Geophysical Survey Report

Hammond Ground, Read, Ribble Valley

Lancashire

For

Tetra Tech RPS

On behalf of

Applethwaite

Magnitude Surveys Ref: MSSD2344

HER Event Number: TBC

OASIS Number: TBC

March 2026

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Abstract

Magnitude Surveys was commissioned to assess the subsurface archaeological potential of c. 17ha of land at Hammond Ground, Read, Lancashire. A fluxgate gradiometer survey was successfully completed across the survey area. The geophysical survey has detected anomalies of agricultural, industrial, natural and undetermined origins. Anomalies of agricultural origin were identified as historical ridge and furrow ploughing regimes, drainage features and possible unmapped field boundaries. Anomalies of industrial origin have been identified correlating to areas of quarrying and corresponding to recorded areas of mining. Variations within the geology were detected as well as depressions visible on LiDAR. Discrete, linear and curvilinear anomalies of undetermined origin have been detected across the survey area. Magnetic interference was limited to field boundaries and buried services.

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1. Introduction

1.1. Magnitude Surveys Ltd (MS) was commissioned by Tetra Tech RPS on behalf of Applethwaite to undertake a geophysical survey over a c. 17ha area of land at Hammond Ground, Read, Lancashire (SD 76227 34647).

1.2. The geophysical survey comprised a quad-towed, cart-mounted 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 Written Scheme of Investigation (WSI) produced by MS (Stead, 2026).

1.5. The survey commenced on 19th January 2026 and took three 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 was 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 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 this geophysical survey was to assess the subsurface archaeological potential of the survey area.

4. Geographic Background

4.1. The survey area was located immediately west of Read, Lancashire (Figure 1). Gradiometer survey was undertaken across two fields under pasture. The survey area was bordered by residential properties to the north and east, with a wood and a brook to the west and Whalley Road (A671) to the south (Figure 2). Approximately 1ha was unable to be surveyed due to poor ground conditions and obstructions.

4.2. Survey considerations:

Survey Area	Ground Conditions	Further Notes
1	Pasture field with a steep slope from north to south.	The survey area was bordered on all sides by metal wire fences, with hedgerows to the west and south. Trees were present throughout the survey area, as well as drainage ditches, which ran from the northwest, northeast, and southwest corners to the centre.
2	Pasture field with a steep slope from north to south.	The survey area was bordered by a wire fence to the west, southwest, and east, a metal fence to the north, a stone wall to the southeast, and a hedgerow in the southwest. Trees were present in the centre and northwest of the field.

4.3. The underlying geology primarily comprises bands of Pennine Lower Coal Measures Formation mudstone, siltstone and sandstone in the centre and southwest of the survey area, Rough Rock sandstone and Woodhead Hill Rock sandstone in the northwest corner of Area 1, and a band of Woodhead Hill Rock sandstone in the southwest of Areas 1 and 2. The superficial deposits of the survey areas comprise Devensian diamicton till across the majority of the survey area, with no recorded deposits in the north of Area 1 (British Geological Survey, 2026).

4.4. The soils consist of slowly permeable seasonally wet acid loamy and clayey soils (Soilscapes, 2026).

5. Archaeological Background

5.1. The following is a summary of an Archaeological Desk-Based Assessment produced and provided by Tetra Tech RPS (Lee, 2025).

5.2. There is little evidence for prehistoric activity throughout the vicinity of the survey area. A Neolithic hand axe was recorded c. 800m southwest of the survey area (PRN2027) and three Bronze Age axes have been recorded (PRN188) as being found in Read.

5.3. Romano-British activity is sparse in the wider environs of the survey area. Two Roman coins were recorded c. 90m (PRN41805) and c. 250m (PRN189) east of the survey area.

5.4. The medieval Read Hall (PRN737) is located c. 220m west of the survey area, with the original building dating back to the 14th century. Ridge and furrow earthworks are recorded within the survey area. A lead weight (PRN41983) and two lead spindle whorls (PRN41927; PRN41981) are recorded c. 115-130m east of the survey area.

