



**magnitude
surveys**

**Geophysical Survey Report
Gartree 2 – Geophysical Survey**

**For
Orion Heritage**

**On Behalf Of
Ministry of Justice**

**GTX0000 Project Wide
661277-0000-MAC-GTX0000-XX-SU-J-0002**

**Issue Number P02
S3 – Suitable for Review and Comment**

Security Classification: OFFICIAL-SENSITIVE

Magnitude Surveys Ref: MSSP976

HER Event Number: To be confirmed

OASIS Number: To be confirmed

June 2021



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Issue Date:

18 June 2021

Issue	Date	Comment	Author	Checked
P01	17.07.21	First Issue. S3 – Suitable for Review and Comment	LT	FS
P02	13.08.21	S3 – Suitable for Review and Comment	LT	KA

Abstract

A fluxgate magnetometer survey was successfully undertaken across a c.21ha area of land outside of Market Harborough, adjacent to HMP Gartree. Anomalies associated with the former RAF Market Harborough Airfield have been identified and interpreted as remnants of structures and related debris. A change in the enhancement of the magnetic background coincides with the historical boundary of the airfield, and likely relates to debris from the airfield being incorporated into the topsoil during its use and decommissioning. A collection of weak undetermined anomalies have been detected within this area of disturbance, which may indicate possible archaeological remains, but the intervening debris has made a secure interpretation difficult: they may equally be the result of coincidental alignments within the enhanced spread. Two former field boundaries and ridge and furrow along varying orientations have been identified throughout the survey area. Modern interference, aside from the airfield related material, has been detected from metal fencing and debris alongside field boundaries, overhead cables and two services.

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Appendix – Written Scheme of Investigation for MSSP976 – Land at Gartree 2, Market Harborough.

1. Introduction

- 1.1. Magnitude Surveys Ltd (MS) was commissioned by Orion Heritage Ltd on behalf of the Ministry of Justice to undertake a geophysical survey over a c.21ha area of land at Gartree 2, Market Harborough (SP70449 88871).
- 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 by MS (Salmon. F, 2021).
- 1.5. The survey commenced on 7th June 2021 and took two and a half 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 is 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 Kayt Armstrong has a PhD in archaeological geophysics from Bournemouth University, is a Member of CifA, the Editor of ISAP News, and is the UK Management Committee representative for the COST Action SAGA; 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 nominated representative for the EAA Archaeological Prospection Community to the board 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. 400m south of Gartree, Market Harborough (Figure 1). The gradiometer survey was undertaken across multiple fields under pasture. The survey area was situated directly south of HM Prison Gartree, to the east of Welland Avenue and was surrounding by arable land on the remaining sides (Figure 2).

4.2. Survey considerations:

Survey Area	Ground Conditions	Further Notes
1	The survey area comprised a flat pasture field with long grass.	Metal fencing enclosed the survey area, with trees bordering the north, east and west perimeters. A metal gate was situated along the western fencing.
2	The survey area comprised a pasture field which sloped towards the northwest in the centre.	Metal fencing enclosed the survey area, with trees bordering the southeast and southwest perimeters. Overgrown vegetation and metal troughs were present in the southern corner of the survey area and a manhole was located in the west corner of the survey area.
3	The survey area comprised a pasture field which sloped towards the west within the west of the survey area and sloped towards the south within the southeast of the survey area.	Metal fencing enclosed the survey area. A concrete track orientated north to south is situated in the centre of the survey area, from the north perimeter to the southern and was not surveyed. Two clusters of trees were located in the north of the survey area. Overgrown vegetation was present along the edges of the concrete track and in the northwest of the survey area. Four boreholes were located across the survey area.
4	The survey area comprised a pasture field which sloped towards the southeast.	Metal fencing enclosed the survey area except for the northern perimeter of the survey area which had no physical boundary. A pond was located in the centre of the survey area, as well as some power lines that crossed the survey area and were orientated north to south.
5	The survey area comprised a pasture field which sloped towards the southwest.	Metal fencing marked the perimeter of the southern and eastern edges of the survey area. No physical boundary marked the northern perimeter, and a cluster of trees made up the western perimeter. Metal debris and a manhole were present in the northeast corner of the survey area.

4.3. The underlying geology comprises the Dyrham Formation, which is made up of interbedded siltstone and mudstone (British Geological Survey, 2021).

4.4. The soils consist of slowly permeable, seasonally wet, slightly acid but base-rich loamy and clayey soils (Soilscapes, 2021).

5. Archaeological Background

- 5.1. The following is a summary of an archaeological desk-based assessment (DBA) produced and provided by Orion Heritage Ltd (Willis, 2020).
- 5.2. A previous geophysical survey was carried out in the fields immediately south of the survey area: this survey identified possible undated archaeological features including pits, ridge and furrow, and evidence of the former airfield. This geophysical survey was requested by the county archaeologist (Salmon, 2021)
- 5.3. The HER records three trial trench excavations within the 1km study area. The first, c.420m to the east of the survey area recorded Iron Age enclosures, ring ditches and possible structural remains, a Roman settlement and medieval ridge and furrow (ELE7460). The second was c.855m to the southeast of the survey area, and recovered three lengths of Iron Age pit alignments, Iron Age boundaries, enclosures and settlement features alongside an early Roman settlement (ELE10743). The third excavation was c.920m to the southeast of the survey area, and recorded an Iron Age-Roman settlement site/farmstead alongside medieval ridge and furrow (ELE9884).
- 5.4. Two key settlements during the Saxon and early medieval period are located approximately 1km to the north, Foxtan (MLE10125) and south, Lubenham (MLE9316) of the survey area and both lie in conservation areas. Holmes Farm is recorded c.840m to the southwest of the study site (MLE18664). The HER entry indicates that the farm is well preserved and has been in use since the early medieval period.
- 5.5. The former Market Harborough Airfield (MLE15969) occupies most of the eastern half of the survey area. Evidence of the former airfield runway and dispersal pens are clearly visible within the survey area on satellite imagery. To the immediate west of the study site, the HER records ancillary buildings to the airfield including mess blocks (MLE22409), ablutions blocks (MLE22408, MLE22405), gymnasium (MLE22406), workshop (MLW22416) and standby set house (MLE22407). After 1945 the buildings were used as a Polish resettlement camp (MLE22402). Structures, including a Nissen Hut and blast shelter, located within the north of the survey area have been recorded on an excerpt plan of RAF Market Harborough.

