magnitude surveys

Geophysical Survey Report

of

Hemingfield Road, Barnsley

For

MAP Archaeological Practice Ltd

On behalf of

Hargreaves Land Limited

Magnitude Surveys Ref: MSSE1837

HER Event Number: TBC

OASIS Number: TBC

September 2024

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Abstract

Magnitude Surveys was commissioned to assess the subsurface archaeological potential of a c. 5.8ha area of land at Hemingfield Road, Barnsley, South Yorkshire. A magnetic gradiometer survey was successfully undertaken across the survey area. The geophysical survey has detected anomalies of archaeological, agricultural and undetermined origins. Anomalies denoting ring ditches suggestive of prehistoric activity were identified, and a trackway/bridleway predating anything indicated on historical maps was recorded. Historical agricultural activity was detected in the form of mapped former field boundaries and a footpath. Agricultural trends associated with modern ploughing regimes and a drainage system were also identified. Numerous weakly enhanced, linear anomalies have been identified which are difficult to discern from the magnetically enhanced background of the survey area and in most cases lack a clear distinctive morphology. As such, an 'undetermined' origin has been ascribed to these. Modern interference is limited to the edges of the survey area by extant field boundaries and a footpath, and within the survey area to that caused by an electric fence and service cover.

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1. Introduction

1.1. Magnitude Surveys Ltd (MS) was commissioned by MAP Archaeological Practice Ltd on behalf of Hargreaves Land Limited to undertake a geophysical survey over a c. 5.8ha area of land at Hemingfield, Barnsley (SE 39310 01804).

1.2. The geophysical survey comprised of a quad-towed, 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 (Langston, 2024).

1.5. The survey commenced on the 13th of September 2024 and took two days over two separate deployments 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); and 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 CIfA, 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 the survey area was to assess the subsurface archaeological potential of the survey area.

4. Geographic Background

4.1. The survey area was located c. 215m north of Hemingfield (Figure 1). The gradiometer survey was undertaken across an arable field and a field of pasture. The survey area is bordered by the A6195 to the north, pasture to the east, Briery Meadows and Hemingfield Road to the south and Hemingfield Road to the west (Figure 2).

4.2. Survey considerations:

Survey Area	Ground Conditions	Further Notes
1	The survey area consisted of a flat arable field containing crop stubble.	The area was surrounded by bushes and fencing. A service cover was present within the centre of the survey area.
2	The survey area consisted of flat, pasture.	The area was surrounded by bushes and fencing. A footpath was identified within the northern edge of the survey area running in an east-west orientation. An electric fence ran through the centre and northeastern edge of the survey area in a northeast – southwest and east -west orientation respectively.

4.3. The underlying geology comprises sandstone of the Woolley Edge Rock Formation. In the northern corner mudstone, siltstone and sandstone of Pennine Middle Coal Measures Formation was also noted. No superficial deposits are recorded within the survey area (British Geological Survey, 2024).

4.4. The soils consist of freely draining slightly acidic loamy soils (Soilscapes, 2024).

5. Archaeological Background

5.1. The following is a summary of a Desk Based Assessment (DBA) produced and provided by MAP Archaeological Practice (Puntorno et al, 2023).

5.2. Iron Age and Romano-British activity is well recognised within Wombwell Wood c. 400m northwest of the survey area, designated as a scheduled monument (NHLE1004796). The complex, which comprises settlement features, enclosures, a trackway, and field systems, is visible as earthworks. Four further non-designated heritage assets of Late Prehistoric or Romano-British settlement activity were also recorded within or in the immediate vicinity of Wombwell Wood. This includes an enclosure and strip lynchet c. 680m northwest (HER01236/01), an enclosure c. 820m northwest (HER04025/01) and two enclosures c. 900m northwest of the survey area (HER03806/01 and HER03806/02), visible in aerial photographs. Trail trenching in 2007 identified a number of pits, ditches and gullies c. 200m south of the survey area. Though no datable evidence was recovered, stratigraphy and soil colour suggest a Late Iron Age to Roman-British date.

5.3. A geophysical survey was conducted c. 400m southwest of the survey area. The magnetic readings possibly infer the presence of medieval ridge and furrow regimes (HER04533/01).

