Crimea Farm, Mansfield Woodhouse, Nottinghamshire: Geophysical Survey Report

Harworth Group

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Contents

Tables

Figures

Executive Summary

Cura Terrae were instructed by Harworth Group to undertake an archaeological geophysical survey at land adjacent to Crimea Farm, Mansfield Woodhouse, Nottinghamshire. The survey produced good results throughout and confirmed the presence of anomalies that have been interpreted as being possibly archaeological in origin.

A large, ovular anomaly noted in the northeast corner of the Site may indicate an enclosure of possible pre-historic provenance. Furthermore, the possible remains of a rectilinear enclosure are situated within its centre and may represent a different phase of land use within the landscape. Further evidence of possible pre-historic activity is also visible to the south in the form of an additional, ovular enclosure. Although smaller in size, the anomaly is of similar morphology to the larger, suspected feature.

Several further, weakly positive, circular and ovular anomalies are also noted in the southern portion of the Site. Their morphologies are indicative of possible ring-ditches and likely Iron-Age to Romano British in provenance. However, these anomalies may be natural in origin, associated with variations in the magnetic susceptibility of the underlying geological deposits.

Two, potential former boundary ditches on parallel alignments, are noted in the southwest corner of the Site. Furthermore, both features have incorporated subcircular enclosures within their overall morphology, indicating both an association and an unrecorded area of land division.

Two possible pit-like features are also noted in the dataset and may be indicative of areas of mineral extraction of refuse, though variations within the underlying geological deposits or modern agricultural activity cannot be entirely ruled out.

The remaining anomalies consist of a diffuse linear anomaly which corresponds to former boundary illustrated on historical Ordnance Survey (OS) maps (1888 – 1915). Areas of geological variation are noted within the Site, as are modern land drains and several underground services. Ferrous disturbances and increased magnetic responses are also visible. Dipolar ferrous ‘spikes’ are also noted throughout the Site and can attributed to modern and or agricultural waste within the subsoil.

1. Introduction

1.1 Project Background

1.1.1 Cura Terrae Land and Nature were instructed by Harworth Group to undertake a geophysical survey ahead of a forthcoming planning application for development of land at Crimea Farm, Mansfield (hereafter 'the Site').

1.1.2 The Site is centred on National Grid Reference (NGR) 455502 364452 (SK 55502 64452) (Figure 1).

1.2 Location, Topography and Geology

1.2.1 The Site was c. 12.9 ha in size, comprised of one field, and was situated approximately 1.7 km northeast of the town of Mansfield Woodhouse, and approximately 3.6 km northeast of the town of Mansfield, in the county of Nottinghamshire.

1.2.2 The survey area was bounded by trees, hedgerows and fencing on all sides. The western edge of the field bordered domestic dwellings, and the northeast bordered a farm access track. Further agricultural land is noted to the east and the A6025 bounds the very southern extent of the survey area.

1.2.3 The Site was undulating on a southeast facing slope and is recorded at approximately 77 m above Ordnance Datum (aOD) to the northwest, and slopes down from approximately 96 m aOD in the southeast.

1.2.4 The underlying bedrock of the Site was recorded as Lenton Sandstone Formation (Sandstone), whilst the southeast of the Site is recorded as Chester Formation (Sandstone) (British Geological Survey, 2025).

2. Archaeological and Historical Background

2.1 Introduction

2.1.1 Below is a summary of archaeological and heritage data compiled from publicly available Historic Environment Records (online) within an approximate 1 km search radius of the Site. While not exhaustive, this section aims to present a summary of findings considered relevant to the interpretation of the geophysical survey data collected.

2.2 Summary

Prehistoric

2.2.1 A Palaeolithic to Late Bronze Age find spot, 444 m southwest to the Site, contained a flint knife and a spread of associated flint (HER L4042).

2.2.2 A Bronze Age findspot containing a leaf-shaped side-looped bronze spear head is located approx. 450 m southwest (HER L4003).

Romano-British

2.2.3 A possible Iron-Age to Romano-British Hillfort with associated earthworks was located approx. 850 m to southwest of the Site. It has since been built over (HER M4004).

Post-Medieval

2.2.4 A ruinous c.17th country house, known as Park Hall, is located approx. 1 km northwest of the Site. It was occupied until the end of the Second World War, when damage from being requisitioned left it untenable (HER M5325).

2.2.5 The Park at Park Hall is a Post Medieval to late 20th century landscaped park associated with Park Hall house (MNT26642).

2.2.6 A large 18th-21st century fishpond, still identifiable on modern mapping, is located within the grounds of Park Hall. This was a duck decoy pond (HER M7567).

2.2.7 An associated ha-ha was found within the grounds of the aforementioned Park Hall (HER M6068). An icehouse was found within the grounds of Park Hall (HER M7476).

Unknown

2.2.8 Undated linear features representing three sides of an enclosure were identified via aerial photography approx. 444 m north of the Site (HER L4084).

2.2.9 Undated cropmark circles and linear features were identified through aerial photography 530 m southwest of the Site (HER L5905).

2.2.10 An undated enclosure and field system was identified on aerial photography approx. 888 m northeast of the Site (HER L4080).

3. Geophysical Survey Methodology

3.1.1 All survey work was completed to appropriate standards, as outlined by existing guidance (CIfA 2020a; 2020b; 2020c, 2022; and Schmidt *et al*. 2015).

3.1.2 This geophysical survey was completed using a Sensys FMG650/3 system. Readings were recorded at a resolution of 0.01 nT and data collected with a traverse interval of 1 m and a sample interval of between 0.16 - 0.25 m.

3.1.3 Data was collected by traversing the survey area in 4 m increments using a quadbike-towed non-magnetic cart system to achieve the best possible results.

3.1.4 Real Time Kinematic (RTK) differential GPS equipment (Carlson BRX7 GNSS Smart Antenna) was used to accurately determine the position of the survey equipment and survey monitor data.

3.1.5 The data processing was undertaken using TerraSurveyor64 software and consisted of a 'DeStripe' process. This process determines the average of the datapoints in each track, and subtracts that value from all the datapoints along each survey track.