5.5. The survey area lies within the 19th century Read Park. Historical mapping produced following the sale of Read Hall depicts cisterns, a well and water supply mains within the survey area (PRN37695). Earthwork remains of two coalpits are recorded in the northeast of the survey area (PRN37318), as well as a large area of former sandstone quarrying in the northwest, visible in Area 1 (PRN6185). The earthwork remains of another coal pit (PRN37317) are located c. 190m southwest of the survey area, along with the site of a former coal staithe and tramway to Dunkirk Mine c. 380m to the south.

6. Methodology

6.1.Data Collection

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

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

6.1.3. Table of survey strategies:

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

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

6.1.4.1. MS' cart 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. 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 5). 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 (2026) 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 (EPSG:27700) 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 (Figure 6) and LiDAR (Figure 7).

7.2.2. A fluxgate gradiometer survey was successfully undertaken across c. 17ha of land at Hammond Ground, Read, Lancashire. The survey responded well to the local environment of the survey area against an enhanced magnetic background. Anomalies of agricultural, natural, industrial and undetermined origins were detected. Magnetic interference was limited to field boundaries and buried services.

7.2.3. Evidence of agricultural activity has been identified within the survey area. Linear and curvilinear anomalies have been detected, some of which correspond to ditches visible in LiDAR imagery and may be natural features that have been reused as field boundaries. Ridge and furrow ploughing regimes of varying orientations have also been identified across the survey area and are recorded on the HER (Figure 4). Field drains and more modern agricultural ploughing regimes have also been identified.

7.2.4. A series of anomalies detected in Area 1 correspond to a feature recorded by the Mining Remediation Authority as a coal mine entrance **[1a]** (2026)**.** This corresponds to an area on 1840's Ordnance Survey mapping marked as sandstone quarrying.

7.2.5. Amorphous and linear natural anomalies of varied magnetic enhancement have been identified across the survey area. A large sinuous anomaly across the centre of both areas corresponds to a ditch visible in LiDAR imagery.

7.2.6. Across the survey area, discrete, linear and curvilinear anomalies have been detected and categorised as undetermined due to a lack of a clear pattern or context. Several linear anomalies are perpendicular and appear to form boundaries, but it is unclear whether these are of archaeological or agricultural origin.

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. **Data Artefact** – Data artefacts usually occur in conjunction with anomalies with strong magnetic signals due to the way in which the sensors respond to very strong point sources. They are usually visible as minor 'streaking' following the line of data collection. While these artefacts can be reduced in post-processing through data filtering, this would risk removing 'real' anomalies. These artefacts are therefore indicated as necessary in order to preserve the data as 'minimally processed'.

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

7.3.1.4. **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.

7.3.1.5. **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.

7.3.1.6. **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.

Magnetic Results - Specific Anomalies

7.3.1.7. **Agricultural (Weak) –** Across the survey area, several linear and curvilinear anomalies displaying weak magnetic enhancement have been detected (Figures 3 & 4). Some of these anomalies correspond to ditches visible in LiDAR imagery and may be former unmapped field boundaries (Figure 7). This interpretation is supported by the ridge and furrow ploughing regimes also identified within the survey area, which align with the varying orientations of these ditches.

7.3.1.8. **Ridge and Furrow (Trend)** – Anomalies indicative of historical ridge and furrow ploughing regimes have been identified across the survey area. These anomalies have a variety of orientations and a regular spacing of c. 4-10m. Some of these anomalies are visible on satellite imagery and LiDAR (Figures 6 & 7).

7.3.1.9. **Drainage Feature (Trend)** – Linear anomalies displaying a weak dipolar magnetic enhancement have been detected in the west of Area 1. These anomalies are typical of drainage channels.

7.3.1.10. **Natural (Strong, Weak & Spread)** – Across the survey area, amorphous and sinuous anomalies of varying enhancements have been detected (Figures 3 & 4). These anomalies are primarily located within areas recorded as mudstone, siltstone and sandstone bedrock of the Pennine Lower Coal Measures (see section 4.3). One of these anomalies corresponds to a ditch visible on LiDAR imagery and has a magnetic enhancement different from those interpreted as former field boundaries. It is possible that this anomaly is the result of the accumulation of material within the ditch.