5.4. Post-medieval activity is documented by Hemingfield Colliery established during the 19th century. The colliery, located c. 730m south of the survey area which is now designated as a Scheduled Monument (NHLE 1465079), is also referred to in early documents as Low Elsecar Colliery. Lime kilns dated to the 17th century, were identified during a watching brief c. 600m west of the survey area (HER05008), and bell pits were recorded c. 250m northwest of the survey area (HER02853/01).

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, 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 (Figure 7). 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 (2024) 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, 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 7).

7.2.2. The fluxgate gradiometer survey has responded well to the environment of the survey area, despite the naturally enhanced magnetic background being exacerbated by modern agricultural practices. The geophysical survey is characterised by anomalies of an archaeological, agricultural, and undetermined origin. Magnetic disturbance is limited to the edges of the field by extant field boundaries and a footpath, and within the survey area to a service cover and electric fencing.

7.2.3. The geophysical survey has detected two weakly enhanced penannular anomalies, and a further weakly enhanced curvilinear anomaly within the west of Area 1 (Figure 5). These anomalies are indicative of ring-ditches which may be associated with prehistoric activity recorded within the wider environment (See Section 5.2). Two sets of parallel linear anomalies have also been recorded running across Areas 1 and 2, indicative of a trackway/bridleway predating available historical maps (Figure 7).

7.2.4. Anomalies highlighting the prolonged use of the landscape for agricultural activities have been recorded and identified in the form of former field boundaries and a trackway recorded on historical maps (Figures 4 and 6). Anomalies indicative of agricultural and modern practices were also identified throughout the survey area and correspond with modern ploughing regimes and a sewer.

7.2.5. Weakly enhanced linear anomalies have been recorded within the south of Area 2 [**2a**] (Figure 5). These anomalies may be indicative of enclosures or former field systems of an undetermined origin. However, as these anomalies are difficult to differentiate from the surrounding natural enhanced background an undermined origin has been ascribed. Several weakly enhanced, linear anomalies have also been recorded throughout the survey area, indicative of ditches containing magnetically enhanced infill (Figure 5). However, as these anomalies lack a clear diagnostic morphology and are difficult to

distinguish from the surrounding magnetically enhanced background an undetermined origin has been ascribed.

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. **Probable Archaeology (Ring Ditches) (Strong/Weak)** – Two weakly enhanced, penannular anomalies have been recorded within the west of Area 1, suggestive of ring ditches (Figure 5). The morphology of these anomalies clearly differentiates them from the surrounding linear anomalies and may be indicative of a prehistoric origin. Known Iron Age – early Romano-British activity is noted within Wombwell Wood to the northwest of the survey area lending credence to this interpretation (See Section 5.2). Two weakly enhanced, curvilinear anomalies have been recorded running parallel through the centre of Area 1 and north of Area 2 on an east-west orientation. The shape and c. 4m spacing of these anomalies are suggestive of a possible trackway/bridleway which appears to predate available historical maps (Figure 7).

7.3.2.2. **Possible Archaeology (Weak)** –A weakly enhanced, curvilinear anomaly has also been identified within the west of the survey area in close proximity to the aforementioned ring ditches (Figure 5). The shape of the anomaly may be suggestive of a partial ring ditch. However, a more confident categorisation

cannot be ascribed as it is difficult to differentiate this anomaly from the enhanced natural background.

7.3.2.3. **Agricultural (Weak) –** Weakly enhanced, linear anomalies have been identified within Areas 1 and 2 forming rectilinear patterns. These anomalies correspond with former field boundaries and a trackway depicted on historical maps (Figure 7).

7.3.2.4. **Agricultural (Trend) –** Strongly enhanced, linear anomalies are present within Area 1 running in a northwest-southeast orientation and along the edges of the area. These anomalies are closely spaced around the survey area edges and are spaced c. 22m apart within the centre. These anomalies correspond with tractor tramlines and ruts identified at the time of survey.

7.3.2.5. **Foul Sewer –** A weakly enhanced linear anomaly has been identified running through areas 1 and 2 in a roughly northeast – southwest alignment (Figure 5). This anomaly corresponds with a sewer depicted in a drainage layout map, which was based upon a recent trace of the sewer (February 2024). A service cover was also noted along the route of this anomaly during the survey lending credence to this categorisation.

