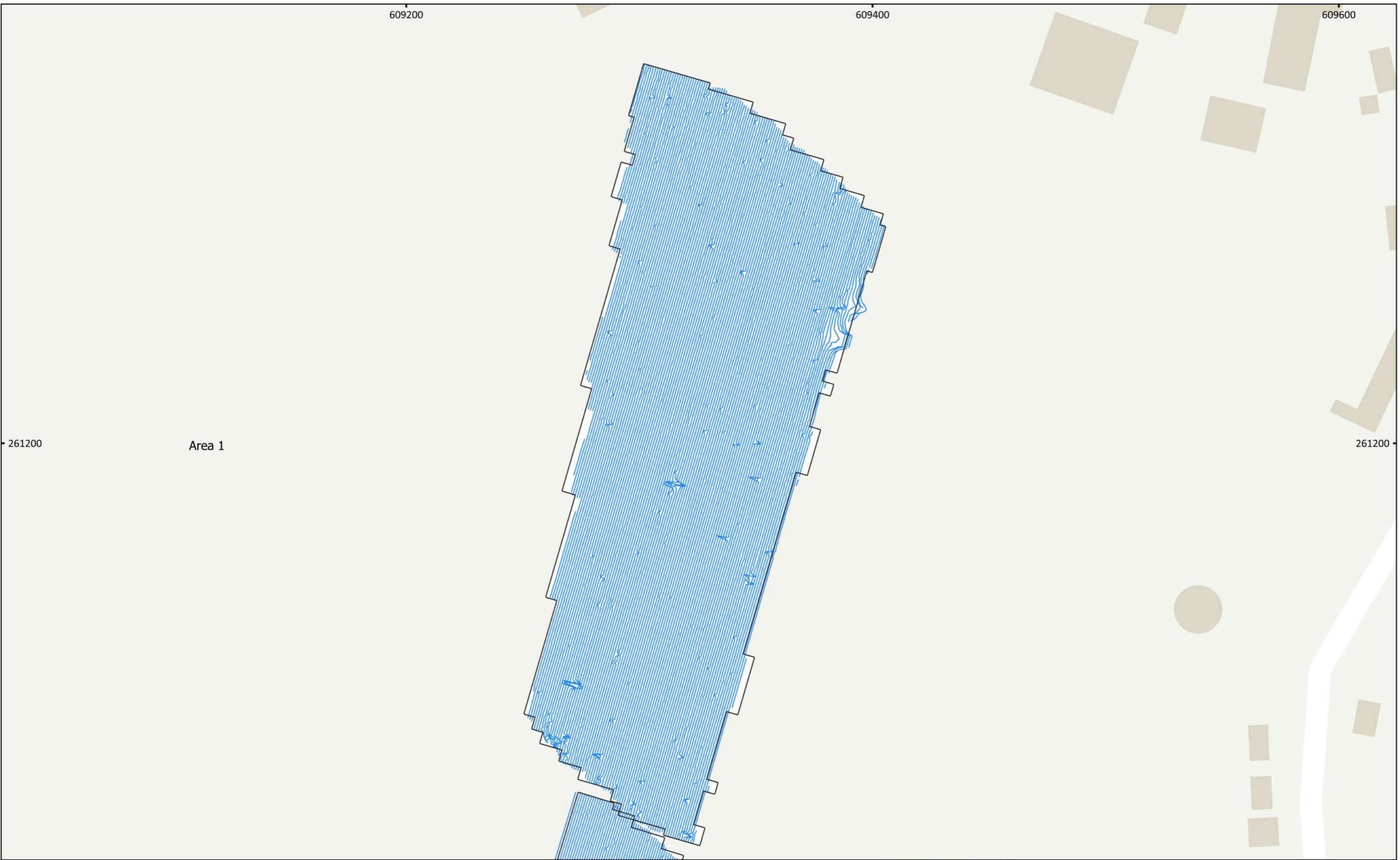


MSTM1514 - Stowmarket Solar Farm, Middlewood Green, East of Stowmarket, Suffolk
 Figure 8 - Magnetic Interpretation (Area 1)
 1:1,500 @ A3
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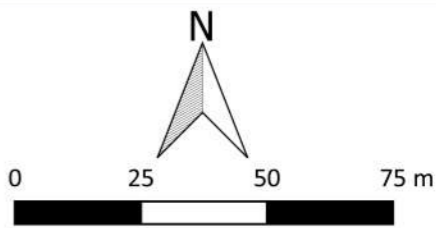
- Natural (Weak)
- Magnetic Disturbance
- Natural (Spread)
- Ferrous (Spike)