3.1.6 Illustrations were created using QGIS software. Interpretation of identified anomalies was achieved through analysis of anomaly patterning and increases in magnetic response and was aided by examining the available supporting information, including but not limited to Greyscale plots, Colourscale plots and XY Trace plots. The interpretations follow Cura Terrae colour coding and categorisations of anomalies and attempt, where possible, to suggest the nature of buried features.

3.1.7 Further details of geophysical survey methodology can be found in Appendix A.

4. Mitigating Factors

4.1.1 The results of geophysical survey may not reveal all potential archaeology within a survey area, and geological, agricultural, and modern features may limit the detection of weaker archaeological responses.

4.1.2 At the time of survey, the Site conditions were wet but firm underfoot.

4.1.3 Localised geological variation is noted in the survey data within the northern and central portions of the Site and is likely caused by the presence of deposits of Lenton Sandstone. This has limited the ability to confidently assert an archaeological origin to anomalies identified within the dataset.

4.1.4 Modern services are noted also traversing the survey data from east to west and northeast to southwest, respectively in the southern central portion of the survey area. The strong magnetic response resulting from the presence of this feature has affected the data, and likely limited the detection of potential weaker anomalies in their vicinity, if present.

4.1.5 Field boundaries comprised hedgerows and metal fences. Where necessary, a 2 m buffer was observed along metal fences although some interference is still noted at the survey periphery. The buffer was observed to minimise the effects or magnetic interference on the survey and to help to reduce as far as is reasonably practicable any non-detection of potential buried features.

5. Results and Interpretation

5.1.1 Anomalies found within the survey data are listed in Table 1 and illustrated on Figures 3, 5 and 7.

Table 1: Survey Anomalies

Anomaly Number	Anomaly Type	Description	Interpretation
E1a. (Field 1, Figure 3)	Possible Archaeology	Weak, positive, curvilinear anomaly located in the northern portion of the Site. Measures 77 m long on a northeast to southwest alignment.	This anomaly may indicate the northern extent of a large, former, ovular enclosure. It is associated with anomalies (E1b – E1c). Its morphology is characteristic of a pre-historic provenance, though it is also plausible that the responses may indicate topographic or underlying geological variations.
E1b. (Field 1, Figures 3 and 5)	Possible Archaeology	Weak, positive, curvilinear anomaly located in the northern portion of the Site. Measures 276 m long.	This anomaly may indicate the western extent of the large enclosure noted in Field 1 and is associated with (E1a) and (E1b). Though topographic or geological variations cannot be entirely ruled out.
E1c. (Field 1, Figures 3 and 5)	Possible Archaeology	Weak, positive, curvilinear anomaly located by the northeast corner of the Site. Measures 100 m long on a broadly northwest to southeast alignment.	This anomaly may indicate the eastern extent of the large enclosure noted in Field 1 and is associated with (E1a - E1b), though localised variations in underlying geology cannot be entirely ruled out.

Anomaly Number	Anomaly Type	Description	Interpretation
E2. (Field 1, Figure 5)	Possible Archaeology	Weak, positive ovular anomaly located in centre of the Site. Measures 48 m in diameter.	This anomaly may represent a former enclosure. Its morphology is characteristic of a pre-historic provenance, though it is unclear as to whether it shares the same phase of land use as anomalies (E1a – E1c). Though it is plausible that it is result of localised variations in the underlying geology.
E3. (Field 1, Figures 3 and 5)	Possible Archaeology	Weak, positive circular anomaly located in the western portion of the Site and adjoined immediately west of (L1a) and immediately east of (L1b). Measures 18 m in diameter.	This anomaly might indicate a possible enclosure feature, as part of unrecorded boundary (L1a – L1b). Furthermore, anomalies (L2a – L2b) and (E4) are of similar, respective morphologies and are on a broadly parallel alignment. Suggesting they have occupied the same phase of land use within the historical landscape.
E4. (Field 1, Figures 3 and 5)	Possible Archaeology	Weak, positive circular anomaly located in the western portion of the Site and adjoined immediately west of (L2a) and immediately east of (L2b). Measures 9 m in diameter.	This anomaly may represents a possible enclosure feature, as part of unrecorded boundary (L2a – L2b). Furthermore, anomalies (L1a – L1b) and (E3) are of similar, respective morphologies and are on a broadly parallel alignment. Suggesting they have occupied the same phase of land use within the historical landscape.

Anomaly Number	Anomaly Type	Description	Interpretation
E5. (Field 1, Figure 7)	Possible Archaeology	Weak, positive circular anomaly located in the southern portion of the Site. Measures 15 m in diameter.	This anomaly is characteristic of a ring-ditch of Iron-Age to Romano-British provenance. It is nearby other anomalies of similar morphologies (E6a – E9) suggesting a shared phase of land use within historical landscape. Though, it cannot be determined if they share the same phase of land use with noted anomalies in the northern portion of the Site.
E6a. (Field 1, Figure 7)	Possible Archaeology	Weak, positive half-circular anomaly located in the southern portion of the Site and adjoined immediately west of (E6b). Measures 30 m in diameter.	This anomaly may represent the remains of a ring-ditch of Iron-Age to Romano-British provenance. It is adjoined immediately west of (E6b) which is indicative of a former enclosure.
E6b. (Field 1, Figure 7)	Possible Archaeology	Weak, positive circular anomaly located in the southern portion of the Site. Measures 8 m in diameter.	This anomaly is indicative of a former enclosure. It is adjoined immediately east of (E6a) inferring an association.
E7. (Field 1, Figure 7)	Possible Archaeology	Weak, positive circular anomaly located in the southern portion of the Site. Measures 13 m in diameter.	This anomaly is characteristic of a former ring ditch of Iron-Age to Romano-British provenance.
E8. (Field 1, Figure 7)	Possible Archaeology	Weak, positive ovular anomaly located in the southern portion of the Site. Measures 20 m in diameter.	This anomaly is characteristic of a former ring ditch of Iron-Age to Romano-British provenance.