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.

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

6.1.2. 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

6.1.3. The magnetic data were collected using MS' bespoke hand-carried GNSS-positioned system.

6.1.3.1. 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.

6.1.3.2. 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.

6.1.3.3. 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 7 and 10). 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 (2021) was also consulted, to compare the results with recent land use.

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.

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 (Figure 4).

7.2.2. The fluxgate gradiometer survey has responded well to the survey area and has detected widespread possible remains of RAF Market Harborough Airfield, as well as ridge and furrow and agricultural anomalies, services and other undetermined anomalies which have proven difficult to classify with certainty. Modern interference has been detected from metal fencing and debris alongside field boundaries, and overhead cables.

- 7.2.3. Strong anomalies have been detected across the survey area which relate to the former RAF Market Harborough Airfield, known to be situated within the survey area. Some linear anomalies which are particularly strongly magnetically enhanced (Figures 5 and 8), in the northeast of the survey area, are most likely the remnants of structures (Section 5.5). Some anomalies are not as coherent and are more characteristic of general debris within the topsoil. Plans of RAF Market Harborough show a correspondence between the location of anomalies, both those interpreted as structures, and those interpreted as spreads of debris, and features on the plan (Section 5.5); specifically, anomalies in Area 1 that are associated with structures and a small rectangular anomaly in Area 3.
- 7.2.4. A large spread of magnetic enhancement located in the east of the survey area (Figure 3) has been detected and possibly associated with the airfield; however, this type of generally noisy data may also result from agricultural practices, such as the spread of green waste. This generalised noisy magnetic enhancement has been detected across the east side of the survey area and is noticeably different to the quiet magnetic background of the west side of the survey area (Figure 3). This difference in magnetic background coincides with the outer boundary of the airfield described in the archaeological background (Section 5.5), which appears to mark the boundary between the former airfield and land in consistent agricultural use.
- 7.2.5. Anomalies interpreted as former field boundaries have been identified and matched to those depicted on OS 2nd Edition Mapping (Figure 4). Ridge and furrow, which has been detected across the survey area in varying orientations, demonstrates the long term agricultural use of the western part of the survey area.
- 7.2.6. A collection of weak anomalies have been identified in the east of the survey area that exhibit morphology suggestive of a possible archaeological origin. This is supported by the proximity of an excavation c.420m to the east of the survey area with recorded Iron Age enclosures, ring ditches and possible structural remains and a Roman settlement (Section 5.2.). However, these anomalies have been obscured by the enhanced magnetic background of the area may equally be the result of coincidental alignments within this spread; therefore, they have been categorised as ‘Undetermined’. These anomalies are all also generally confined to the noisy area in the eastern part of the survey area; no continuation is observed in the more magnetically quiet western part.

7.3. Interpretation

7.3.1. General Statements

- 7.3.2. Geophysical anomalies will be discussed broadly as classification types across the survey area. Only anomalies that are distinctive or unusual will be discussed individually.

- 7.3.2.1. **Ferrous (Spike)** – Discrete dipolar anomalies are likely to be the result of isolated pieces of modern ferrous debris on or near the ground surface.

- 7.3.2.2. **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.
- 7.3.2.3. **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.
- 7.3.2.4. **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.

7.3.3. Magnetic Results - Specific Anomalies

- 7.3.3.1. **Agricultural (Weak)** – Weak linear anomalies have been detected in Areas 1 and 3 (Figure 6), which have been identified using OS 2nd Edition Historical Mapping as former field boundaries (Figure 4).
- 7.3.3.2. **Ridge and Furrow** – Linear and curvilinear anomalies have been identified throughout the survey area (Figures 6 and 9), which are characteristic of ridge and furrow, in various orientations. Whilst these regimes cannot be dated using geophysical data alone, further ridge and furrow regimes from the medieval period have been identified to the south and southeast of the survey area (Section 5.2) suggesting a similar date for these features.
- 7.3.3.3. **Possible Airfield (Strong/Weak)** – Strong and weak positive linear, discrete and curvilinear anomalies have been detected across the survey area and have been related to the former RAF Market Harborough Airfield. Some particularly distinct anomalies are detected as a rectilinear highly magnetic signal within Areas, 1, 3 and 4 (Figures 6 and 9) and are indicative of structural features (Section 5.5). Anomalies that are not as coherent have been identified in Areas 1, 3 and 5 (Figures 6 and 9) and are more characteristic of general remnant debris. A strong linear anomaly [4a] in north of Area 4 has similar geophysical signal to the anomalies in the east of the survey area associated with the airfield but lay outside the boundary described in the archaeological desk-based assessment (Section 5.5). As the anomaly appears to run to a pond situated in the centre of Area 4 (Figure 9) and is strongly magnetically positive, it has been classified as relating to the airfield, and may relate to drainage or service provision.
- 7.3.3.4. **Ferrous Spread** - A large spread of magnetic enhancement located within the east of the survey area (Figures 5 and 8) has been detected and is interpreted as a spread of debris or rubble material associated with the former airfield, however an agricultural origin cannot be ruled out, as this type of generalised enhancement

and magnetic 'noise' may also be the result of the spread of green waste as a soil improver.

7.3.3.5. **Services** – Two linear dipolar ferrous anomalies, in Areas 4, have been identified as services (Figure 9).

7.3.3.6. **Overhead Cables** – Magnetic disturbance has been detected in the south of Area 4 (Figures 8 and 9) and is interpreted as the effect of overhead cables, which were identified at the time of survey (Section 4.2).

7.3.3.7. **Undetermined (Weak)** - Multiple weak linear, curvilinear and rectilinear anomalies have been identified across the east of Area 3 (Figures 6 and 9). The anomalies do not appear to be in any discernible pattern but do exhibit a morphology suggestive of an archaeological origin. Although the magnetic enhancement in this area has obscured these anomalies, their proximity to recorded archaeology (Section 5.2) means that an archaeological origin cannot be ruled out. However, they may be the result of coincidental alignments within the enhanced background and therefore, they have been categorised as 'Undetermined'.