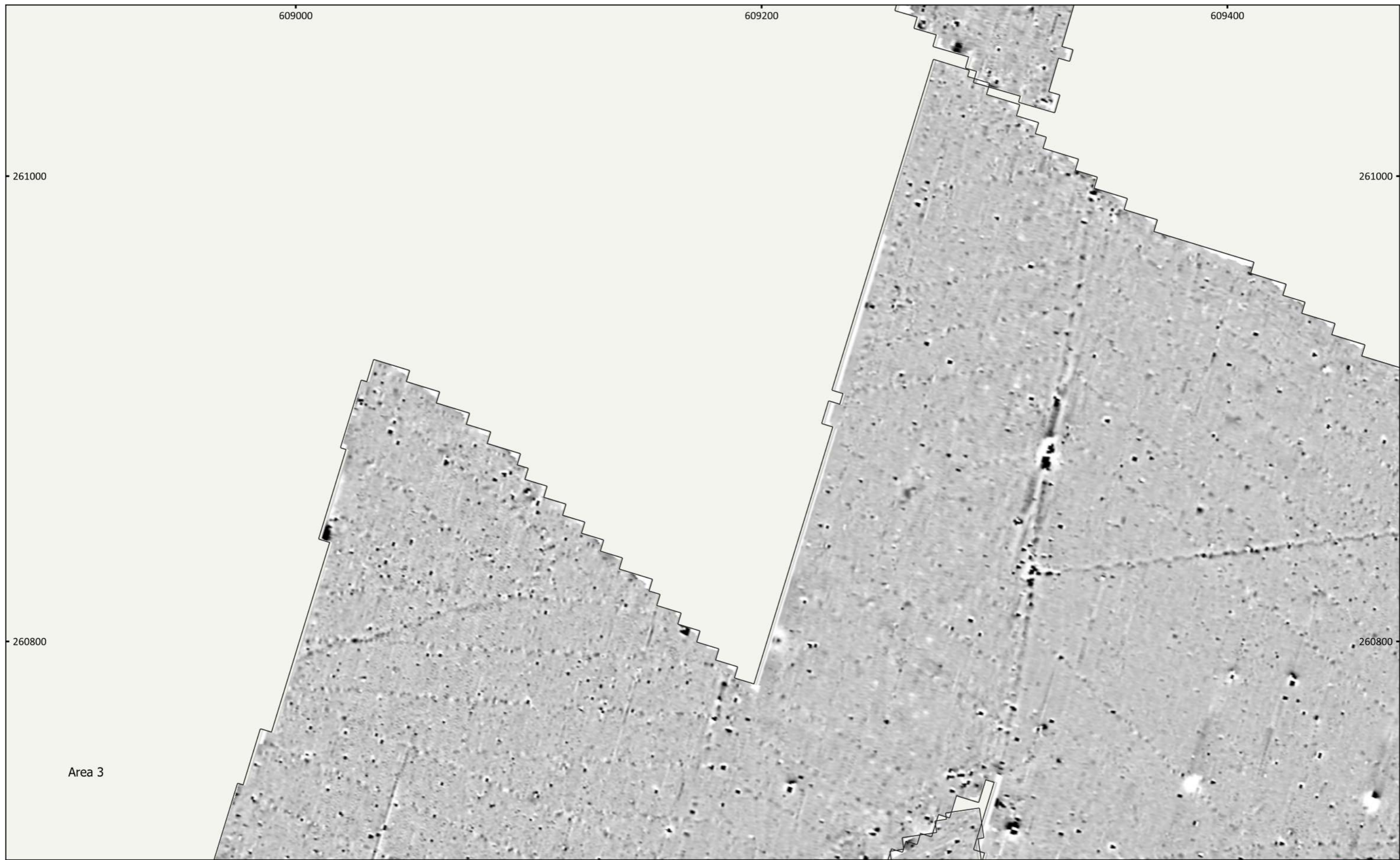
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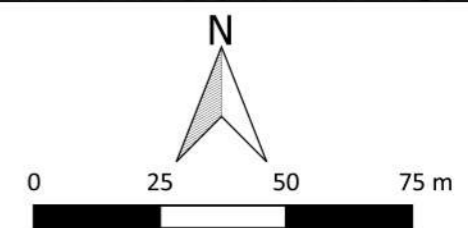
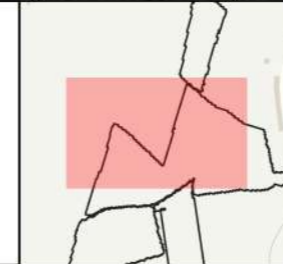
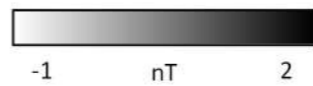
MSTM1514 - Stowmarket Solar Farm, Middlewood Green, East of Stowmarket, Suffolk
Figure 9 - XY Trace Plot (Area 1)
30nT/cm at 1:1,500 @ A3
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MSTM1514 - Stowmarket Solar Farm, Middlewood Green, East of Stowmarket, Suffolk
Figure 10 - Magnetic Gradient (Area 3 (East))
1:1,500 @ A3
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609000

609200

609400

261000

261000

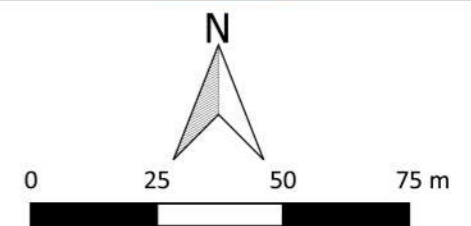
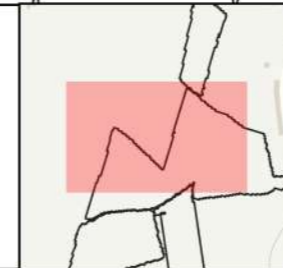
260800

260800

Area 3

MSTM1514 - Stowmarket Solar Farm, Middlewood Green, East of Stowmarket, Suffolk
 Figure 11 - Magnetic Interpretation (Area 3 (East))
 1:1,500 @ A3
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- | | |
|---|--|
|  Agricultural (Weak) |  Magnetic Disturbance |
|  Natural (Spread) |  Drainage Feature |
|  Undetermined (Weak) |  Ferrous (Spike) |



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surveys

609000

609200

609400

261000

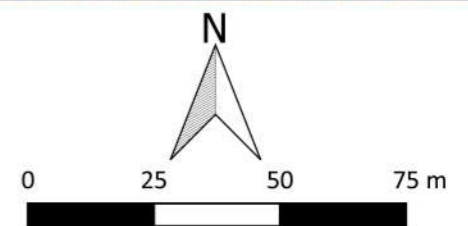
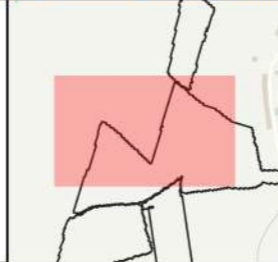
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260800

