magnitude surveys

# Geophysical Survey Report

# of

# Reading Golf Club

**For**

**Fairfax (Reading) Limited**

**And**

**Reading Golf Club Limited**

**Magnitude Surveys Ref: MSSU661**

**October 2021**

**Unit 17, Commerce Court**

**Challenge Way**

**Bradford**

**BD4 8NW**

**01274 926020**

**info@magnitudesurveys.co.uk**

**Report By:**

Alison Langston BA PCIfA, Sophie Peel BSc (Hons)

**Report Approved By:**

Finnegan Pope-Carter BSc (Hons) MSc FGS

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# Abstract

Magnitude Surveys was commissioned to assess the subsurface archaeological potential of a c. 11ha area of land at Reading Golf Course. A fluxgate gradiometer survey was successfully completed across the survey area. No anomalies suggestive of significant archaeological features have been identified. The geophysical survey has primarily detected land management features relating to the site's current and historic usage as a golf course, including golf course features and drainage. Anomalies have been classified as undetermined where a precise origin has not able to be ascribed, though it is considered likely these may be related to further drainage or agricultural anomalies. Anomalies related to historical agricultural use have been detected and interpreted as a mapped former field boundary, along with a footpath and ploughing regimes. Natural variations have also been identified. Aside from the golf course features, the impact of modern activity is generally limited to the edges of the survey areas, and as broad magnetic disturbance around several service lines.

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# 1. Introduction

1.1. Magnitude Surveys Ltd (MS) was commissioned by Fairfax Properties to undertake a geophysical survey on a c.11ha area of land at Reading Golf Club (SU 7157376806).

1.2. The geophysical survey comprised hand-carried GNSS-positioned fluxgate gradiometer survey.

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, 2014) and the European Archaeological Council (Schmidt et al., 2015).

1.4. The survey was conducted in line with a WSI produced by MS (2020).

1.5. The survey commenced on 04/05/2020 and took two 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 of Archaeological Prospection).

2.2. The directors of MS are involved in the cutting edge of 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, 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 have relevant degree qualifications to archaeology or geophysics. All MS field and office staff have relevant archaeology or geophysics degrees 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 as requested by Berkshire Archaeology.

# 4. Geographic Background

4.1. The survey area was located c.2.8km north of Reading (Figure 1). Survey was undertaken across two fields which were in use as a golf course at the time of survey. The survey area was bounded by further golf course areas to the north, housing off Brooklyn Drive to the northeast, Kidmore End Road to the east, Lyefield Court and Emmer Green Primary School to the south and Eric Avenue to the west (Figure 2). An area totalling c. 1.82ha was unable to be surveyed due to the presence of bunkers, ditches, hedges and dense tree cover.

4.2. Survey considerations:

| Survey Area | Ground Conditions | Further Notes |
|---|---|---|
| 1 | Undulating golf course, with dense tree cover in some areas which prevented small sections of survey. | Bounded to the northeast by a footpath, hedgerow, and housing and the golf course continued to the northwest. Bounded to the east by a car park and the golf club buildings and to the south and west by hedgerow, trees, and housing. |
| 2 | Undulating golf course, with dense tree cover in some areas which prevented small sections of survey. | The golf course continues to the north and south. Bounded by hedgerows, trees and housing to the east and west. |

4.3. The underlying geology comprises chalk of the Seaford Chalk Formation and Newhaven Chalk Formation across the north and centre of Area 2. In the southeast of Area 2 and across Area 1, clay, silt, and sand of the Lambeth Group have been recorded. Superficial deposits are recorded on the west of the site consisting of sand and gravel of the Black Pearl Gravel Member (British Geological Survey, 2020).

4.4. The soils consist of slightly acid loamy and clayey soils with impeded drainage (Soilscapes, 2020).

# 5. Archaeological Background

5.1. The following is a summary of a desk-based assessment produced by Archaeology South-East (Stephenson, P., 2019) and provided by Fairfax Properties.