7.3.3.8. **Undetermined (Strong/Weak)** - Discrete anomalies in the south of Area 4 and the north of Area 2 (Figures 6 and 9), have been detected as having a strong positive magnetic signal and are most likely to do with the former airfield within the survey area. However, their isolation from similar anomalies means that an archaeological or agricultural origin cannot be entirely ruled out. Therefore, these anomalies have been classified as 'Undetermined'.

8. Conclusions

- 8.1. The fluxgate gradiometer survey was carried out over c. 20.93 ha of land at Gartree 2, Market Harborough. The geophysical survey results will inform trial trenching on site, the results of which will be added to a separate report. The survey detected the remains of RAF Market Harborough Airfield, as well as ridge and furrow and more recent agricultural anomalies, along with services and extensive weak undetermined anomalies. Modern interference has been detected from metal fencing and debris alongside field boundaries and related to overhead cables.
- 8.2. Anomalies associated with the former RAF Market Harborough Airfield have been identified as remnants of structures and related debris within the confines of the airfield. A change in the enhancement of the magnetic background coincides with the boundary between the airfield and agricultural land.
- 8.3. Two former field boundaries and ridge and furrow in varying orientations have been identified throughout the survey area, as well as two services.
- 8.4. A collection of weak undetermined linear and curvilinear anomalies have been detected in the east of the survey area which may be of archaeological origin. However, they have been obscured by the enhanced magnetic background of the area and may equally be the result of

coincidental alignments within the spread of debris causing the altered magnetic background within the boundary of the former airfield.

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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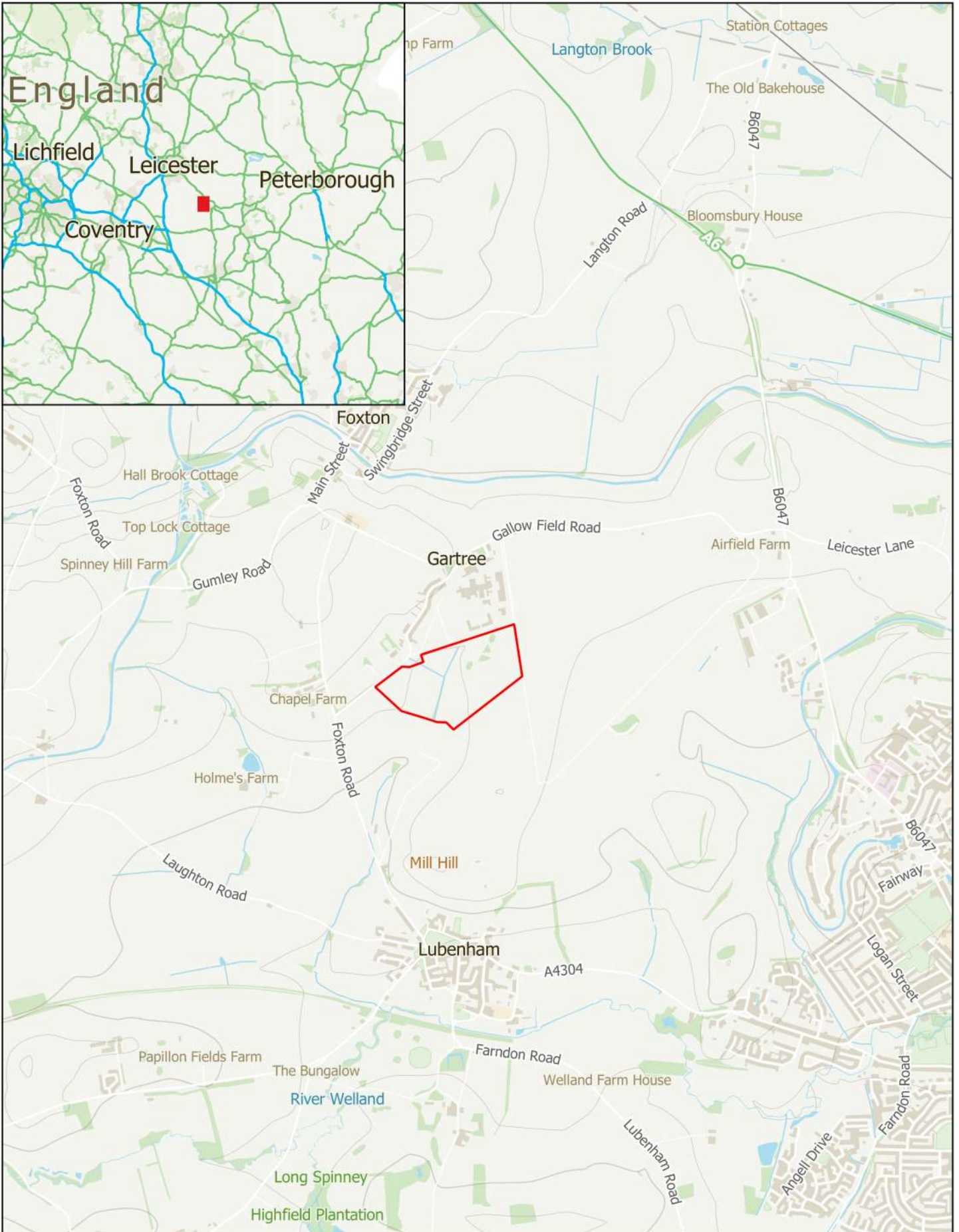
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12. Project Metadata

MS Job Code	MSSP976
Project Name	Geophysical Survey Report of Land at Gartree 2, Market Harborough
Client	Orion Heritage Ltd.
Grid Reference	SP 70449 88871
Survey Techniques	Magnetometry
Survey Size (ha)	20ha (Magnetometry)
Survey Dates	2021-06-07 to 2021-06-10
Project Lead	Freddie Salmon BSc FGS ACIfA
Project Officer	Freddie Salmon BSc FGS ACIfA
HER Event No	To be confirmed
OASIS No	To be confirmed
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	LT	FS	17 June 2021
0.2	Draft for Director Review	LT	KA	17 June 2021
0.3	Comments from client	WR	WR	13 August 2021