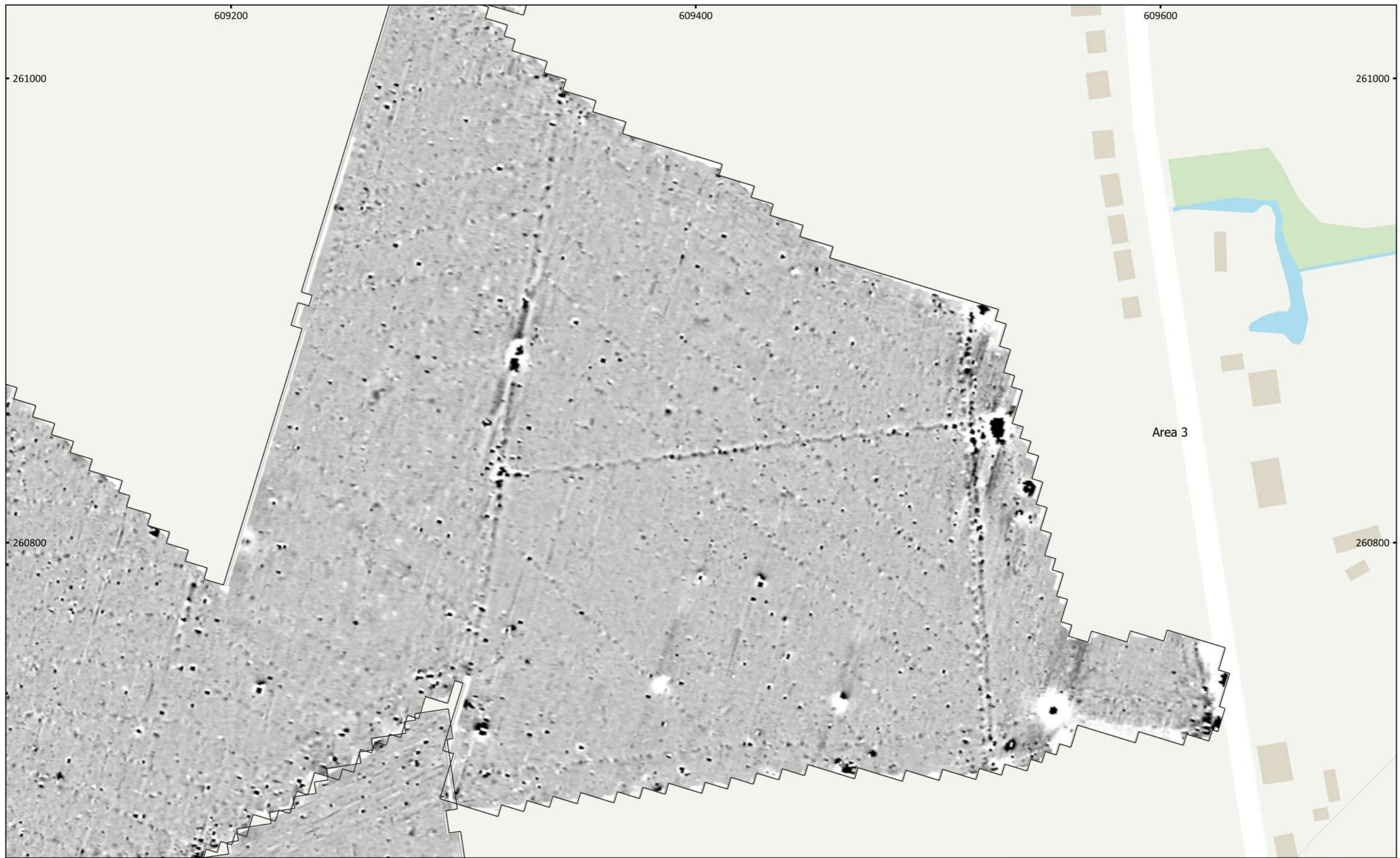
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Area 3

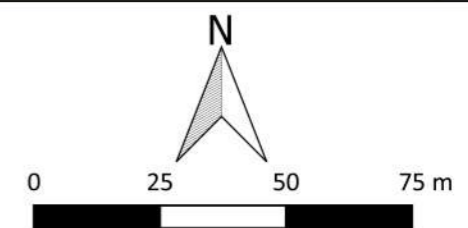
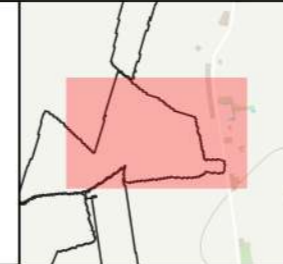
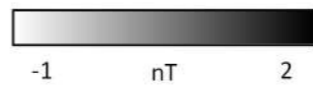
MSTM1514 - Stowmarket Solar Farm, Middlewood Green, East of Stowmarket, Suffolk
Figure 12 - XY Trace Plot (Area 3 (East))
30nT/cm at 1:1,500 @ A3
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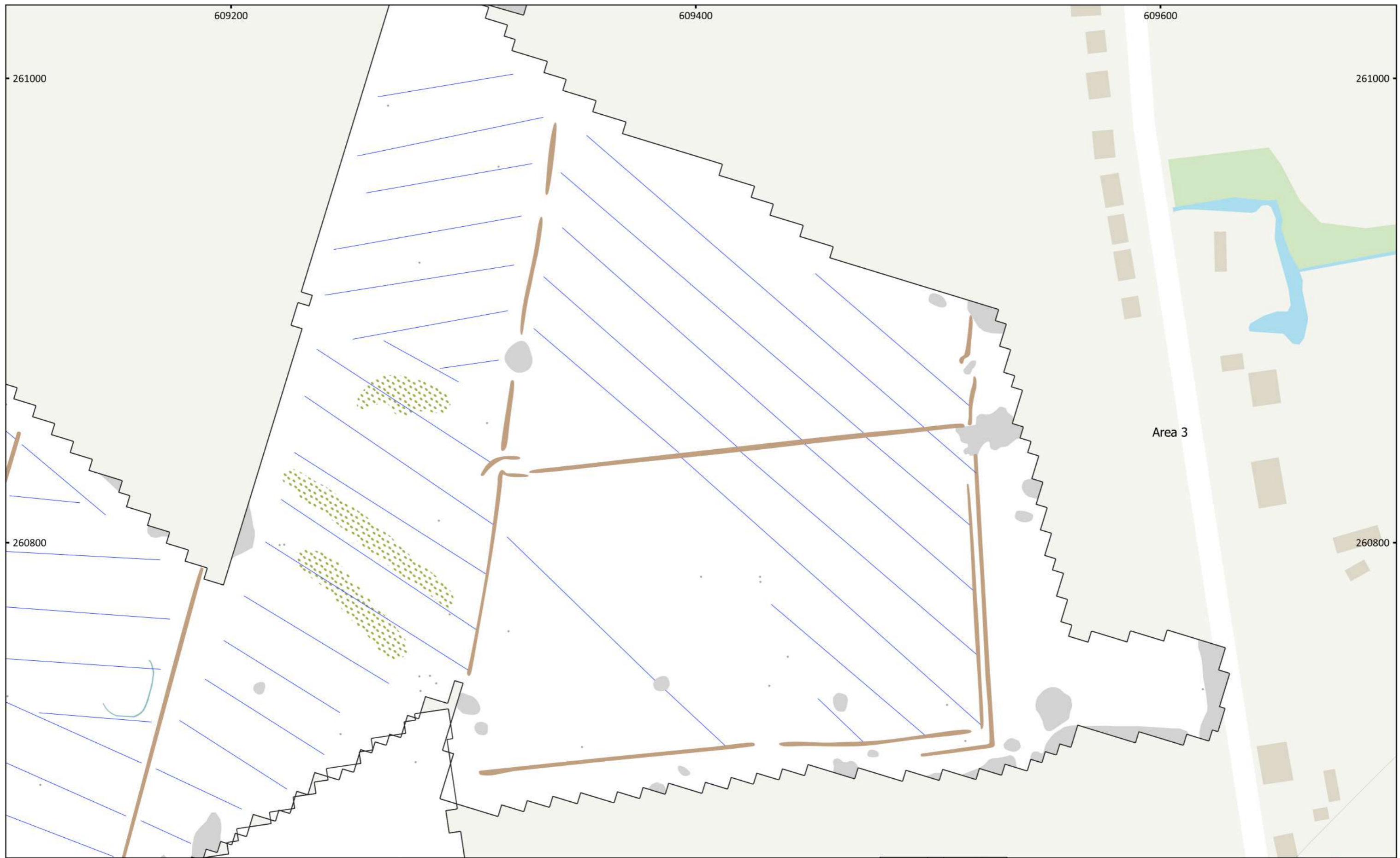
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MSTM1514 - Stowmarket Solar Farm, Middlewood Green, East of Stowmarket, Suffolk
 Figure 13 - Magnetic Gradient (Area 3 (West))
 1:1,500 @ A3
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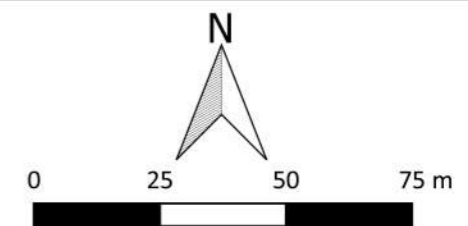
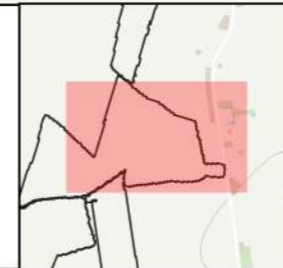