Anomaly Number	Anomaly Type	Description	Interpretation
E9. (Field 1, Figure 7)	Possible Archaeology	Weak, positive ovular anomaly located in the southern portion of the Site. Measures 39 m in diameter.	This anomaly is characteristic of a former ring ditch of Iron-Age to Romano-British provenance.
R1a. (Field 1, Figure 3)	Possible Archaeology	Weak, positive rectilinear anomaly located in the northeast corner of the Site. Measures 41 m long.	This anomaly may represent the northern extent of a larger, rectilinear enclosure associated with (R1b – R1c). The morphology differs from other nearby anomalies, which may suggest a different phase of land use. It is also plausible that it may be the result of modern agricultural activity.
R1b. (Field 1, Figure 3)	Possible Archaeology	Weak, positive rectilinear anomaly located in the northeast corner of the Site. Measuring 29 m x 27 m.	This anomaly might represent the southeast extent of the proposed enclosure associated with (R1a) and (R1c). A modern agricultural origin is also plausible.
R1c. (Field 1, Figure 3)	Possible Archaeology	Weak, positive linear anomaly located in the northeast corner of the Site. Measures 28 m long on a north to south alignment.	This anomaly may indicate the western extent of the proposed enclosure associated with (R1a – R1b). A modern agricultural origin is also plausible.
R2. (Field 1, Figures 3 and 5)	Possible Archaeology	Positive rectilinear anomaly, with varied dipolar responses located by the southwest boundary of the Site and immediately south of (L1b) Measuring 16 m x 6 m.	This anomaly may represent the remains of an enclosure. It is unclear as to whether it is associated with (L1b) or other nearby anomalies. The variable, dipolar response is likely the result of upcast associated with the construction of the nearby housing estate.

Anomaly Number	Anomaly Type	Description	Interpretation
L1a. (Field 1, Figures 3 and 5)	Possible Archaeology	Weak, positive curvilinear anomaly located in the southwest corner of the Site and adjoined immediately west of (E3). Measures 34 m long.	This anomaly is characteristic of a former boundary ditch feature. The feature extends eastwards (L1b) and is partitioned by a possible enclosure (E3) but may be of a more recent origin.
L1b. (Field 1, Figures 3 and 5)	Possible Archaeology	Weak, positive linear anomaly located in the southwest corner of the Sie and adjoined immediately east of (E3). Measures 56 m long.	This anomaly is a continuation of (L1a) as part of a wider boundary feature and is partitioned by a possible enclosure (E3) but may be of a more recent origin.
L2a. (Field 1, Figures 3 and 5)	Possible Archaeology	Weak, positive linear anomaly located in the southwest corner of the Site and adjoined immediately west of (E4). Measures 57 m long.	This anomaly is characteristic of a former boundary ditch. The feature extends eastwards (L2b) and is partitioned by a possible enclosure (E4).
L2b. (Field 1, Figures 3 and 5)	Possible Archaeology	Weak, positive curvilinear anomaly located in the southwest corner of the Site and adjoined immediately east of (E4). Measures 27 m long.	This anomaly is a continuation of (L2a) as part of a wider boundary feature and is partitioned by a possible enclosure (E4).
L3. (Field 1, Figure 3)	Possible Archaeology	Positive linear anomaly located in the western portion of the Site. Measures 85 m long on a broadly north to south alignment.	This anomaly is tentatively indicative of a former boundary ditch. However, its somewhat isolated located and lack of clear association with nearby anomalies precludes a more accurate interpretation. It is also plausible that it is the result of modern agricultural activity.

Anomaly Number	Anomaly Type	Description	Interpretation
P1 – P2 (Field 1, Figures 3 and 5)	Possible Archaeology	Two, positive subcircular anomalies located in both the western and central portions of the Site, respectively. Measuring between 5 m to 6 m in diameter.	These anomalies are tentatively indicative of pit-like features associated with mineral extraction of refuse. A date of origin cannot be currently inferred. It is equally plausible that they are the result of localised geological variation.
B1. (Field 1, Figures 3 and 5)	Former Boundary	Diffuse linear anomaly located in the western portion of the Site. Measures 177 m long on a northeast to southwest alignment.	This anomaly corresponds to a former land division illustrated on historical OS maps (1888 – 1915).
NA. (Field 1, Figures 3 and 5)	Land Drain	Two, weakly positive, parallel anomalies located in the northern portion of the Site. Measuring between 55 m to 83 m long on a northeast to southwest alignment.	These anomalies are likely to indicate more recent or modern land drains.
NA. (Field 1, Figures 3 and 5)	Geology	Three weakly positive, amorphous anomalies within the Site survey data.	These anomalies represent localised variations in the underlying geological deposits.
NA. (Field 1, All Figures)	Service	Highly dipolar linear anomalies located in the both the centre and long the east boundary of the Site.	These anomalies represent underground services.
NA. (Field 1, All Figures)	Ferrous Disturbance	Dipolar, amorphous anomalies predominately located along the survey boundaries.	These anomalies have likely been caused by proximity to metal fencing at the survey periphery as well as ferrous material beyond the survey extents.

Anomaly Number	Anomaly Type	Description	Interpretation
NA. (Field 1, Figure 3)	Increased Magnetic Response	Amorphous areas of varying magnetic response located along the northern boundary of the Site.	These anomalies are the likely result of disturbed ground, or re-deposited or upcast material associated with the farm track located north of the Site.
NA. (Field 1, All Figures)	Ferrous 'Spike'	Small, dipolar 'spikes' located sporadically throughout Site.	These anomalies are typically caused by small ferrous material and debris within the topsoil, resulting from modern agricultural activity.

6. Discussion

6.1.1 The geophysical survey produced good results throughout and confirmed the presence of anomalies that have been interpreted as being possibly archaeological in origin. However, due to the localised geological variation noted in the survey data, a more confident assertion for the origin of these cannot be given.