5.2. Extensive evidence of prehistoric activity has been recorded in the wider environs ranging from Palaeolithic to Iron Age. Multiple assemblages of Palaeolithic material were uncovered within the vicinity of the site (MOX852M, MOX8125, MOX8055, MRD1230, MRD8670, MRD8672, MRD8678), three Palaeolithic finds lie within close proximity to the site including a handaxe c. 450m to the north of Area 2 (MOX7888), palaeoliths c. 485m to the southeast of Area 1 (MRD1229) and flakes from an ancient channel of the Thames c. 715m to the south of the survey area (MRD15713). A number of finds, mainly consisting of worked lithics dating to the Neolithic or Bronze Age have been found between c. 840m and 1km west of the survey area (MRD8687, MRD1233, MRD1234). Aerial photography and a geophysical survey led to the discovery of a Bronze Age barrow cemetery at Emmer Green, c, 110m south of the survey area (MRM16170). Other Bronze Age activity in the area consists of a hoard of three Bronze Age axes recovered

during construction of Emmer Green Primary School also immediately south of the site (MRD8627).

5.3. In the areas to the south and west of the survey area, a high concentration of Iron Age archaeology has been recorded. To the south an Iron Age-Roman ditch and a nearby dated posthole was identified c. 105m to the south (MRM16443). A gold stater (MRD8631) and a gully with Middle Iron Age finds and three undated postholes (MRM16101) were also identified c. 115m south of the survey area. Finds c. 170m to the west of the site include a series of postholes and a collapsed wall (MRD1237, MRD1238, MRD1239, MRD1240) which yielded an assortment of Iron Age finds as well as parts of floor and pieces of grit which has been suggested to be evidence of a late Iron Age or Roman building (MRD1235). Several Roman findspots are recorded surrounding the survey area, including Romano-British pottery at Shripnell's Farm c. 825m to the west of the survey area (MRM16259, MOX7846, MRD8614, MRD8615), Roman coins found north-east and south-east of the site (MOX23662, MRM17642) and a Roman bracelet c.270m to the east (MRD8626).

5.4. Cartographic evidence allows for the study of changes in land use of the site in more modern times. The earliest map dated to 1761 show the site extends across two fields bounded on all sides by roads with an east-west boundary crossing the centre of the site between the two fields. To the north-west of the site is a possible homestead and a rectangular enclosure and a series of roadsides enclosures flank the roads to the west and eastern boundaries, possibly within the area covered by the site however their exact location is difficult to ascertain due to the antiquity of the map. The tithe map of 1846 indicates the site extended across multiple land plots under arable crop. OS map from 1878 show the site lay across three large fields divided by a north-south boundary and a possible stream in the north of the site, aligned north-east to south-west. Two parallel boundaries extended north-east establishing a south-western boundary to the site by 1898. By 1936 the golf course was created, with a small club house in the south-east and all field boundaries removed, a map from 1956 shows the development of tree plantations on the golf course in line with its modern condition.

# 6. Methodology

## 6.1. Data Collection

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 Historic England's standards for "raw or minimally processed data" (see sect 4.2 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 upper and/or 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 at different plotting ranges have been used for data interpretation. Greyscale images should be viewed alongside the XY trace plot (Figures 8 & 11). XY trace plots visualise the magnitude and form of the geophysical response, aiding in 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, historic

maps, LiDAR data, and soil and geology maps. Google Earth (2020) was consulted as well, to compare the results with recent land usages.

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 of further work in order to constantly improve our knowledge and service.

## 7.2.Discussion

7.2.1. The geophysical results are presented in consideration with satellite imagery over historic maps (Figure 6).

7.2.2. The fluxgate gradiometer survey has responded well to the environment of the survey area, although the effects from extant golf course features may have obscured weaker anomalies had any been present. The geophysical survey has primarily detected anomalies related to the golf course, although historic agricultural anomalies and anomalies of an undetermined origin were also identified. Modern activity is limited to magnetic haloes around services, and at the perimeters of the survey area, especially in the east around the golf club and car park (Section 4.2). Natural variations are identified as weak curvilinear bands, along with zones of mottled natural, that are likely related to the slopes present across the survey area.

7.2.3. A number of anomalies have been identified across the survey area that relate to its current use as a golf course. These anomalies are visible within the dataset as linear anomalies, likely related to drainage, and areas of magnetic enhancement related landscaping features. The extensive landscaping of the greens and fairways of the course has impacted the magnetic data, as have the extant features of the golf course, such as bunkers etc. (Figure 6).