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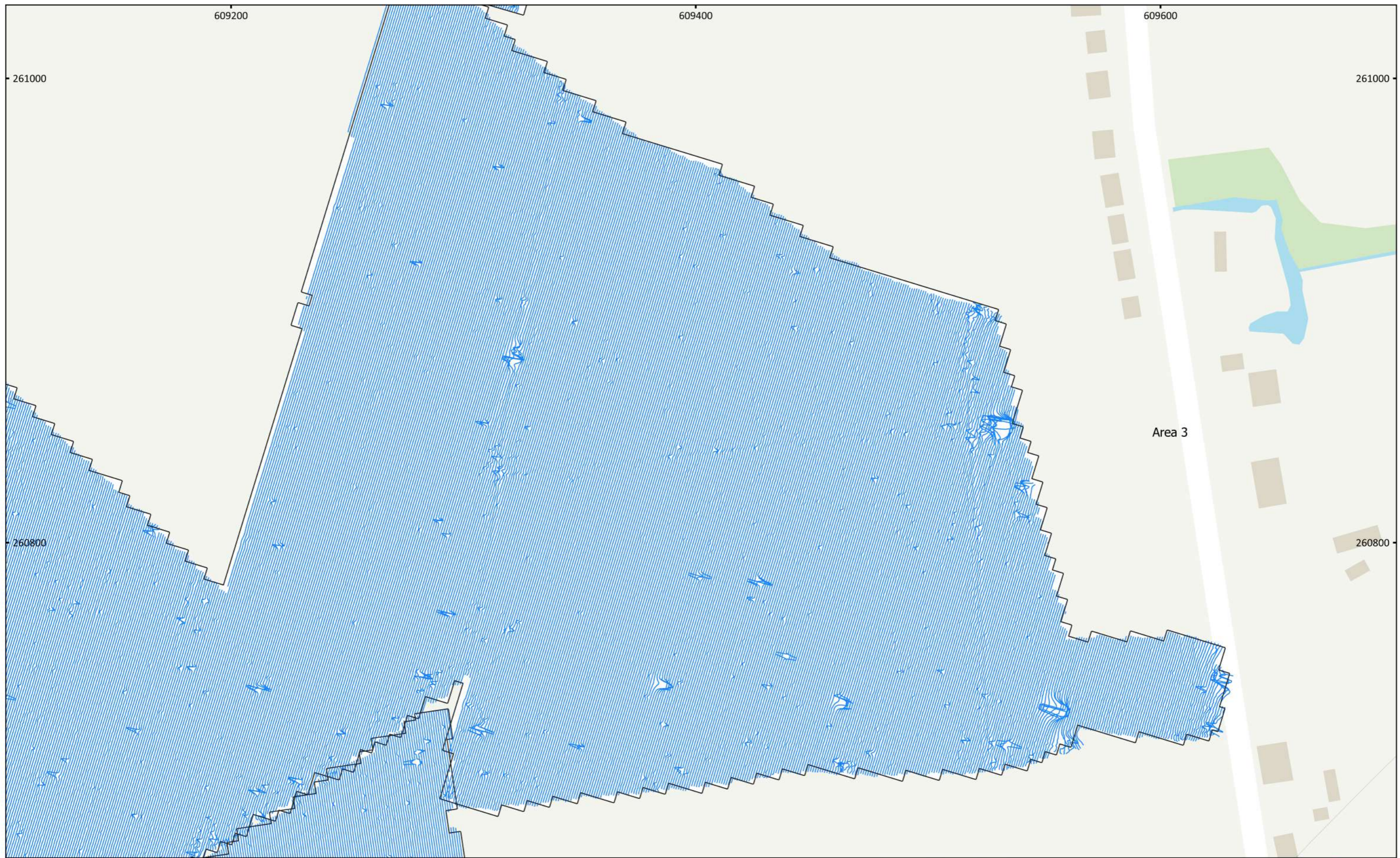