7.3.1.11. **Industrial** – A series of strongly enhanced linear and discrete anomalies, **[1a]**, have been detected in Area 1. The discrete anomalies correspond to a feature recorded by the Mining Remediation Authority (2026) as a coal mine entrance. An area of sandstone quarrying is recorded in this area on 1840's historical mapping. Linear anomalies extending southwest from the discrete anomalies likely relates to a trackway from the mine entrance (Figure 7).

7.3.1.12. **Undetermined (Strong and Weak)** – Across the survey area discrete, linear and curvilinear anomalies were detected (Figures 3 & 4). Several of these are perpendicular to one another and possibly form enclosures, however there is insufficient context to categorise them further at this time. These anomalies may be related to Hammond Well and a water supply recorded on mapping but due to their weak enhancement this is not possible to ascertain.

8. Conclusions

8.1. A fluxgate gradiometer survey was successfully completed across c. 17ha of land at Hammond Ground, Read, Lancashire. Anomalies of agricultural, natural, industrial and undetermined origins were detected. Magnetic interference was limited to field boundaries and buried services.

8.2. Anomalies of agricultural origin were detected as linear anomalies, representing historical ridge and furrow ploughing regimes and drainage features. Further linear and curvilinear anomalies have been detected that may be unmapped former field boundaries.

8.3. Industrial anomalies were identified as a possible mine entrance through comparison with mining records.

8.4. Anomalies of natural origin displaying variable magnetic enhancements were identified across the survey area, including a sinuous anomaly corresponding with a depression visible in LiDAR imagery.

8.5. Several anomalies were detected across the survey area which lack sufficient context for confident interpretation and have been classified as undetermined in origin.

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. Any third party wishing to use or reproduce any IP owned by MS must seek permission.

11. References

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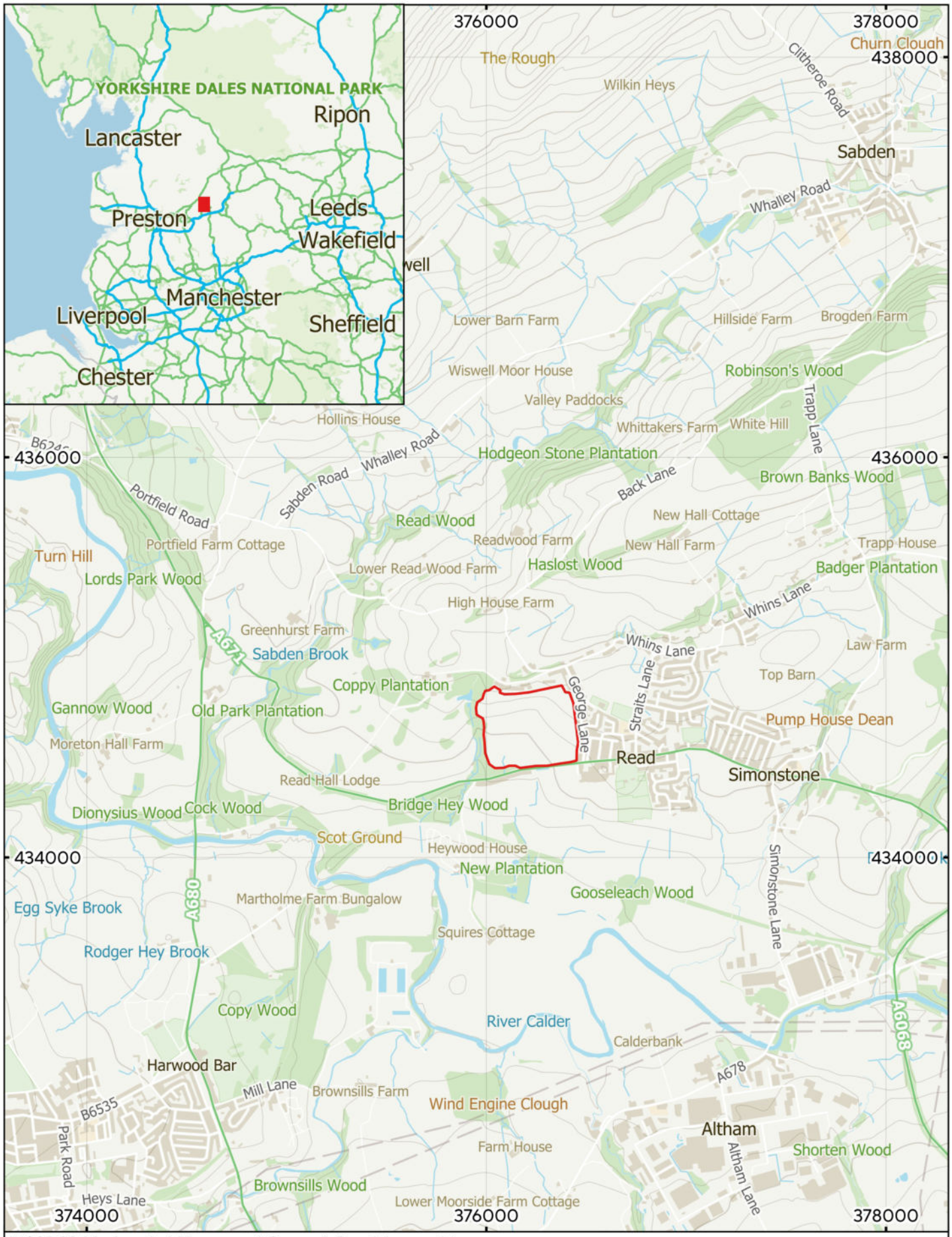
12. Project Metadata