7.2.4. Drainage features have been identified across the survey area, primarily in the form of weak negative linear anomalies, although positive linear anomalies have also been

identified. It is probable that these drains relate to the land management of the golf course.

7.2.5. Agricultural activity has been identified across the survey area in the form of a former field boundary and pathway, both recorded on historic mapping (Figure 6). Ploughing regimes have also been identified in the south of the survey area.

7.2.6. In the south of the survey area, a grouping of anomalies with undetermined origins have been identified, along with isolated anomalies identified in the north. These linear anomalies have faint magnetic signals, unlike the modern golf course related features, and do not correlate with any features recorded on historic maps or satellite imagery. It is possible these anomalies may relate to further drainage features, or unmapped agricultural activity, however a precise origin is unclear hence the "Undetermined" classification.

## 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. **Magnetic Disturbance** – The strong anomalies produced by extant metallic structures along the edges of the field have been classified as 'Magnetic Disturbance'. These magnetic 'haloes' will obscure the response of any weaker underlying features, should they be present, often over a greater footprint than the structure they are being caused by.

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

7.3.1.4. **Ferrous/Debris (Spread)** – A ferrous/debris spread refers to a concentrated deposition of discrete, dipolar ferrous anomalies and other highly magnetic material.

7.3.1.5. **Undetermined** – Anomalies are classified as Undetermined when the anomaly origin is ambiguous through the geophysical results and there is no supporting or correlative evidence to warrant 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 not ferrous in nature.

### 7.3.2. Magnetic Results - Specific Anomalies

7.3.2.1. **Golf Course –** Across the survey area, anomalies have been identified that appear to relate to the landscape management of the golf course within the survey area. In the eastern half of Area 1 a concentration of positively enhanced anomalies [**1a**] and stronger dipolar anomaly [**1b**] have been identified. These may relate to landscape management, or may also be course modifications, as the magnetic signals of these anomalies vary from the surrounding background

material. However, neither [**1a**] or [**1b**] correspond with any mapped or extant golf course features. In the east of Area 2, two anomalies have been identified [**2a**], that appear to correlate with two bunkers visible on satellite imagery (Figure 6). Immediately to the south of this is a weak curvilinear anomaly [**2b**], which corresponds to the edge of the green and is likely evidence of the management of the green. In the south of Area 2, a group of anomalies of varying strengths [**2c**] have also been identified, which appear to correlate with parts of the green and extant bunkers.

7.3.2.2. **Agricultural –** Near the centre of Area 1, two weak linear anomalies running north to south have been identified (Figure 11). These anomalies appear to correspond with a former field boundary recorded on the 2nd Edition OS maps (Figure 6). A series of ploughing trends on roughly east to west and north to south orientations have also been identified, running across the whole field. In the north of Area 2, a series of weak positive and negative linear and curvilinear anomalies [**2d**] have been identified. These run approximately northeast to west and appear to correlate with the location of a former pathway recorded on the 2nd Edition OS maps (Figure 6).

7.3.2.3. **Drains –** Across the survey area multiple examples of drainage features have been identified. These include negative linear anomalies, identified as French drains, and both strong and weak positive linear anomalies, identified as ditch drains. These drainage systems are likely related to the golf course and land management associated with this.

7.3.2.4. **Undetermined –** In the east of Area 1, a series of weak linear anomalies [**1c**] have been identified (Figures 10 & 11). These anomalies appear to form a rectilinear shape although very ephemeral. The faint magnetic signal, only just visible against the background data, and the fragmented nature of these linear undetermined anomalies are in contrast to the stronger, amorphous anomalies relating to the golf course. These anomalies underlie one of the greens, so may be the result of landscaping of the golf course, although the exact origin is unclear. Due to this uncertainty, these have been classified as 'undetermined' as the response is not indicative of a specific type of archaeological or modern feature.

7.3.2.5. **Services –** Across the survey area, multiple strong linear anomalies, both dipolar and positive have been identified. These indicate a very magnetic source, likely modern services or large drains.