MSTM1514 - Stowmarket Solar Farm, Middlewood Green, East of Stowmarket, Suffolk
 Figure 14 - Magnetic Interpretation (Area 3 (West))
 1:1,500 @ A3
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- | | |
|---------------------|----------------------|
| Agricultural (Weak) | Magnetic Disturbance |
| Natural (Spread) | Drainage Feature |
| Undetermined (Weak) | Ferrous (Spike) |



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609200

609400

609600

261000

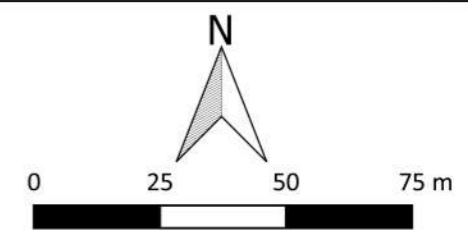
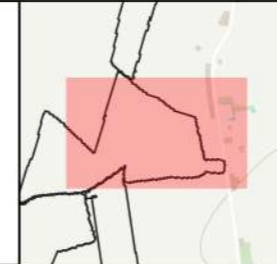
261000

260800

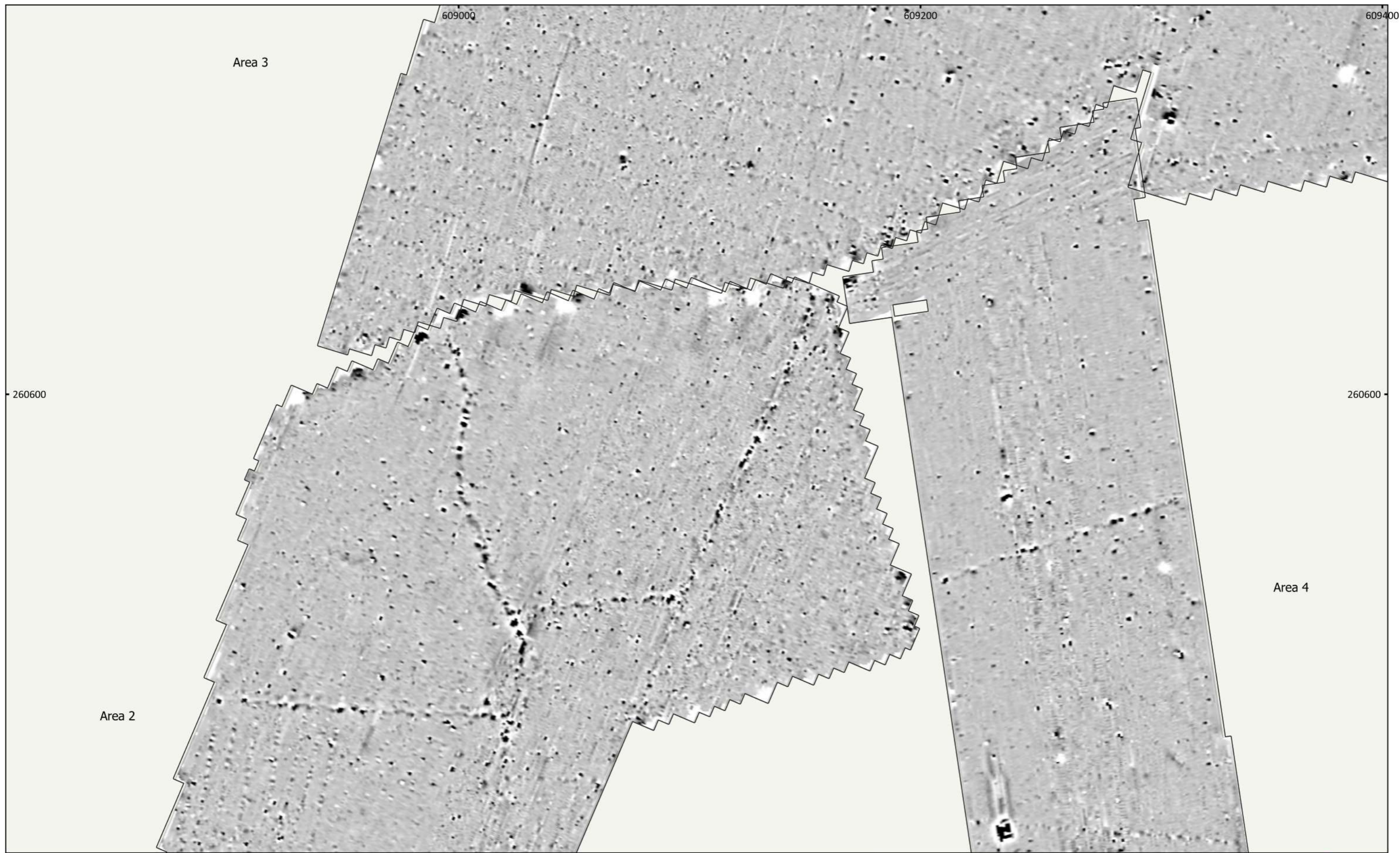
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Area 3