6.1.2 Three, weakly positive curvilinear anomalies (E1a – E1c) are noted in the northeast corner of the Site. It is possible they constitute the remains of a singular, ovular enclosure of unknown pre-historic provenance. A break noted in the northwest corner may also denote a possible entrance. This is supported by the presence of a former Roman Road illustrated on historical OS maps (1888 – 1915) noted as 'Leeming Lane (Roman Road)' which is situated on the modern A60, east of the Site. Furthermore, the weak magnetic response within the dataset could indeed be the result of topographic elevation noted within the northeast portion the Site, both on satellite imagery and historical OS maps (1888 – 1915). Localised variations within the underlying geology also cannot be entirely ruled out.

6.1.3 Two rectilinear anomalies and a single linear anomaly of varying response are also noted in the northeast corner of the Site (R1a – R1c) and are indeed located within the centre of the proposed, ovular enclosure. It is plausible they are the remains of a single rectilinear enclosure. The overall morphology differs from other nearby anomalies, and it cannot be currently inferred as to whether these anomalies are associated with (E1a – E1c) therefore suggesting a different phase of land use within the historical landscape.

6.1.4 A weakly positive, ovular anomaly (E2) is present within the centre of the Site. It is situated 32 m south of anomalies (E1a – E1c). Though smaller in scale, its morphology is suggestive of a shared phase of land use of possible pre-historic provenance. Though this cannot be inferred with certainty.

6.1.5 Several weakly positive anomalies (E5 – E9) are noted in the southern portion of the Site. Their circular and ovular morphologies are characteristic of former ring-ditches of likely Iron-Age to Romano-British provenance. Though, it cannot be determined if they share the same phase of land use with noted anomalies in the northern portion of the Site. However, it is also plausible that the weak responses are the result of modern agricultural activity.

6.1.6 Two curvilinear anomalies of weak response are noted in the southwest corner of the Site (L1a – L1b) and likely denote a former boundary. A weak circular anomaly (E3) is also incorporated into overall morphology, suggesting a singular feature. Furthermore, three anomalies of similar morphologies (L2a - L2a) and (E4) are noted 34 m northwest on a broadly parallel alignment, suggesting an unrecorded area of land division within the historical landscape, though an exact date of origin cannot be currently inferred.

6.1.7 A singular, weakly positive, linear anomaly is visible in the northwest corner of the Site. Its morphology is characteristic of a boundary ditch, although its somewhat isolated located within the dataset and lack of clear associated anomalies precludes an accurate interpretation. It is plausible that it is the result of a modern agricultural activity.

6.1.8 Two, positive subcircular anomalies (P1 – P2) are also noted in the dataset. These magnetic responses are indicative of pit-like features associated with areas of mineral extraction or refuse, though is it plausible that they are the result of localised geological variation. Modern agricultural also cannot be entirely ruled out.

6.1.9 A diffuse linear anomaly in the northern portion of the Site (B1) corresponds to an area of land division illustrated on historical OS maps (1888 – 1915).

6.1.10 Several areas of localised geological variance are also noted in both northern and central portions of the survey area. The remaining anomalies are modern origin and consist or ferrous disturbances caused by proximity to metal fencing or ferrous materials along the survey extents. Increased magnetic disturbances are also noted along the northern boundary of the Site and are likely the result of disturbed ground and or upcast materials associated with the construction of the farm track north of the Site. Modern land drains are also noted as are modern, underground services. Dipolar ferrous 'spikes' are located sporadically throughout the Site and have been caused by modern and or agricultural waster within the subsoil.

7. Curation and Storage

7.1.1 The archive will be prepared in accordance with national guidelines (CIfA 2020b). The integrity of the primary field record will be preserved. Security copies will be maintained where appropriate. Digital records of the geophysical survey and its collected data will be held by Cura Terrae

7.1.2 An OASIS form has been created on the results of the works under the following reference number (curaterr1-538595). Following approval of the report, a pdf version of the final version will be submitted within three months to the Archaeology Data Service via the OASIS form.

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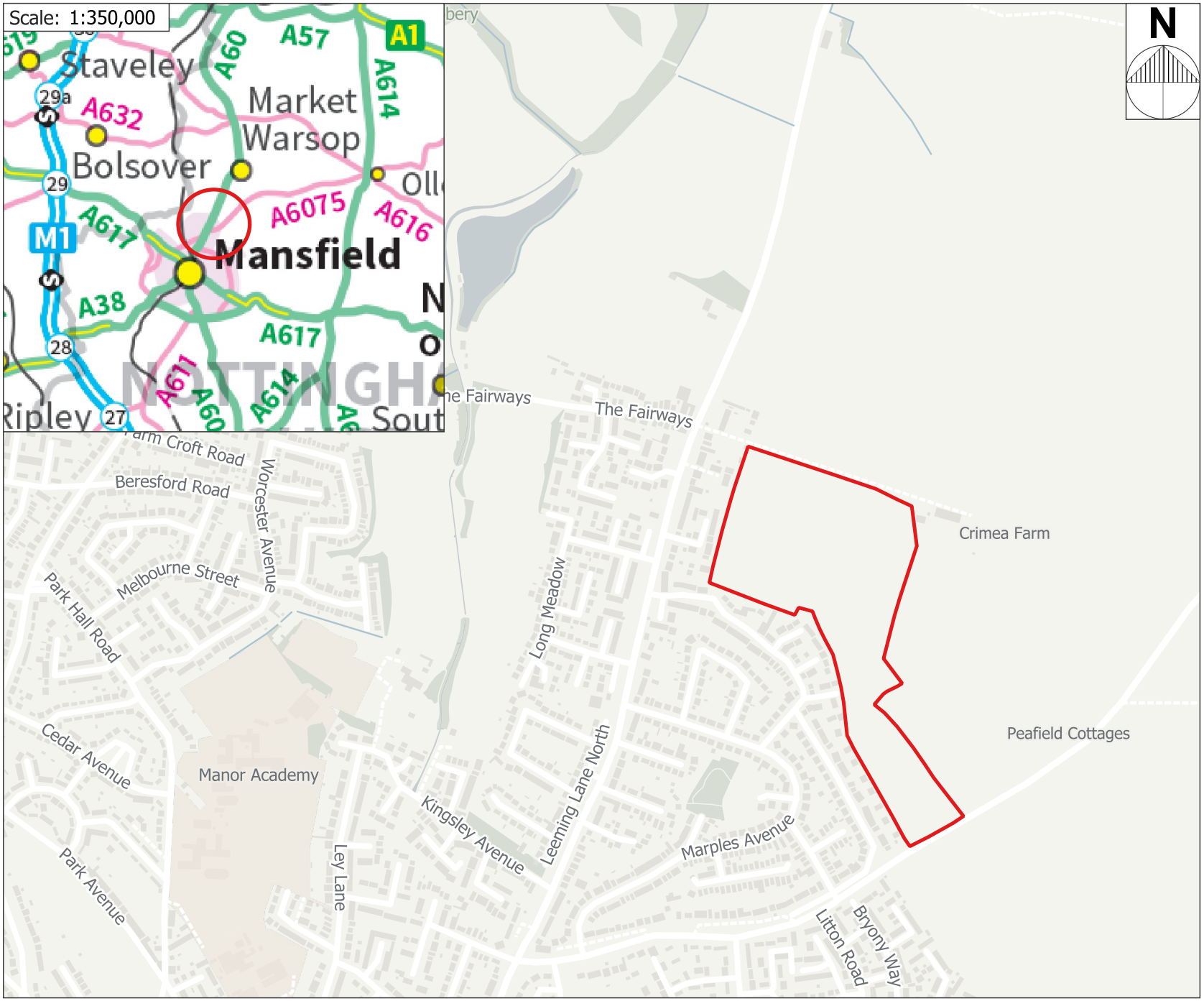