# 8. Conclusions

8.1. A fluxgate gradiometer survey has successfully been undertaken across the survey area. No anomalies suggestive of significant archaeological features were identified. The geophysical survey has detected a range of different types of anomalies of related to the golf course, along with anomalies of agricultural, undetermined and natural origin. Bands of natural relating to the undulating terrain have been identified across the survey area, along with zones of natural that produce a mottled effect in the data. Modern activity is limited to broad magnetic haloes

around services, and at the perimeter of the survey area, particularly noticeable around the golf club and car park in the east.

8.2. Anomalies relating to the landscaping of the golf course have been identified across the survey area, and often correlate with extant features. However, a number of anomalies have been identified which do not correspond with extant golf course features. It is possible these anomalies relate to former golf course features which predate satellite imagery and were not recorded on historic maps. Drainage features relating to the golf course have also been identified across the survey area.

8.3. Agricultural activity has been identified in the north and centre of the survey area, in the form of a former field boundary, a pathway and ploughing regimes.

8.4. Anomalies of an undetermined origin have been identified primarily in the south of the survey area. Many of these anomalies underlie extant golf course features and may be the result of landscaping of the golf course, however, the faint magnetic signal of these anomalies are in contrast to the stronger anomalies relating to the golf course.

# 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 the any dictated time embargoes.

# 10. Copyright

10.1. Copyright and the 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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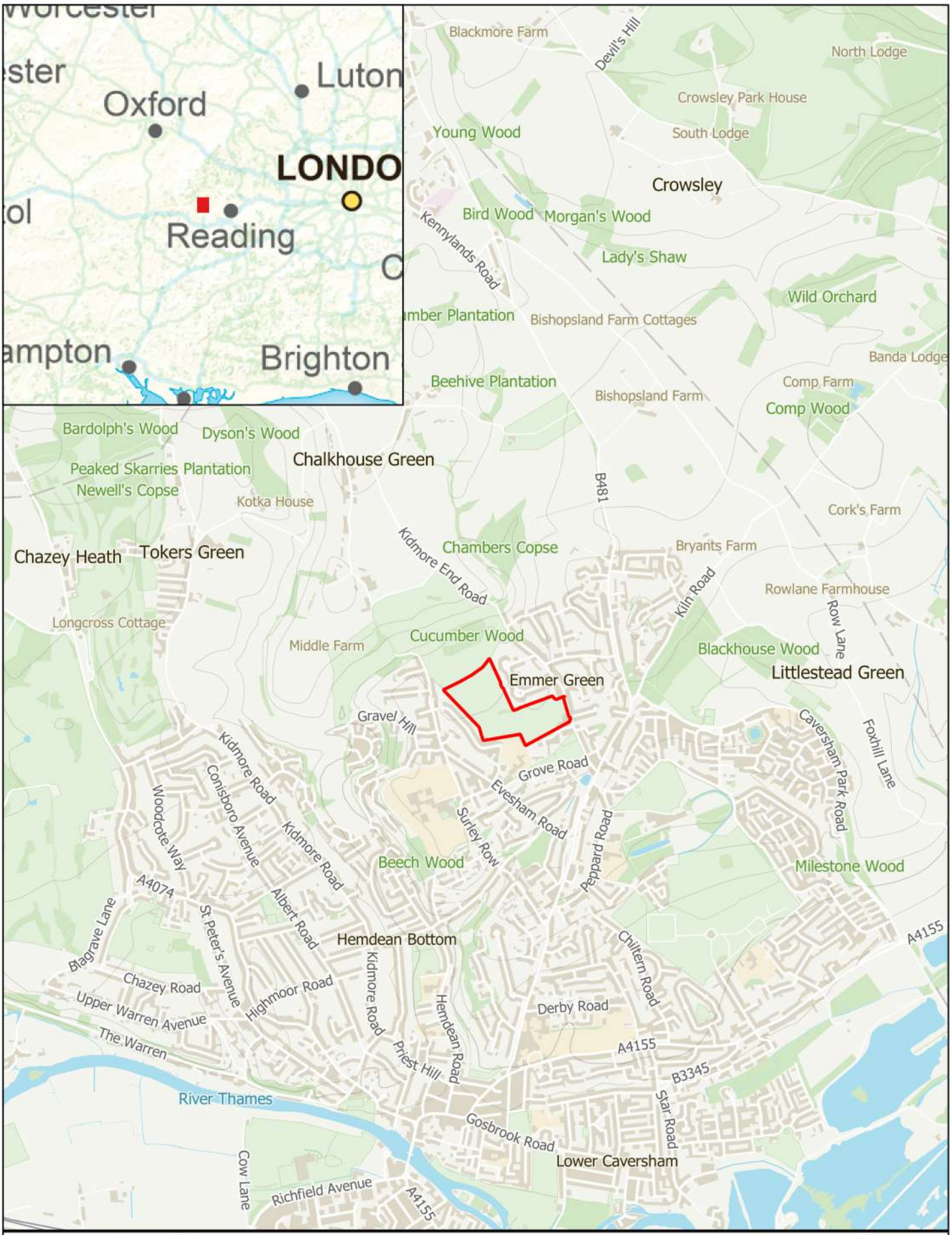
# 12. Project Metadata