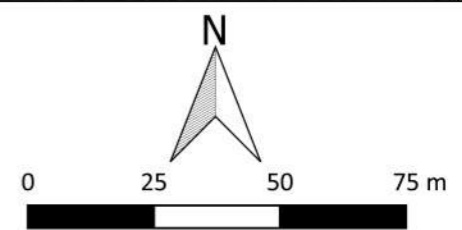
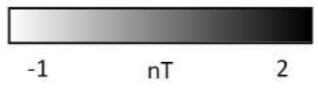
MSTM1514 - Stowmarket Solar Farm, Middlewood Green, East of Stowmarket, Suffolk
Figure 15 - XY Trace Plot (Area 3 (West))
30nT/cm at 1:1,500 @ A3
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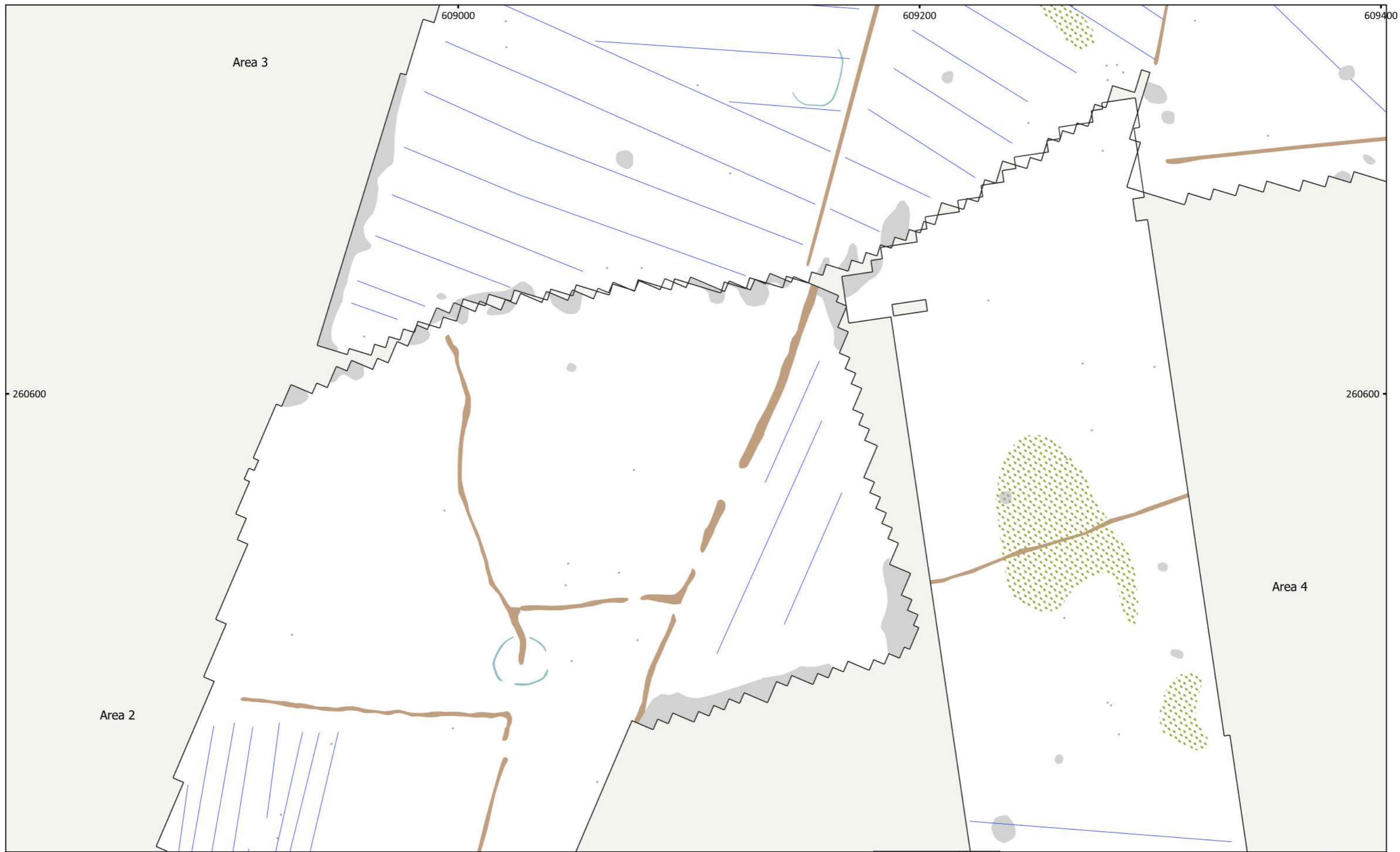


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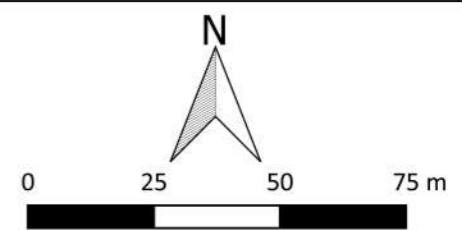
MSTM1514 - Stowmarket Solar Farm, Middlewood Green, East of Stowmarket, Suffolk
 Figure 16 - Magnetic Gradient (Areas 2 & 4 (North))
 1:1,500 @ A3
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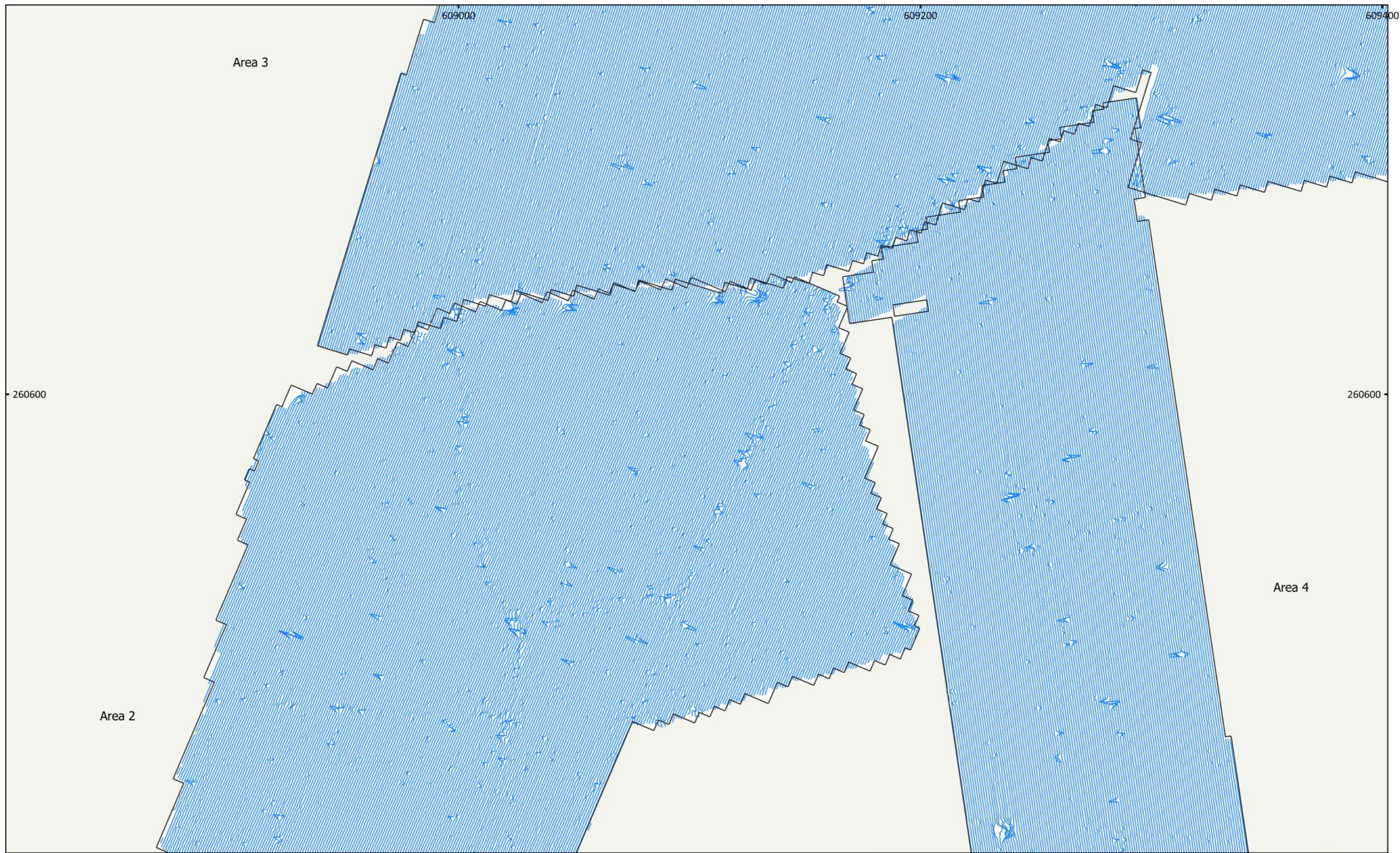