MS Job Code	MSSD2344
Project Name	Land at Hammond Ground, Read, Lancashire
Client	Tetra Tech RPS
Grid Reference	SD 76227 34647
Survey Techniques	Magnetometry
Survey Size (ha)	17ha
Survey Dates	2026-01-19 to 2026-01-21
Project Lead	Matthew Stead BA (Hons) MA ACIfA
Project Officer	Lucy Johnson BA
HER Event No	N/A
OASIS No	N/A
S42 Licence No	N/A
Report Version	0.5

13. Document History

Version	Comments	Author	Checked By	Date
0.1	Initial draft for Project Lead to Review	TO	LJ	09 February 2026
0.2	Corrections	MS	KD	16 February 2026
0.3	Sign Off	MS/ MM	KD	25 February 2026
0.4	Sign Off Revisions	LJ	LAG	18 March 2026
0.5	Client Corrections	MS	MS	20 March 2026



MSSD2344 - Land at Hammond Ground, Read, Lancashire
Figure 1 - Geophysical Survey Location
1:25,000 @ A4

Geophysical Survey Area

0 0.5 1 km

MSSD2344 - Land at Hammond Ground, Read, Lancashire
Figure 2 - Geophysical Survey Areas
1:5,000 @ A3

Survey Extent Unable to be Surveyed

Magnitude Surveys

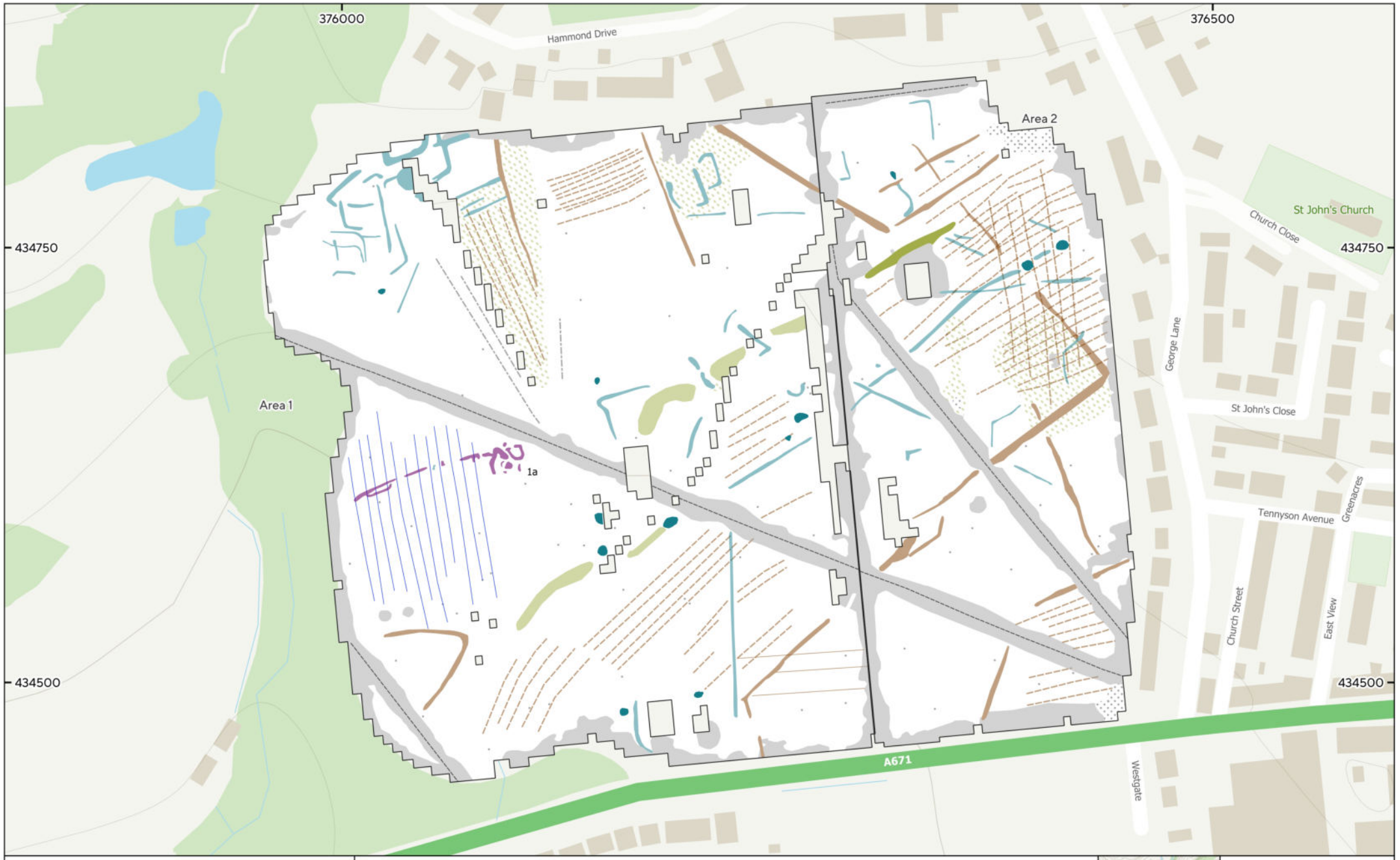
0 50 100 150 200 m

MSSD2344 - Land at Hammond Ground, Read, Lancashire
Figure 3 - Magnetic Gradient
1:2,000 @ A3