CuraTerrae

Key

Site Boundary

0 100 200 300 400 500 m

Crimea Farm, Leeming Lane North, Mansfield

Figure 1
Site Location

A	11.11.25	PFP	-
Rev	Date	Drawn by	Checked by

Site centred on:	SK 55503 64444

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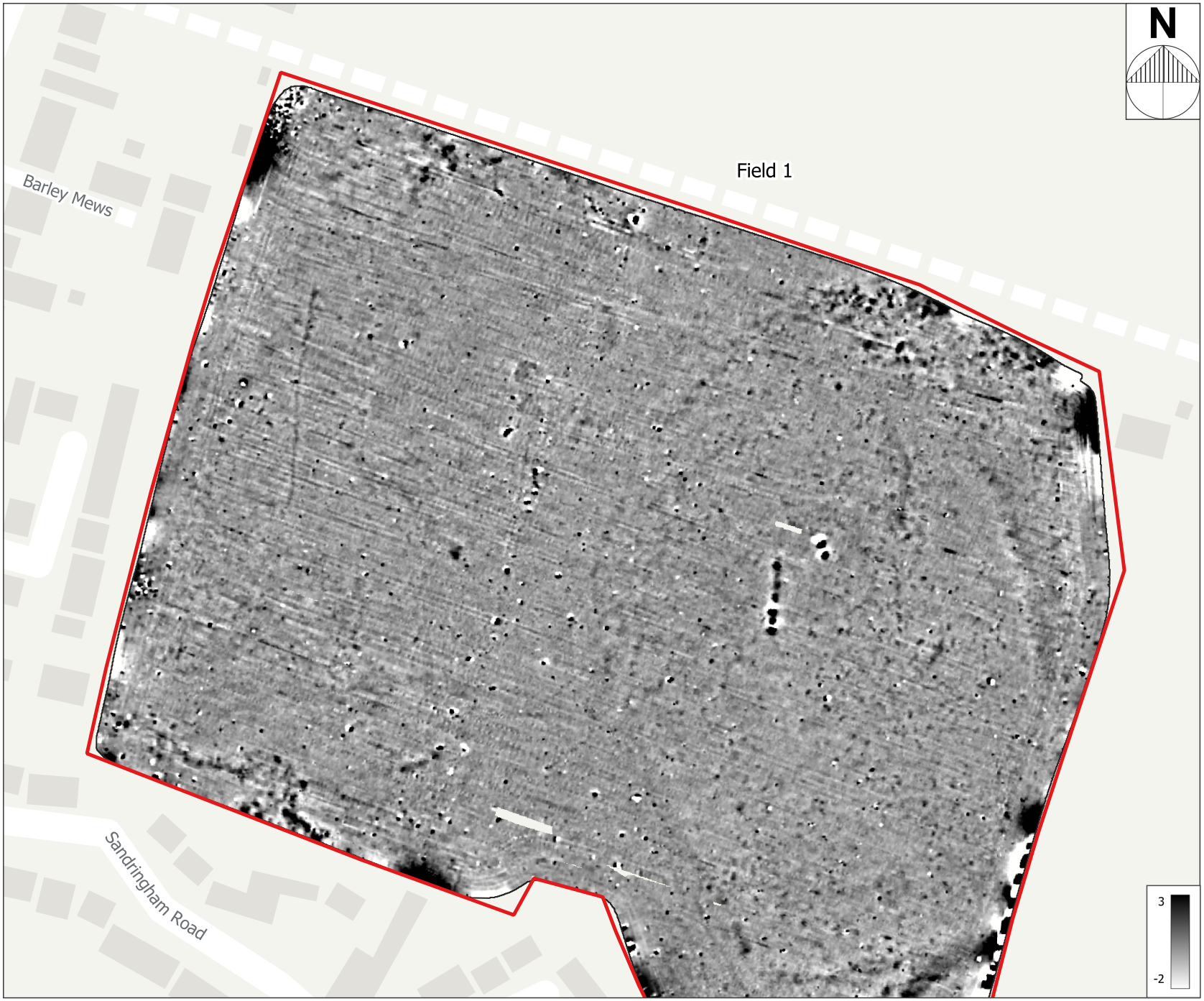
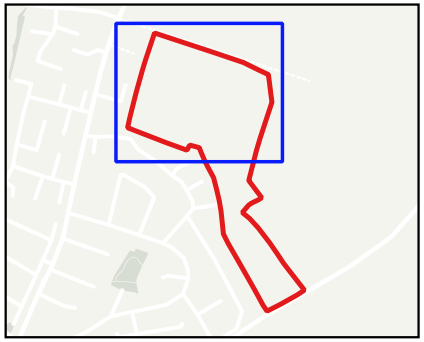
November 2025 | Scale: 1:10,000 @A4 | Drg.Ref: 24749 - GEO - 1 - A