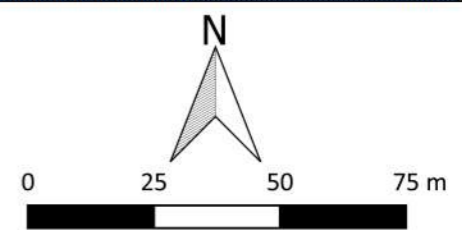
MSTM1514 - Stowmarket Solar Farm, Middlewood Green, East of Stowmarket, Suffolk
 Figure 17 - Magnetic Interpretation (Areas 2 & 4 (North))
 1:1,500 @ A3
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- | | |
|---------------------|----------------------|
| Agricultural (Weak) | Magnetic Disturbance |
| Natural (Spread) | Drainage Feature |
| Undetermined (Weak) | Ferrous (Spike) |





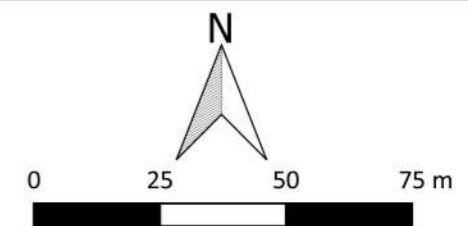
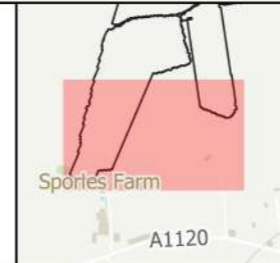
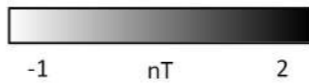
MSTM1514 - Stowmarket Solar Farm, Middlewood Green, East of Stowmarket, Suffolk
Figure 18 - XY Trace Plot (Areas 2 & 4 (North))
30nT/cm at 1:1,500 @ A3
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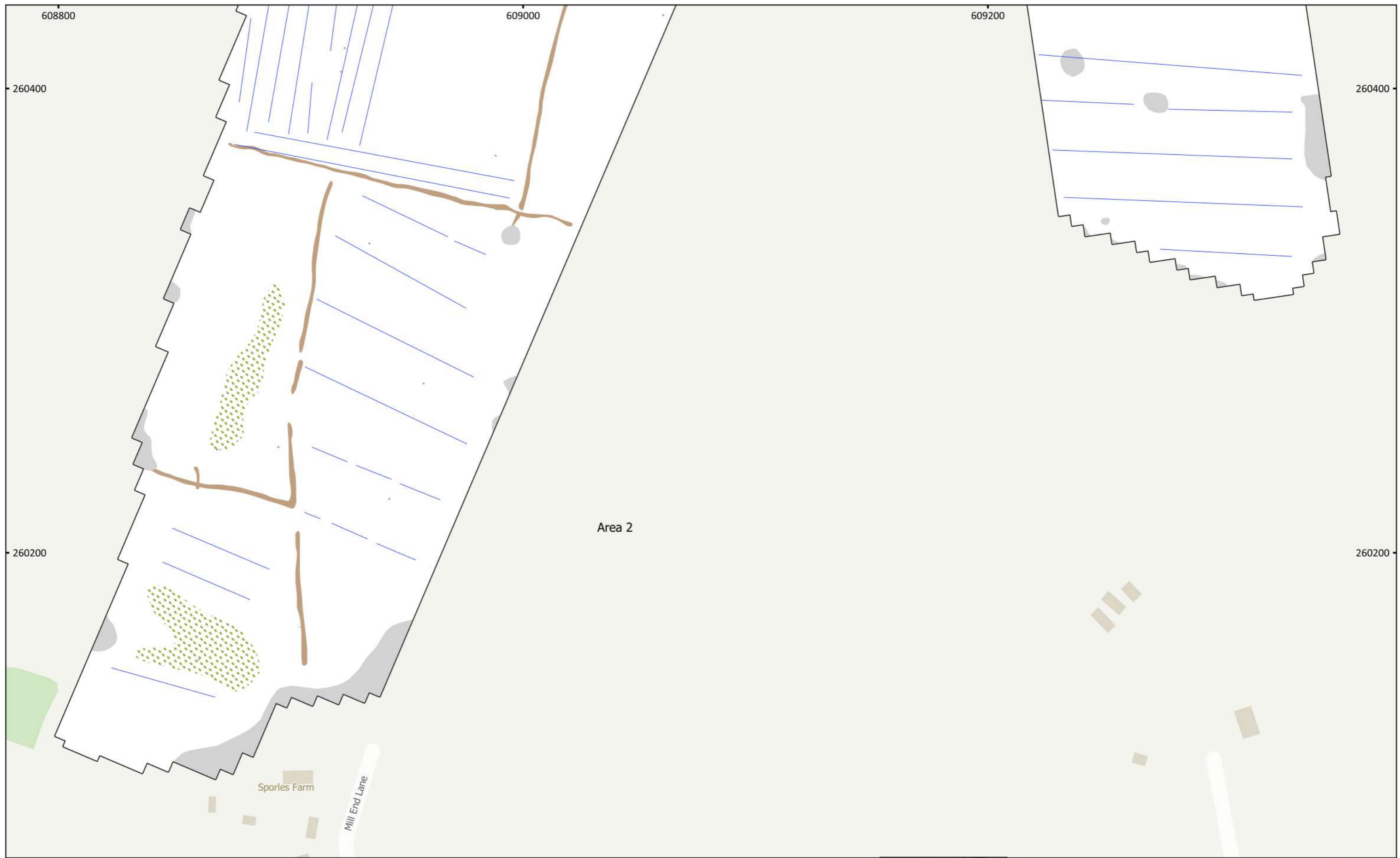