MSSP976 - Land at Gartree 2, Market Harborough

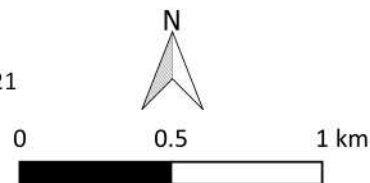
Figure 1 - Site Location

1:25,000 @ A4

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 Site Boundary

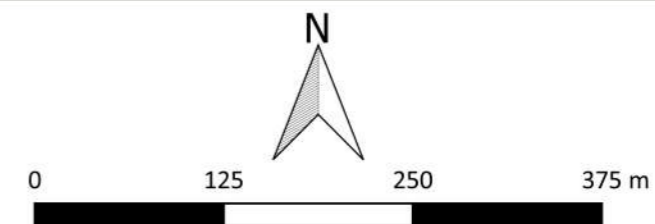


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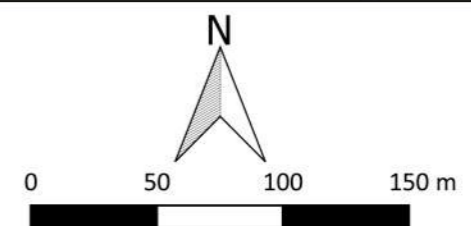
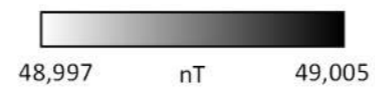
MSSP976 - Land at Gartree 2, Market Harborough
Figure 2 - Location of Survey Areas
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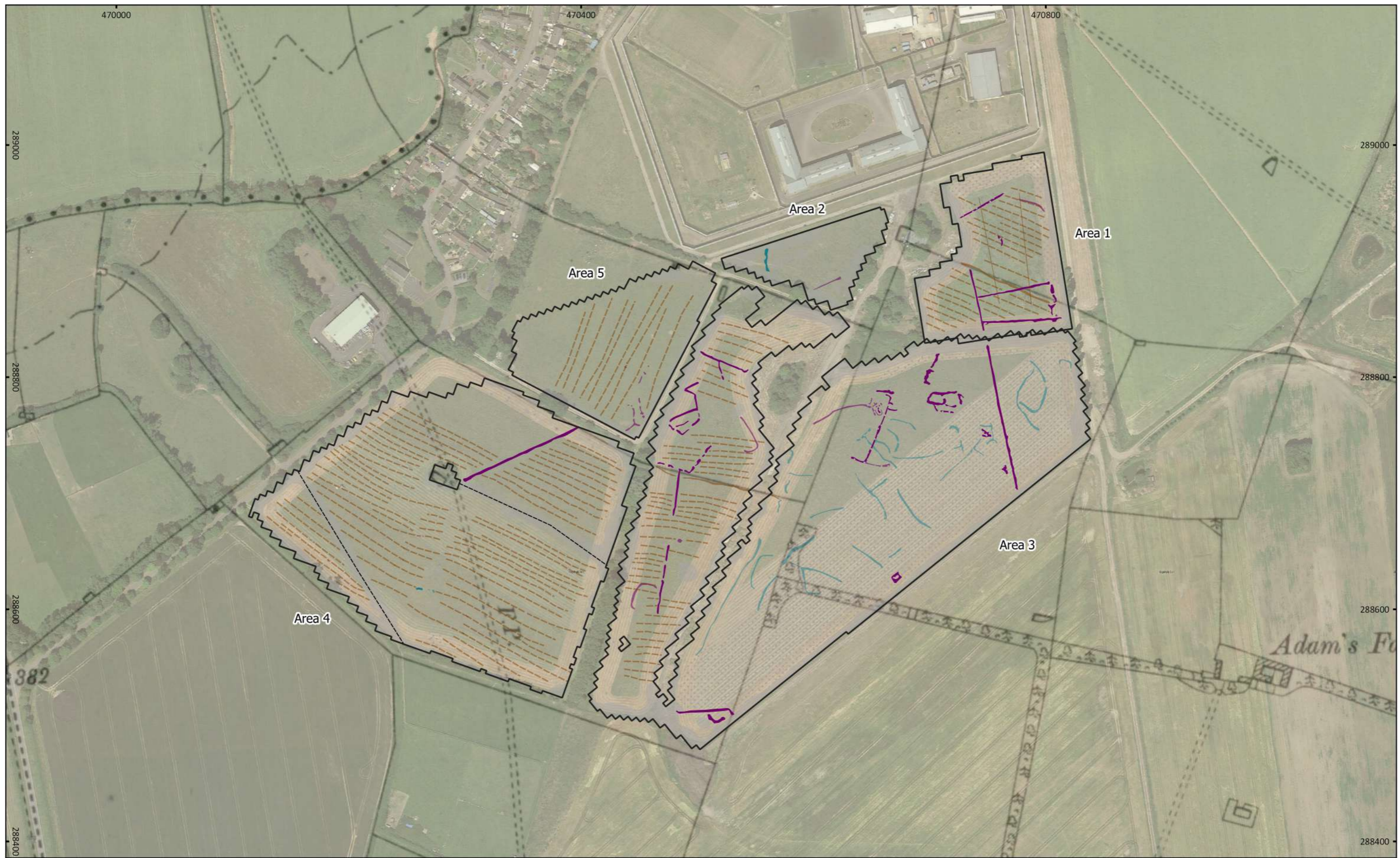
 Survey Extent