-1 nT 2

Magnitude Surveys

0 20 40 60 80 m

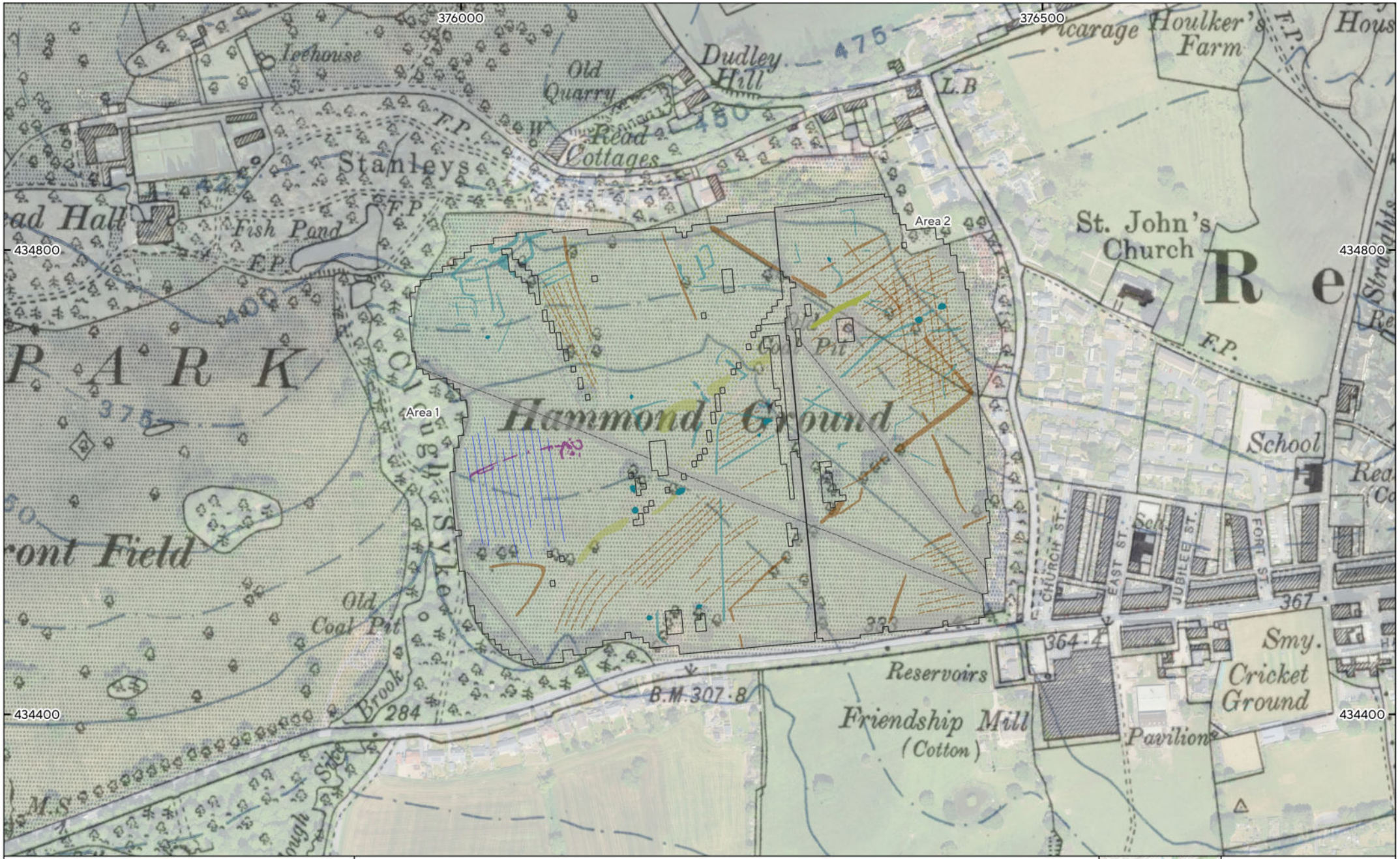


MSSD2344 - Land at Hammond Ground, Read, Lancashire
Figure 4 - Magnetic Interpretation
1:2,000 @ A3

MSSD2344 - Land at Hammond Ground, Read, Lancashire
Figure 5 - XY Trace Plot
120 nT/cm at 1:2,000 @ A3