7.3.2.6. **Undetermined (Weak) –** Weakly enhanced linear anomalies have been identified within the southwest of Area 1 (Figure 5) [**2a**]. The shape and strengths of these anomalies may be suggestive of enclosures or field systems not depicted on historical maps (Figure 7). However, as these anomalies are difficult to differentiate from the magnetically enhanced natural background an undetermined origin has been ascribed. Weakly enhanced, linear and curvilinear anomalies have been recorded within areas 1 and 2. The morphology and strengths of these anomalies may be indicative of ditches containing magnetically enhanced infill. However, these anomalies are difficult to distinguish from the magnetically enhanced natural background and have been categorised as 'undetermined' in origin.

8. Conclusions

8.1. A fluxgate gradiometer survey was successfully completed across the survey area. The survey has detected anomalies of an archaeological, agricultural and undetermined origin. Modern interference was limited to the edges of the survey area by extant field boundaries and by an extant footpath. Magnetic interference was also identified within the centre of the survey area by a service cover and electric fence.

8.2. Penannular anomalies have been identified within the west of the survey area, indicative of ring ditches of a possibly prehistoric origin. This interpretation is reinforced by the presence of prehistoric activity within the wider landscape. Two parallel linear anomalies running on an east-west orientation were also recorded, suggestive of a former trackway or bridleway.

8.3. Historical agricultural activity has been recorded in the form of mapped field boundaries. Agricultural activity was identified within the data in the form of modern ploughing regimes and a drainage system.

8.4. Anomalies of an undetermined origin have been identified throughout the survey area. These anomalies are difficult to discern from the enhanced magnetic background and in most cases lack a clear diagnostic morphology.

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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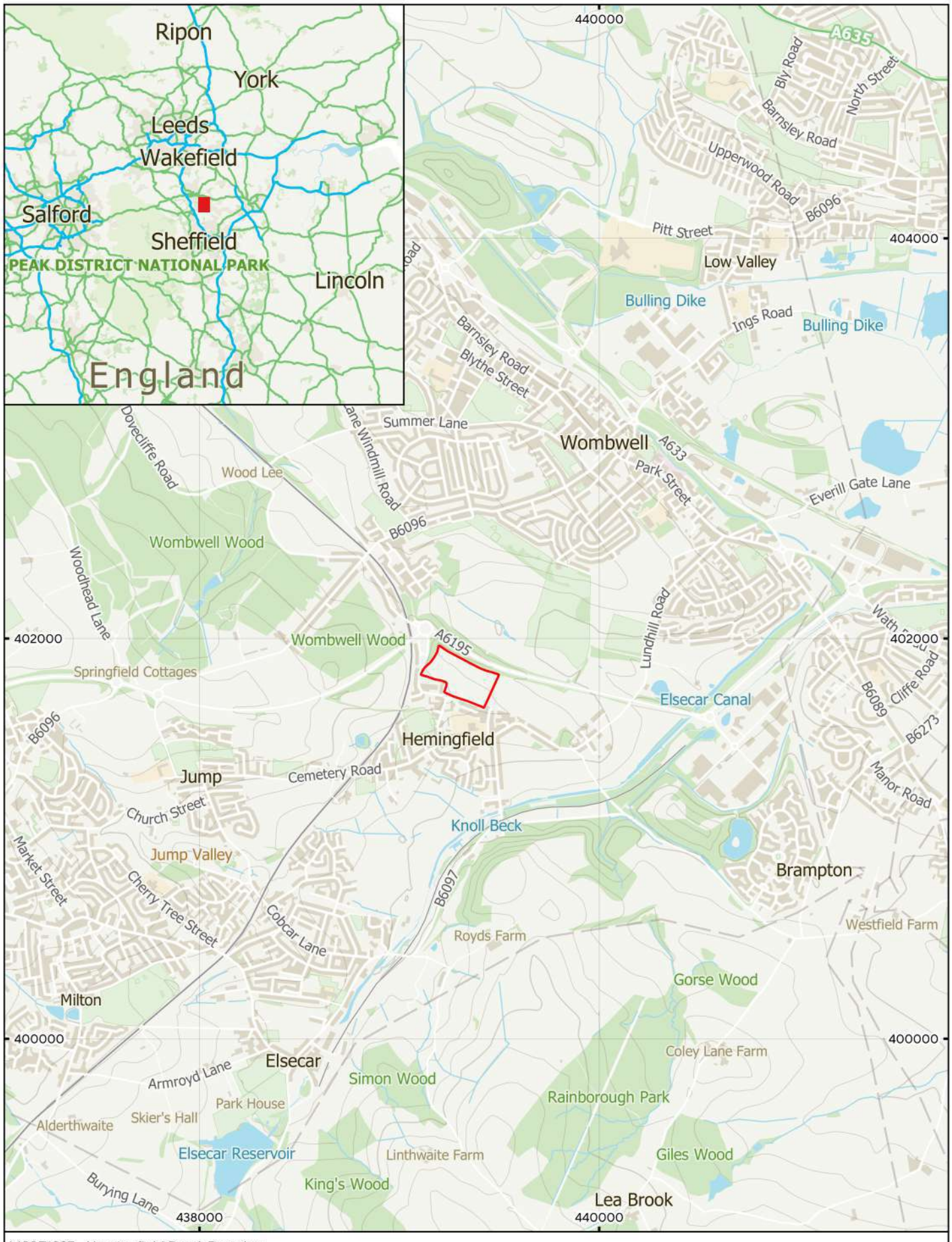
12. Project Metadata