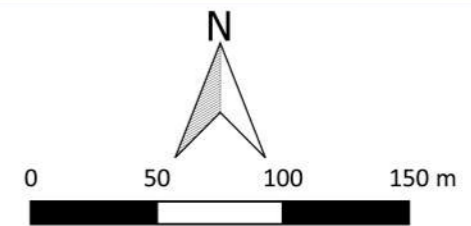
MSSP976 - Land at Gartree 2, Market Harborough
 Figure 3 - Magnetic Total Field (Lower Sensor) (Overview)
 1:3,000 @ A3
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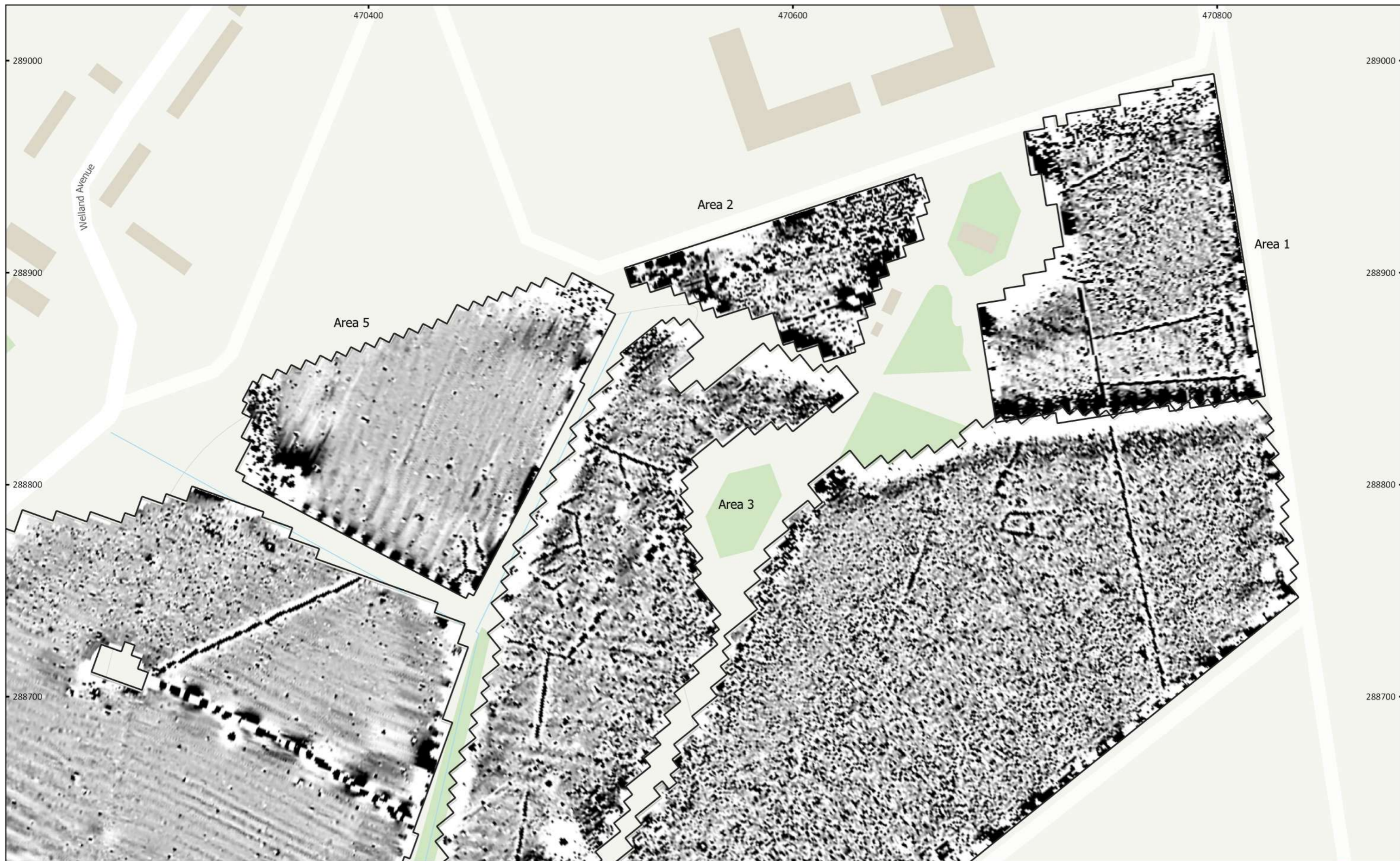




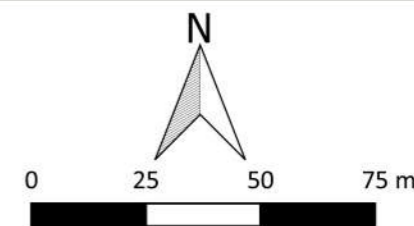
MSSP976 - Land at Gartree 2, Market Harborough
 Figure 4 - Magnetic Interpretation Over Historical Maps and Satellite Imagery (Overview)
 1:3,000 @ A3
 Copyright Magnitude Surveys Ltd 2021
 Contains historical maps: Ordnance Survey, 6" 2nd edition c. 1882-1913.
 Contains satellite imagery © 2021 Bing Satellite