CuraTerrae

Key

- Site Boundary
- Survey Extent



0 20 40 60 80 100 m

Crimea Farm, Leeming Lane North, Mansfield

Figure 2
Greyscale Plot - Field 1 (North)

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Rev	Date	Drawn by	Checked by

Site centred on:	SK 55503 64444

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Key

- Site Boundary
- Survey Extent
- Possible Archaeology
- Former Boundary
- Uncertain Trend
- Land Drain
- Service
- Ferrous spike
- Ferrous Disturbance
- Increased Magnetic Response
- Geology

0 20 40 60 80 100 m

Crimea Farm, Leeming Lane North, Mansfield

Figure 3
Interpretation Plot - Field 1 (North)

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Site centred on:	SK 55503 64444

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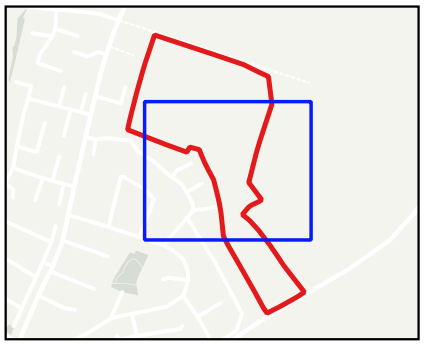
Key

- Site Boundary
- Survey Extent



0 20 40 60 80 100 m

Crimea Farm, Leeming Lane North, Mansfield

Figure 4
Greyscale Plot - Field 1 (Centre)

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Site centred on:	SK 55503 64444

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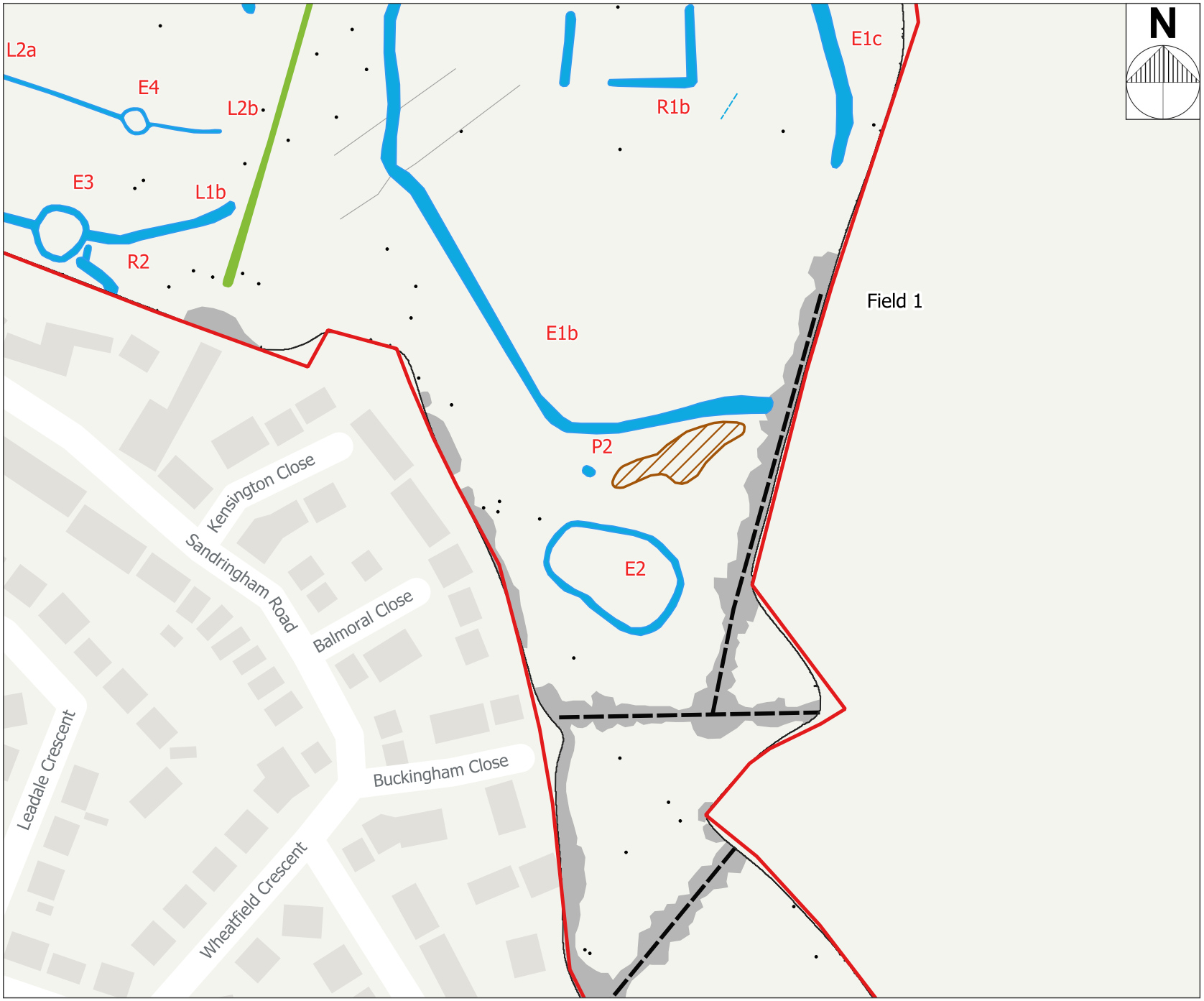