MS Job Code	MSSE1837
Project Name	Hemingfield Road, Barnsley
Client	MAP Archaeological Practice Ltd on behalf of Hargreaves Land Limited
Grid Reference	SE 39310 01804
Survey Techniques	Magnetometry
Survey Size (ha)	5.8ha (Magnetometry)
Survey Dates	2024-09-06 to 2024-09-09
Project Lead	Daniel Wilkinson BA (Hons)
Project Officer	Daniel Wilkinson BA (Hons)
HER Event No	TBC
OASIS No	TBC
S42 Licence No	N/A
Report Version	0.3

13. Document History

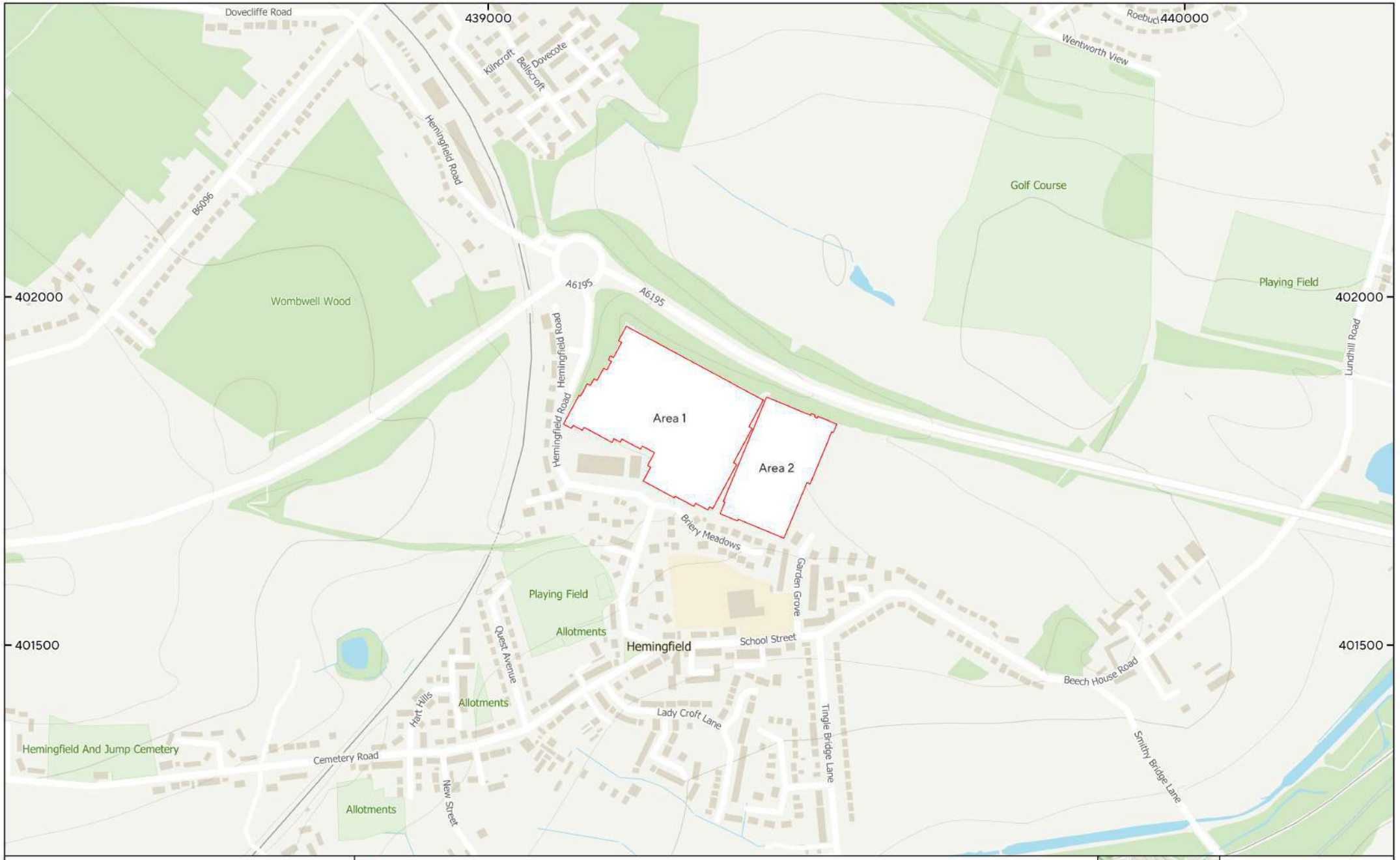
Version	Comments	Author	Checked By	Date
0.1	Initial draft for Director Review	DW	PSJ	16 September 2024
0.2	Secondary draft following Client Feedback	DW	PSJ	19 September 2024
0.3	Further Draft following client corrections	IT	IC, PSJ	4 October 2024



MSSE1837 - Hemingfield Road, Barnsley
Figure 1 - Geophysical Survey Location
1:25,000 @ A4

Geophysical Site

0 0.5 1 km



MSSE1837 - Hemingfield Road, Barnsley
Figure 2 - Location of Survey Area
1:5,000 @ A3

Survey Extent

Wombwell

Magnitude Surveys

0 50 100 150 200 m

MSSE1837 - Hemingfield Road, Barnsley
Figure 3 - Magnetic Total Field (Lower Sensor)
1:1,500 @ A3

48,997 nT 49,005

Wombwell

Magnitude Surveys

0 15 30 45 60 m

MSSE1837 - Hemingfield Road, Barnsley
Figure 4 - Magnetic Gradient
1:1,500 @ A3

MSSE1837 - Hemingfield Road, Barnsley
Figure 5 - Magnetic Interpretation
1:1,500 @ A3

- Archaeology Probable (Strong)
- Archaeology Probable (Weak)
- Archaeology Possible (Weak)
- Agricultural (Weak)
- Undetermined (Weak)
- Magnetic Disturbance
- Ferrous/Debris (Spread)
- Agricultural (Trend)
- Foul Sewer
- Ferrous (Spike)