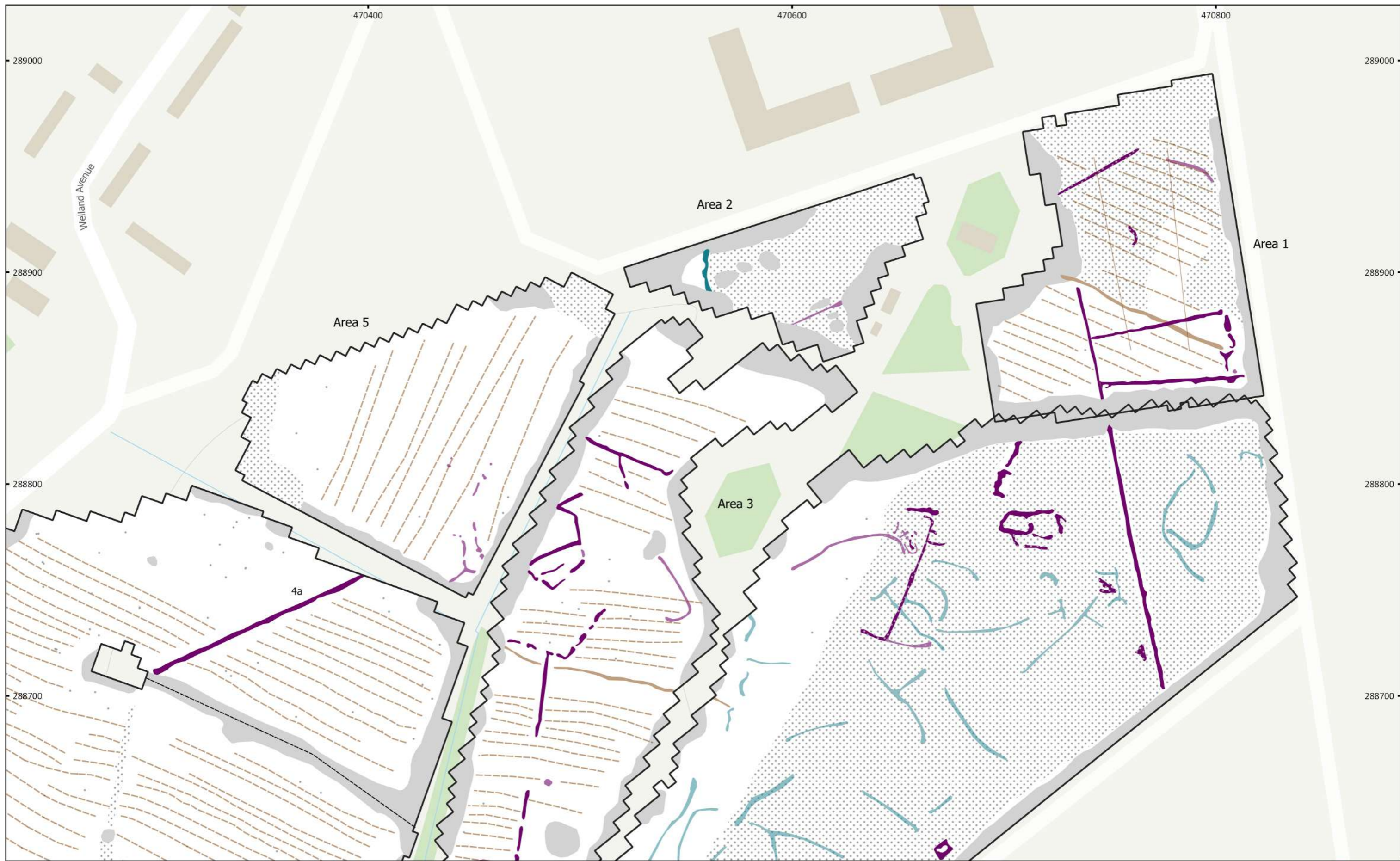
- | | |
|----------------------------|--------------------------|
| Agricultural (Weak) | Undetermined (Weak) |
| Possible Airfield (Strong) | Agricultural (Trend) |
| Possible Airfield (Weak) | Service |
| Magnetic Disturbance | Ridge and Furrow (Trend) |
| Ferrous/Debris (Spread) | Ferrous (Spike) |
| Undetermined (Strong) | |





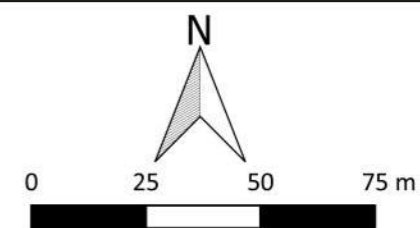
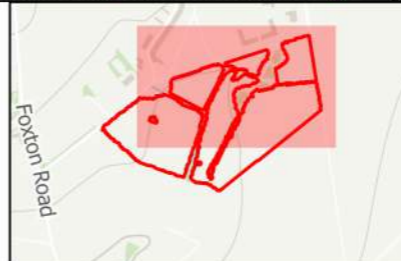
MSSP976 - Land at Gartree 2, Market Harborough
 Figure 5 - Magnetic Gradient (North)
 1:1,500 @ A3
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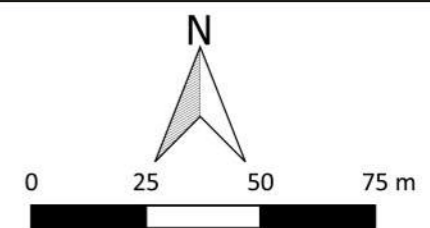
MSSP976 - Land at Gartree 2, Market Harborough
 Figure 6 - Magnetic Interpretation (North)
 1:1,500 @ A3
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- | | |
|----------------------------|--------------------------|
| Agricultural (Weak) | Undetermined (Weak) |
| Possible Airfield (Strong) | Agricultural (Trend) |
| Possible Airfield (Weak) | Service |
| Magnetic Disturbance | Ridge and Furrow (Trend) |
| Ferrous/Debris (Spread) | Ferrous (Spike) |
| Undetermined (Strong) | |