| | |
|---|---|
| MS Job Code | MSSU661 |
| Project Name | Reading Golf Club |
| Client | Fairfax (Reading) Limited and Reading Golf Club Limited |
| Grid Reference | SU 71573 76806 |
| Survey Techniques | Magnetometry |
| Survey Size (ha) | 11ha (Magnetometry) |
| Survey Dates | 2020-05-04 to 2020-05-05 |
| Project Lead | Finnegan Pope-Carter BSc (Hons) MSc FGS |
| Project Officer | Leanne Swinbank, BA ACIfA |
| HER Event No | N/A |
| OASIS No | N/A |
| S42 Licence No | N/A |
| Report Version | 1.0 |

# 13. Document History

| Version | Comments | Author | Checked By | Date |
|---|---|---|---|---|
| 0.1 | Initial draft for Project Lead to Review | AL, SP | LS | 14 May 2020 |
| 0.2 | Incorporation of comments from Project Officer | AL | FPC | 15 May 2020 |
| 1.0 | Draft Issued as Final | N/A | LS | 29 October 2021 |




MSSU661 - Reading Golf Club
Figure 1 - Site Location
1:25,000 @ A4
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Site Boundary

N

0 0.5 1 km

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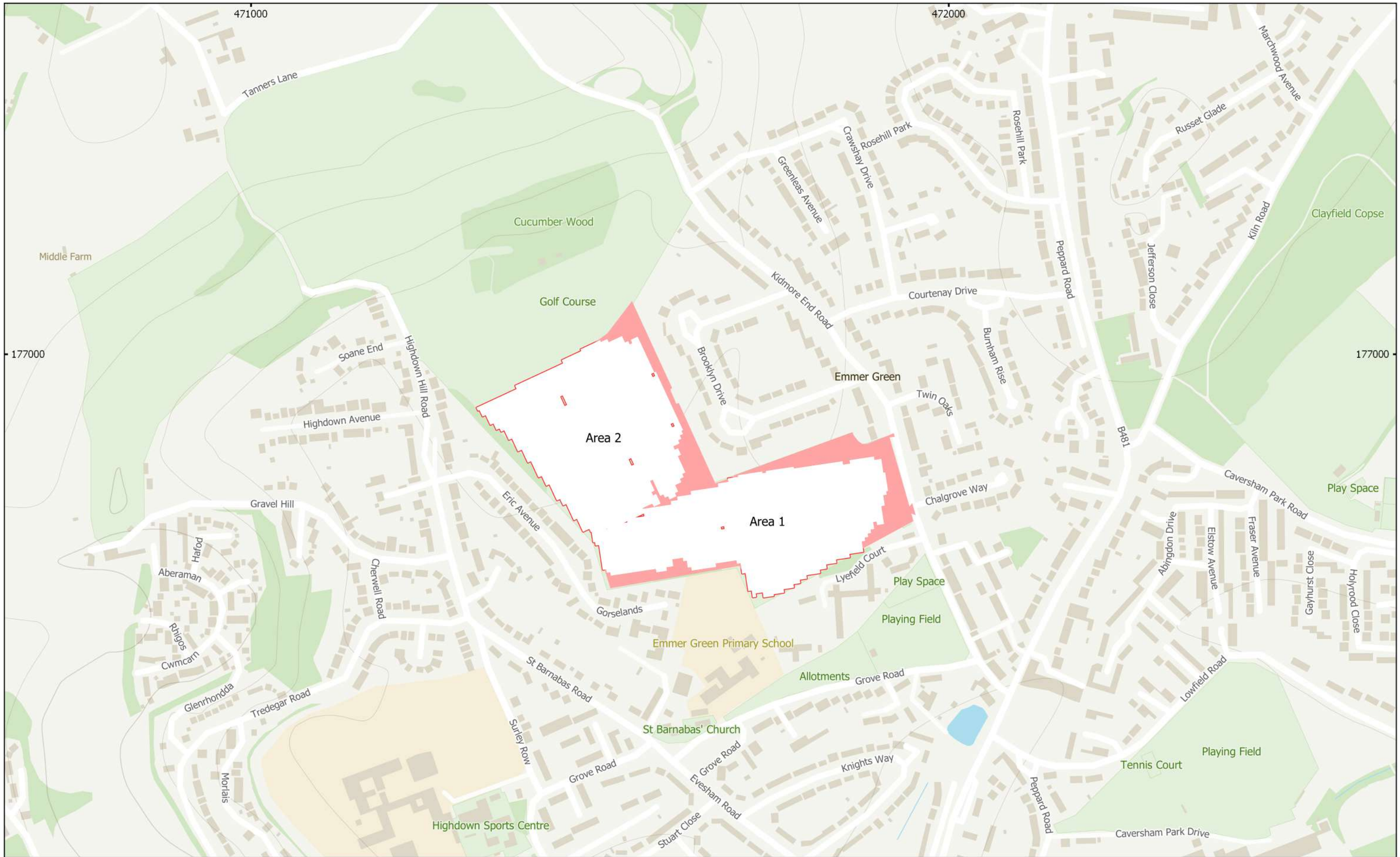


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Figure 2 - Location of Survey Areas
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Survey Extent
Unsurveyable Areas

N

0 100 200 300 m

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Figure 3 - Magnetic Gradient (Overview)
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-1 nT 2