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Key

- Site Boundary
- Survey Extent
- Possible Archaeology
- Former Boundary
- Uncertain Trend
- Land Drain
- Service
- Ferrous spike
- Ferrous Disturbance
- Geology

0 20 40 60 80 100 m

Crimea Farm, Leeming Lane North, Mansfield

Figure 5
Interpretation Plot - Field 1 (Centre)

A	21.11.25	PFP	-
Rev	Date	Drawn by	Checked by

Site centred on:	SK 55503 64444

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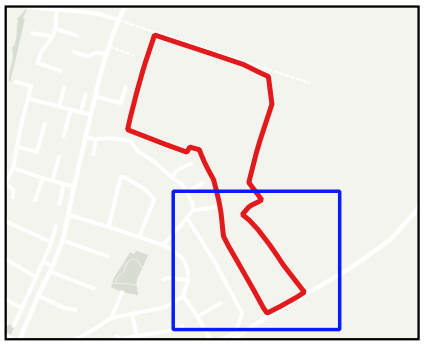
November 2025 | Scale: 1:2,000 @A4 | Drg.Ref: 24749 - GEO - 5 - A

CuraTerrae

Key

Site Boundary

Survey Extent



0 20 40 60 80 100 m

Crimea Farm, Leeming Lane North, Mansfield

Figure 6
Greyscale Plot - Field 1 (South)

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Key

- Site Boundary
- Survey Extent
- Possible Archaeology
- Service
- Ferrous spike
- Ferrous Disturbance

0 20 40 60 80 100 m

Crimea Farm, Leeming Lane North, Mansfield

Figure 7
Interpretation Plot - Field 1 (South)

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Appendix A: Technical Information

Gradiometer Survey

Magnetic surveys measure distortions of variable strength in the earth's magnetic field caused by magnetic fields associated with buried features (Gaffney and Gater 2003, 36) that have either remnant or induced magnetic properties (Aspinal *et al*. 2008, 21–26). Human activity and inhabitation often alter the magnetic properties of materials (Aspinal *et al*. 2008, 21) resulting in the ability for numerous archaeological features to be detected through magnetic surveys.

Intensive burning or heating can also result in materials attaining a thermoremanent magnetisation; examples of which include kilns, ovens, heaths, and brick structures (Aspinal *et al*. 2008, 27; Gaffney and Gater, 2003, 37). However, there is also no way to always confidently assert from the results of Gradiometer surveys alone, whether burned material is in situ or has been redeposited within, for example, a refuse pit.

When topsoil-rich with iron oxides, fills a man-made depression in the subsoil, it creates an infilled feature, such as a pit or ditch, with a higher magnetic susceptibility compared to the surrounding soil (Aspinal *et al*. 2008, 37–41; Gaffney and Gater 2003, 22– 26). Magnetic surveys can also detect features with a lower magnetically susceptibility than the surrounding soil, an example of which is a stone wall.

Limitations

Poor results can be due to several factors including, but not limited to, short lived archaeological occupation and land use, or sites with minimal cut or built features. Results can also be limited in areas where the natural geology is of a similar composition to the fills of cut archaeological features such as ditches, or where soils are naturally deficient in iron compounds. Poor results can also be caused by areas with soils overlying naturally magnetically enhanced geological deposits, which can produce strong or variable responses limiting the detection of earlier archaeological features.

Overlying layers, such as demolition rubble or layers of made ground such as during landscaping works, can also limit the detection of earlier archaeological features. The presence of above ground structures within, or in the near vicinity of, the survey area as well as underground services containing ferrous material such as pipelines or electricity cables can distort survey results, further limiting the detection of earlier archaeological features.

Particularly uneven or locally variable elevation in topography can increase the data processing required, and/or distort results beyond the capabilities of processing. It is also possible in areas containing dramatic topographical changes that natural weathering, such as hill wash, often in combination with intensive modern ploughing or other natural geological deposits, will reduce the topsoil on slopes and towards the peaks of hills and possibly destroy or truncate potential archaeological features as a result.

Conversely features at the bottom of slopes may be covered by a greater layer of topsoil or other deposits, and so if buried features are present, they appear faint or are entirely limited in their detection.

Over-processing of data can also obscure, remove or artificially enhance or create anomalies, especially if there are on the same orientation as the direction of data collection. Consequently, where possible, attempts are made to ensure data is not collected on the same orientation as known potential features and that data quality is sufficient to minimise the required data processing.

Instrumentation

Sensys FGM650/3

The FGM650/ is a single axis, vertical component fluxgate gradiometer with an analogue output. It outputs a voltage as an equivalent of the magnetic flux density. Each sensor contains two fluxgate sensors with a vertical separation of 0.65 m. Each of the fluxgate sensors has a dynamic range of +/ 75,000 nT and the gradiometer data have a range of +/- 8,000 nT. The sensitivity of the gradiometer is 0.6V/µT, the noise below 40pT

The analogue data are converted into a digit by a 24-bit digitizer. Practically, a resolution of 0.15 to 0.2 nT can be reached in a moved system. The sensor is calibrated before it leaves the factory, a daily calibration is not needed. Instead, the data will be compensated during the post-processing.

This system records four or five lines of data on each traverse, with traverses walked in a zig-zag pattern until all the survey area is covered.

Appendix B: Data Visualisation and Further Information

Visualisation

The survey data collected was used to produce a series of images to demonstrate the results of surveys. These are outlined below:

- Greyscale plot – This method visualises the survey data as a shaded drawing, with highest readings showing as black, running through different shades to lowest showing as white. Plotting parameters can be adjusted to aid interpretation of geophysical survey data.
- XY Trace plot – This is an alternative method of data visualisation, plotting the magnitude of responses on a scaled XY trace. The stronger the response, the sharper the rise in the trace. This type of plot can be used to differentiate the origin of an anomaly and is best used in conjunction with an alternative method of interpretation.
- Interpretation plot – Through detailed analysis, anomalies have been interpreted and possible features identified. Interpretation drawings are used to show potential features and to reinforce and clarify the written interpretation of the data. Anomalies have been characterised using the terminology detailed in the following section and have been assigned colour coding, which is outlined in keys on figures associated with this report.