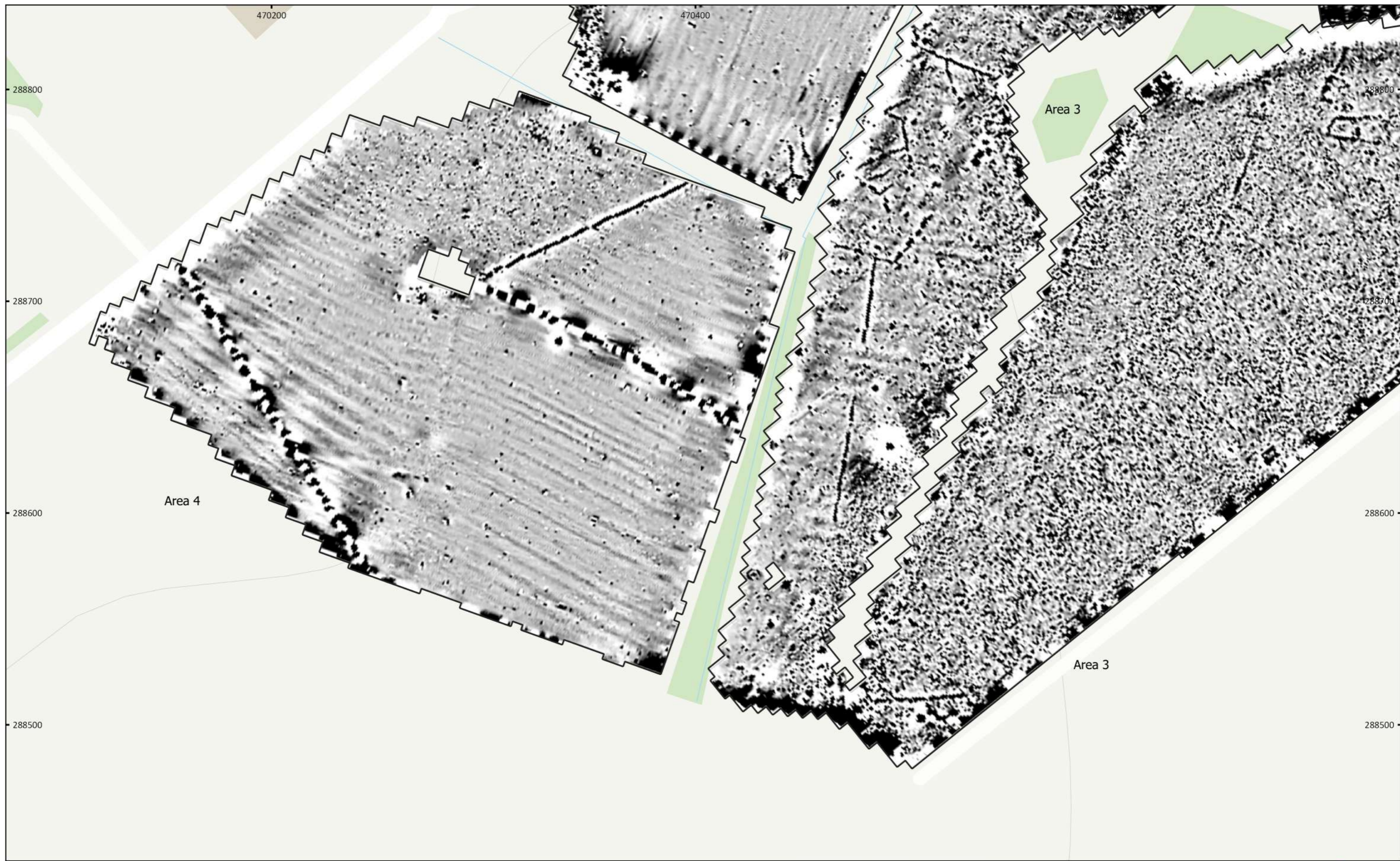




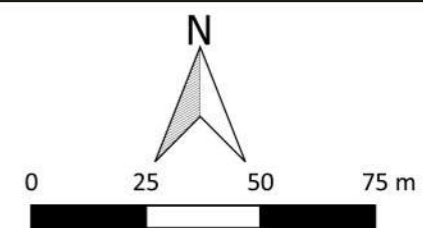
MSSP976 - Land at Gartree 2, Market Harborough
Figure 7 - XY Trace Plot (North)
30nT/cm at 1:1,500 @ A3
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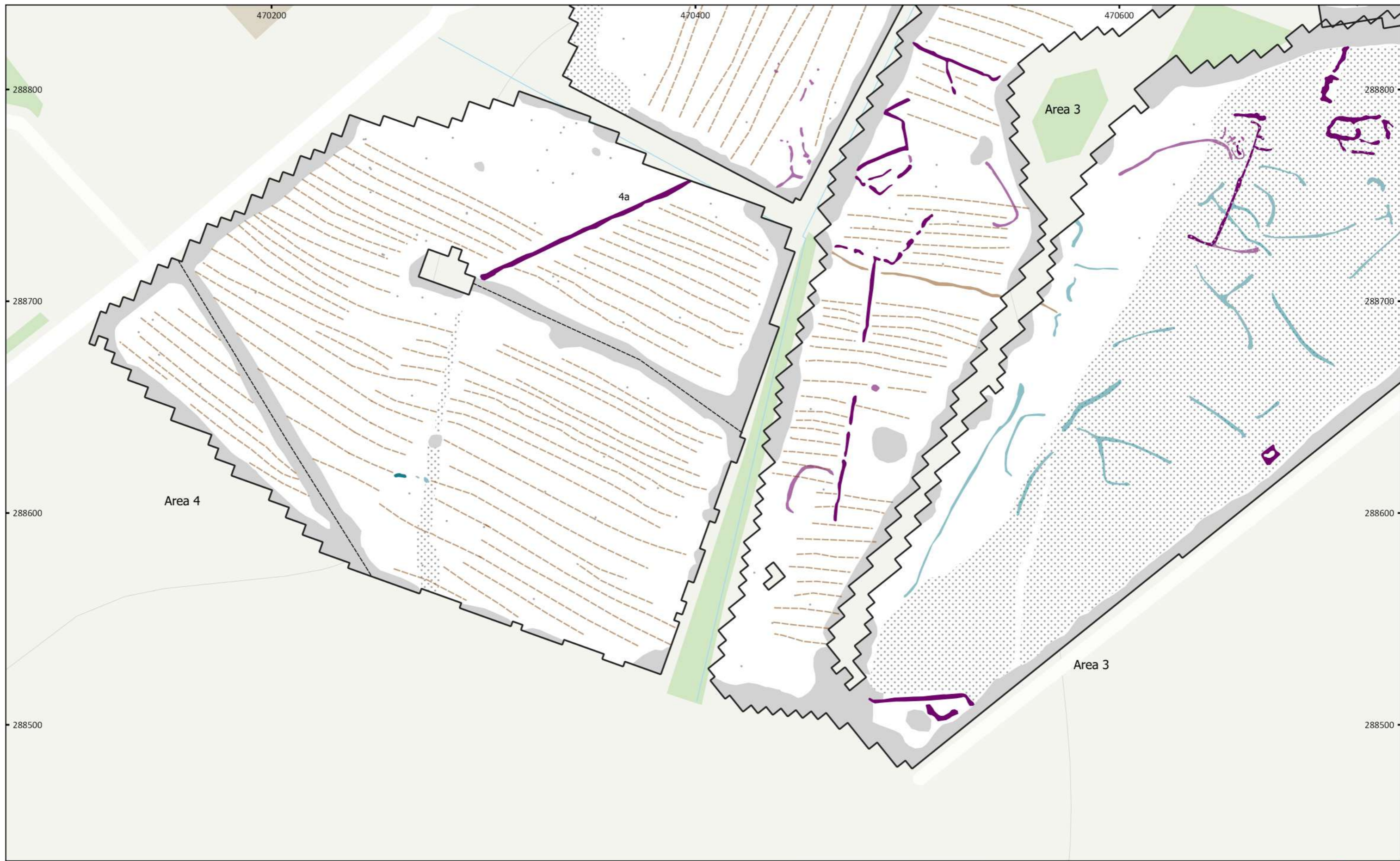