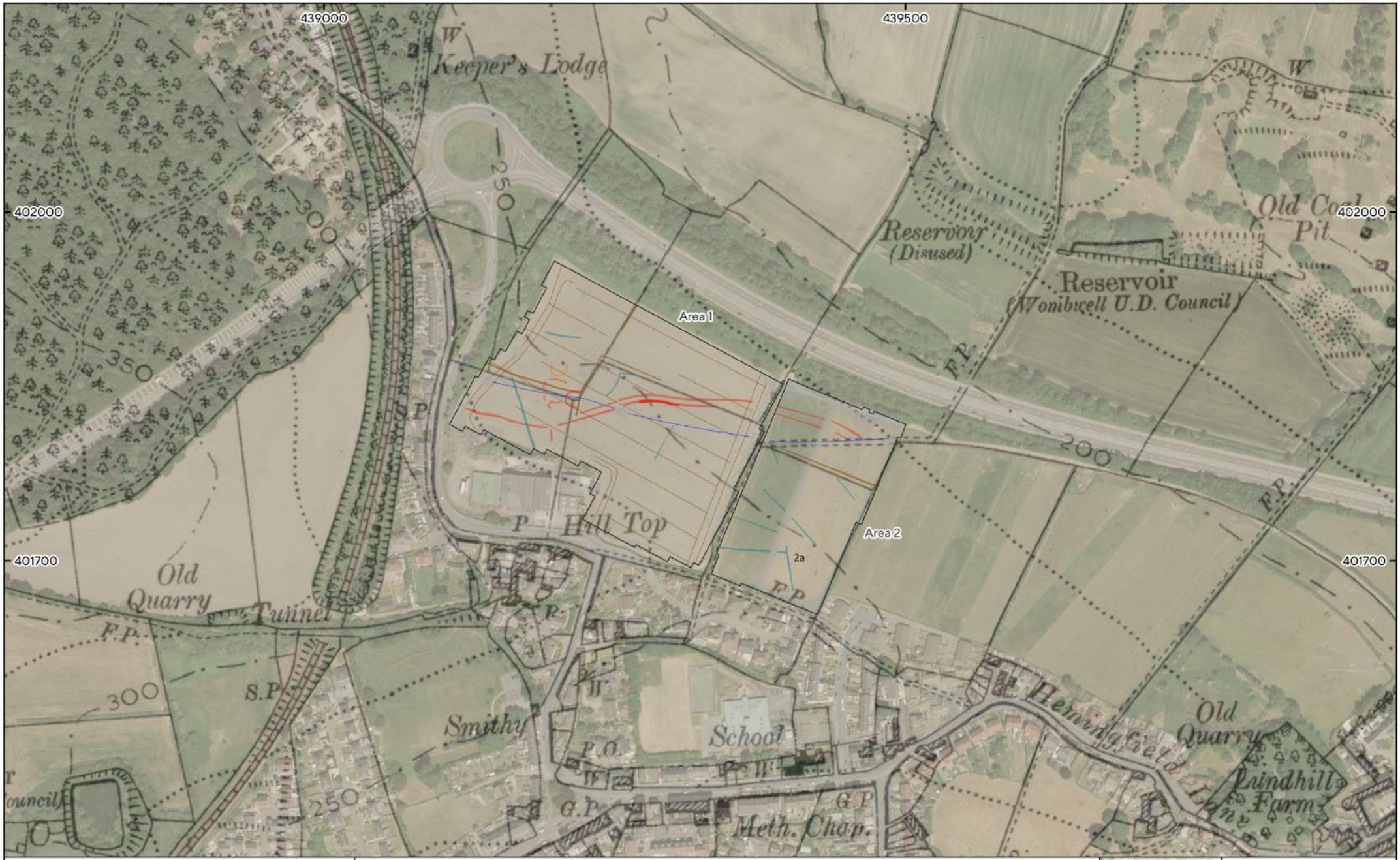
Magnitude Surveys

0 15 30 45 60 m

MSSE1837 - Hemingfield Road, Barnsley
Figure 6 - XY Trace Plot
90nT/cm at 1:1,500 @ A3

Magnitude Surveys

0 15 30 45 60 m



MSSE1837 - Hemingfield Road, Barnsley
Figure 7 - Magnetic Interpretation Over Historical Maps and Satellite Imagery
1:3,000 @ A3

- Archaeology Probable (Strong)
- Archaeology Probable (Weak)
- Archaeology Possible (Weak)
- Agricultural (Weak)
- Undetermined (Weak)
- Magnetic Disturbance
- Ferrous/Debris (Spread)
- Agricultural (Trend)
- Foul Sewer
- Ferrous (Spike)

Magnitude Surveys

0 30 60 90 120 m

MSSE1837 - Hemingfield Road, Barnsley
Figure 8 - GNSS Lines
1:1,500 @ A3

Magnitude Surveys

0 15 30 45 60 m