Magnetic Anomalies

Different anomalies can represent different features created by human occupation, agricultural or modern activity, or natural pedological and/or geological changes in the substrata.

Anomalies interpreted as ‘stronger’ are considered more likely to be of the interpreted characterisation; whereas a ‘weaker’ categorisation represents a more tentative interpretation applied to those anomalies with lesser increases in magnetic response or if the anomaly has incomplete patterning or irregular form. The strength and size of anomalies can vary depending on the magnetic properties of the feature, the magnetic susceptibility of the soil, the depth at which the feature is buried, and the state of preservation.

Terminology

- Anomaly - Any outstanding high or low magnetic response forming a particular shape or covering a specific area within the survey results.
- Feature - A man-made or naturally created object, material or deposit that has been detected through the site investigation works and has sufficient characteristics or supporting evidence for positive identification.
- Magnetic Susceptibility - The ability of a buried feature to be magnetically induced when a magnetic field is applied.
- Magnetic Response - The strength of the changes in magnetic values caused by a buried feature with either a greater or lesser ability to be magnetised compared with the soil around it. Anomalies are considered to either have strong/weak or positive/negative response. The strength of magnetic response (along with patterning) can be essential in determining the nature of a buried feature, but it should be noted that the size or strength of the magnetic response does not always correlate with the size of the buried feature.
- Morphology - The shape or form of an individual anomaly.
- Thermoremanence - The affect caused when a material has been magnetically altered through a process of heating. Thermoremanent magnetisation occurs when an object or material is heated passed the Curie Point and acquires a permanent magnetisation that is associated with the magnetic field that they cooled within (Gaffney and Gater 2003, 37).

Characterisation of Anomalies & Interpretation Categories

Archaeological or Historical Anomalies

- Archaeology – Linear, rectilinear, or curvilinear anomalies with a positive and/or negative magnetic response, composed of a patterning or shape that is suggestive of a buried archaeological feature. These are often indicative of structural remains or infilled cut features such as ditches. The strength of the anomaly signal can be suggestive of the properties of the feature. Negative linear anomalies represent upstanding or infilled features that are less magnetically susceptible than background readings, for example structures such as a ditch-bank, or a cut ditch containing a fill composed of a non-igneous stone material. Bipolar linear anomalies considered to be of an archaeological nature are indicative of material with a high magnetic susceptibility, such as a brick wall. Isolated anomalies or anomalies with a more amorphous form possibly represent infilled features or thermomagnetic features such as areas of heating/burning of an archaeological origin. Unless associated with conclusively identified archaeological remains, such as linear anomalies, absolute identification of positive responses can be problematic as it is often not possible to decipher if they are of an archaeological, modern, or agricultural origin. Consequently, isolated positive responses such as those indicating pit-features, are not always shown within the Interpretation plot(s) unless composed of a broad form or belonging to a series of isolated positive responses. Bipolar responses considered likely to be of an archaeological origin are also interpreted as isolated anomaly (archaeology). These are considered to relate to material with a very strong magnetic susceptibility or thermoremanent magnetisation.

- Possible archaeology – This categorisation is applied where anomalies are weaker or more diffuse in response, resulting in a less certain origin. It is possible that these belong to archaeological features but given their weaker responses or incomplete patterning it is equally plausible that they relate to other sources, such as agricultural features or natural soil formations or geological variations.
- Former Boundary - Linear anomalies, sub/irregular-rectilinear anomalies either with positive or negative magnetic responses, that correspond with the location of former field boundaries, ponds or buildings recorded on historic maps, Aerial photos and/or LiDAR coverage of the site.
- Ridge and Furrow - Broadly spaced linear anomalies or trends that are likely to be indicative of earlier forms of agricultural practice, such as ridge and furrow. These often correspond with the location of earthworks visible on the ground during the survey, or can be identified on aerial or LiDAR survey imagery.

Strongly Magnetic / Bipolar / Dipolar

- Modern Service – Highly magnetic, typically dipolar linear anomalies with an stronger area of variably decreasing ferrous response depending on the vicinity of the survey instrumentation to the buried or extant feature.
- Increased magnetic response – Isolated bipolar responses of a typically modern nature that are likely to relate to buried ferrous material, building debris, or objects, such as magnetically enhanced agricultural debris. If a trend is noted in the alignment or spacing of isolated bipolar responses, it is possible that they are indicative of ferrous fittings or connectors used on buried non-magnetic buried utilities, although occasionally an archaeological origin cannot be ruled out. Also, areas of increased magnetic response denote areas of disturbance containing a high concentration of dipolar or bipolar responses. These are generally considered to be caused by modern debris in the topsoil, including agricultural 'green waste'. It is also possible that the disturbance is in part also caused by isolated archaeological material or geological or pedological changes in the substrata.
- Ferrous disturbance - Areas of magnetic disturbance, often along the edges of survey areas, or surrounding Modern Services caused by highly ferrous material such as standing metal structures like fencing and buildings. Modern Agricultural Anomalies.

Modern Agricultural

- Agricultural Trend - Ploughing trend tends to be regularly spaced linear anomalies, often with a narrower spacing, that conform with ploughing regime at the time of survey, or a recent regime recorded on aerial photos of the site. The response and distribution of land drains varies depending on the composition of the land drain and associated ditch or channel. Consequently, land drains can be composed of weak / strong positive / negative magnetic responses and are identified as a product of either their variance in magnetic values or positioning compared with regularly spaced linear anomalies considered to relate to modern ploughing. Land drains can be located within former agricultural regimes, such as ridge and furrow.
- Land drain – Weakly positive, and/or dipolar, regularly broadly spaced linear trends in a typically parallel or 'herringbone' formation. These are generally modern in origin, although earlier post-medieval ceramic drains are often plausible but cannot be determined.
- Uncertain Trend – Generally positive, although sometimes negative, isolated and weak linear or curvilinear trends. This category is applied where multiple origins can be asserted to a barely detected anomaly.