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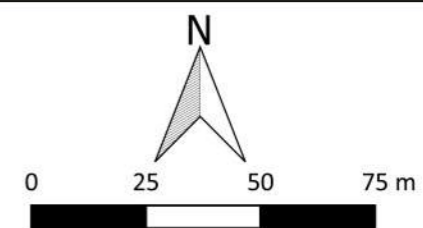
MSSP976 - Land at Gartree 2, Market Harborough
 Figure 8 - Magnetic Gradient (South)
 1:1,500 @ A3
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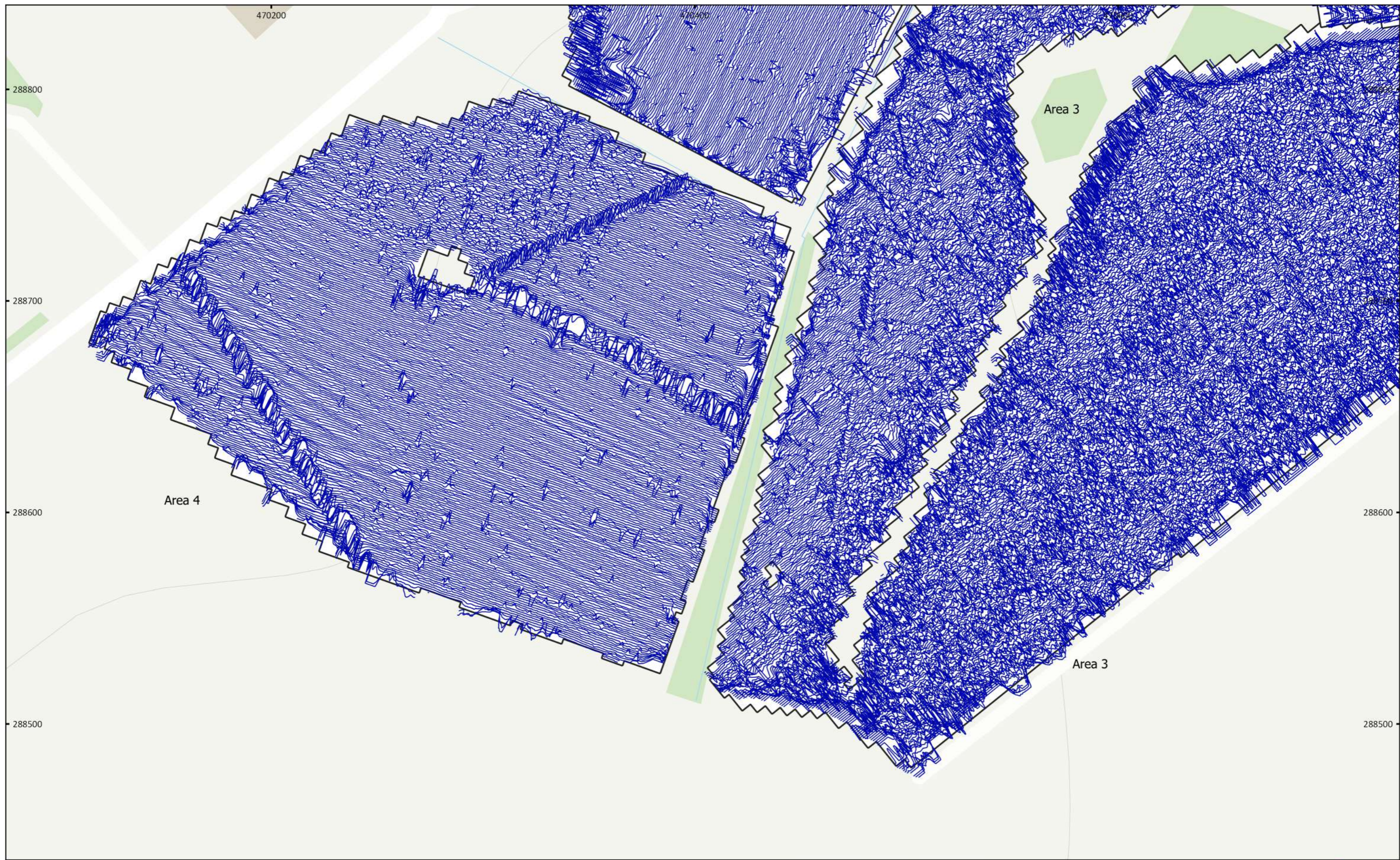




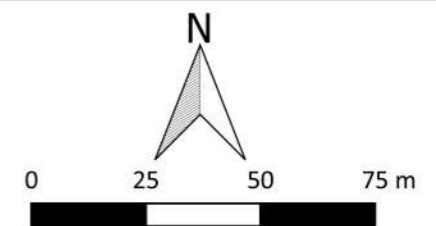
MSSP976 - Land at Gartree 2, Market Harborough
 Figure 9 - Magnetic Interpretation (South)
 1:1,500 @ A3
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- | | |
|----------------------------|--------------------------|
| Agricultural (Weak) | Undetermined (Strong) |
| Possible Airfield (Strong) | Undetermined (Weak) |
| Possible Airfield (Weak) | Service |
| Magnetic Disturbance | Ridge and Furrow (Trend) |
| Ferrous/Debris (Spread) | Ferrous (Spike) |





MSSP976 - Land at Gartree 2, Market Harborough
 Figure 10 - XY Trace Plot (South)
 30nT/cm at 1:1,500 @ A3
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