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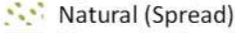

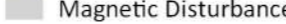


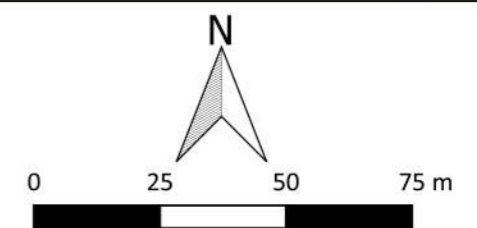
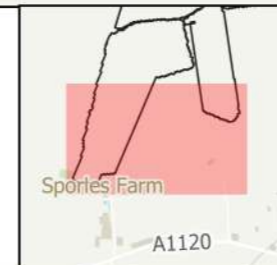
MSTM1514 - Stowmarket Solar Farm, Middlewood Green, East of Stowmarket, Suffolk
 Figure 19 - Magnetic Gradient (Areas 2 & 4 (South))
 1:1,500 @ A3
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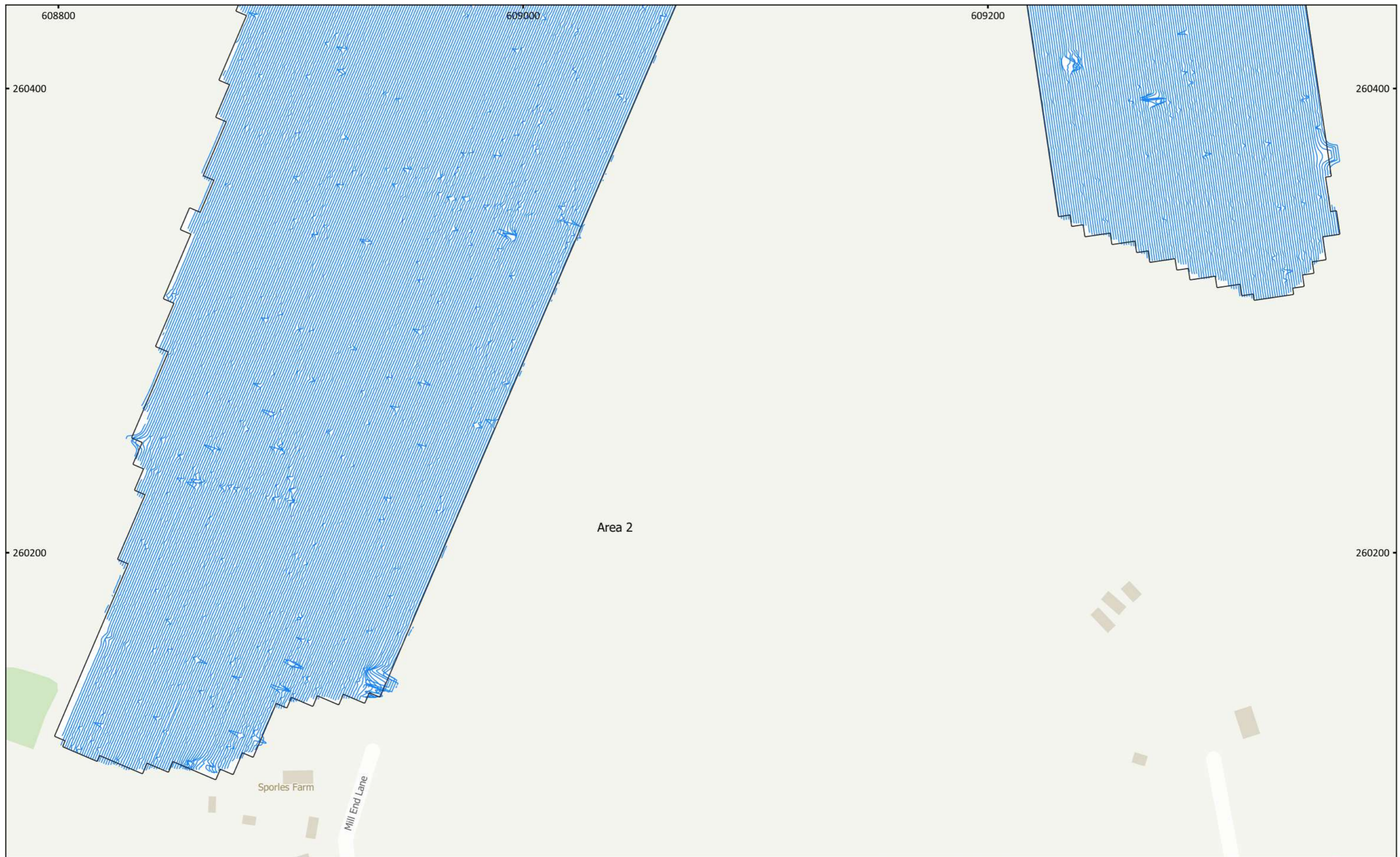




MSTM1514 - Stowmarket Solar Farm, Middlewood Green, East of Stowmarket, Suffolk
 Figure 20 - Magnetic Interpretation (Areas 2 & 4 (South))
 1:1,500 @ A3
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- | | |
|---|--|
|  Agricultural (Weak) |  Drainage Feature |
|  Natural (Spread) |  Ferrous (Spike) |
|  Magnetic Disturbance | |





MSTM1514 - Stowmarket Solar Farm, Middlewood Green, East of Stowmarket, Suffolk
 Figure 21 - XY Trace Plot (Areas 2 & 4 (South))
 30nT/cm at 1:1,500 @ A3
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