Magnitude Surveys

0 20 40 60 80 m



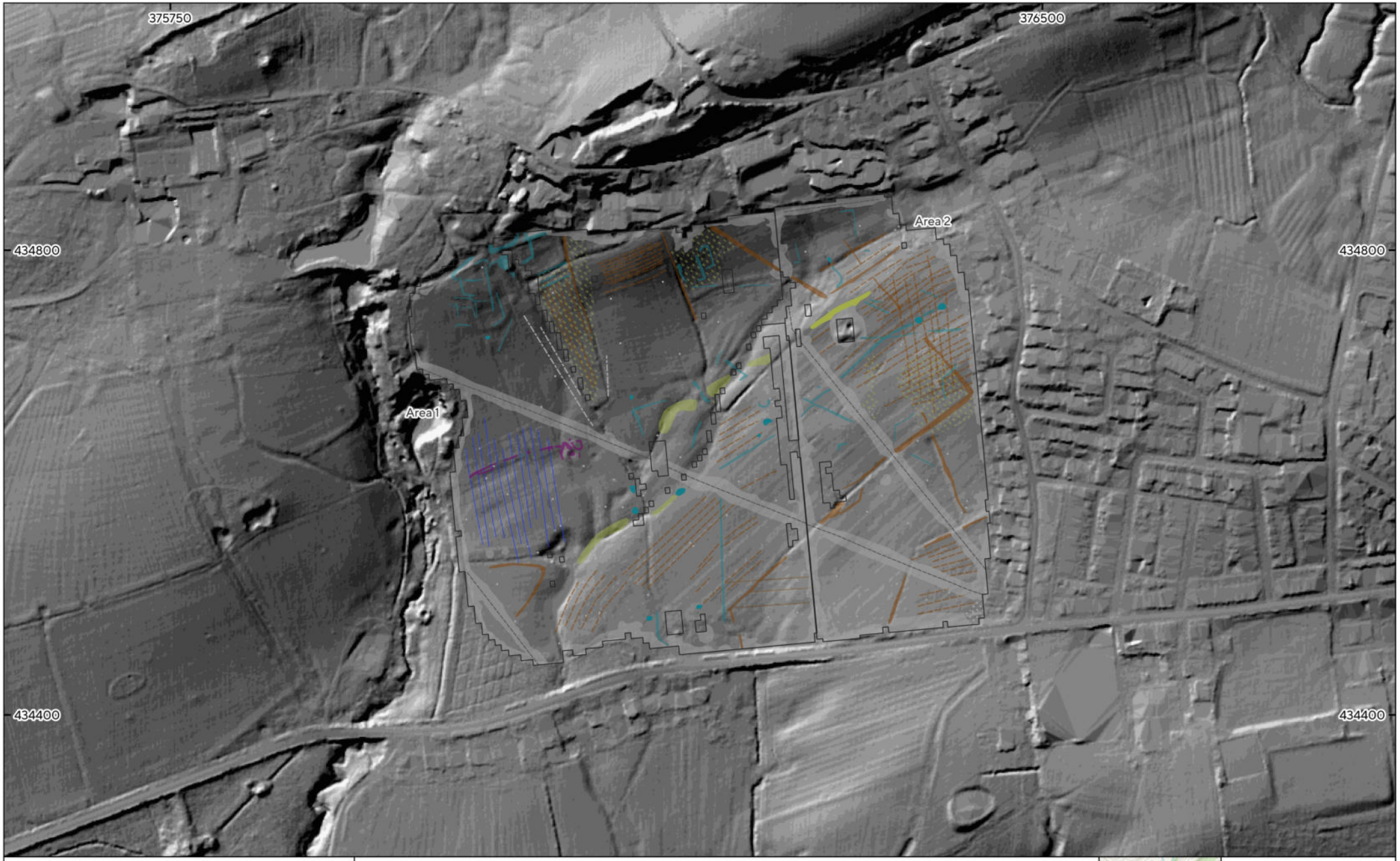
MSSD2344 - Land at Hammond Ground, Read, Lancashire
Figure 6 - Magnetic Interpretation over Historical Mapping and Satellite Imagery
1:3,000 @ A3

Contains historical mapping © CLS Data 2026: Ordnance Survey , 6" 2nd Edition
Contains satellite data © Google Satellite 2026

- Agricultural (Weak)
- Natural (Strong)
- Natural (Weak)
- Natural (Spread)
- Undetermined (Strong)
- Undetermined (Weak)
- Industrial
- Magnetic Disturbance
- Ferrous/Debris (Spread)
- Ridge and Furrow (Trend)
- Drainage Feature
- Agricultural (Trend)
- Ferrous (Trend)
- Service
- Ferrous (Spike)

Magnitude Surveys

0 30 60 90 120 m



MSSD2344 - Land at Hammond Ground, Read, Lancashire
Figure 7 - Magnetic Interpretation over Composite Hillshade LiDAR Imagery
1:3,000 @ A3