N

0 50 100 150 m

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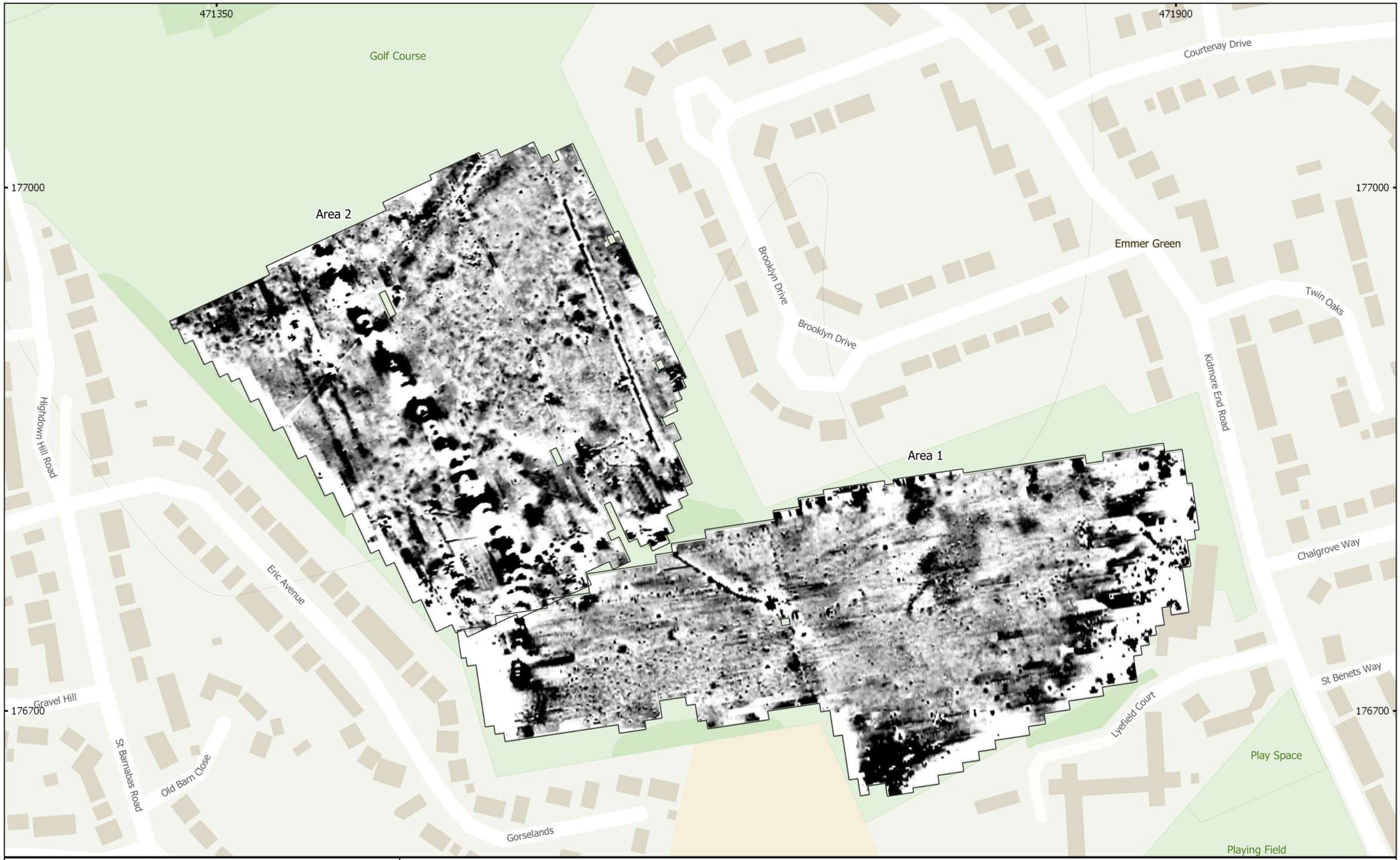


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Figure 4 - Magnetic Total Field (Lower Sensor) (Overview)
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48997 nT 49005

N

0 50 100 150 m

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Figure 5 - Magnetic Interpretation (Overview)
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| | | | |
|---|---|---|---|
| Agricultural (Weak) | Natural (Strong) | Golf Course (Zone) | Service |
| Magnetic Disturbance | Natural (Weak) | Golf Course | Drainage Feature |
| Ferrous/Debris (Zone) | Undetermined (Strong) | Agricultural (Trend) | Ferrous (spike) |
| Natural (Zone) | Undetermined (Weak) | Ferrous (Trend) | |

N

0 50 100 150 m

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Figure 6 - Magnetic Interpretation over Combined Historic Maps and Satellite Imagery (Overview)
1:2,000 @ A3
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Contains historic maps: Ordnance Survey, 2nd edition © National Library of Scotland
Contains satellite imagery © 2020 Google Satellite

Agricultural (Weak)
Magnetic Disturbance
Ferrous/Debris (Zone)
Natural (Zone)
Natural (Strong)
Natural (Weak)
Undetermined (Strong)
Undetermined (Weak)
Golf Course (Zone)
Golf Course
Agricultural (Trend)
Ferrous (Trend)
Service
Drainage Feature
Ferrous (spike)

N

0 50 100 150 m

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Figure 7 - Magnetic Gradient (North)
1:1,500 @ A3
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-1 nT 2

N

0 50 100 150 m

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Figure 8 - Magnetic Interpretation (North)
1:1,500 @ A3
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| | | | |
|---|---|---|---|
| Agricultural (Weak) | Natural (Strong) | Golf Course (Zone) | Service |
| Magnetic Disturbance | Natural (Weak) | Golf Course | Drainage Feature |
| Ferrous/Debris (Zone) | Undetermined (Strong) | Agricultural (Trend) | Ferrous (spike) |
| Natural (Zone) | Undetermined (Weak) | Ferrous (Trend) | |

N

0 50 100 150 m

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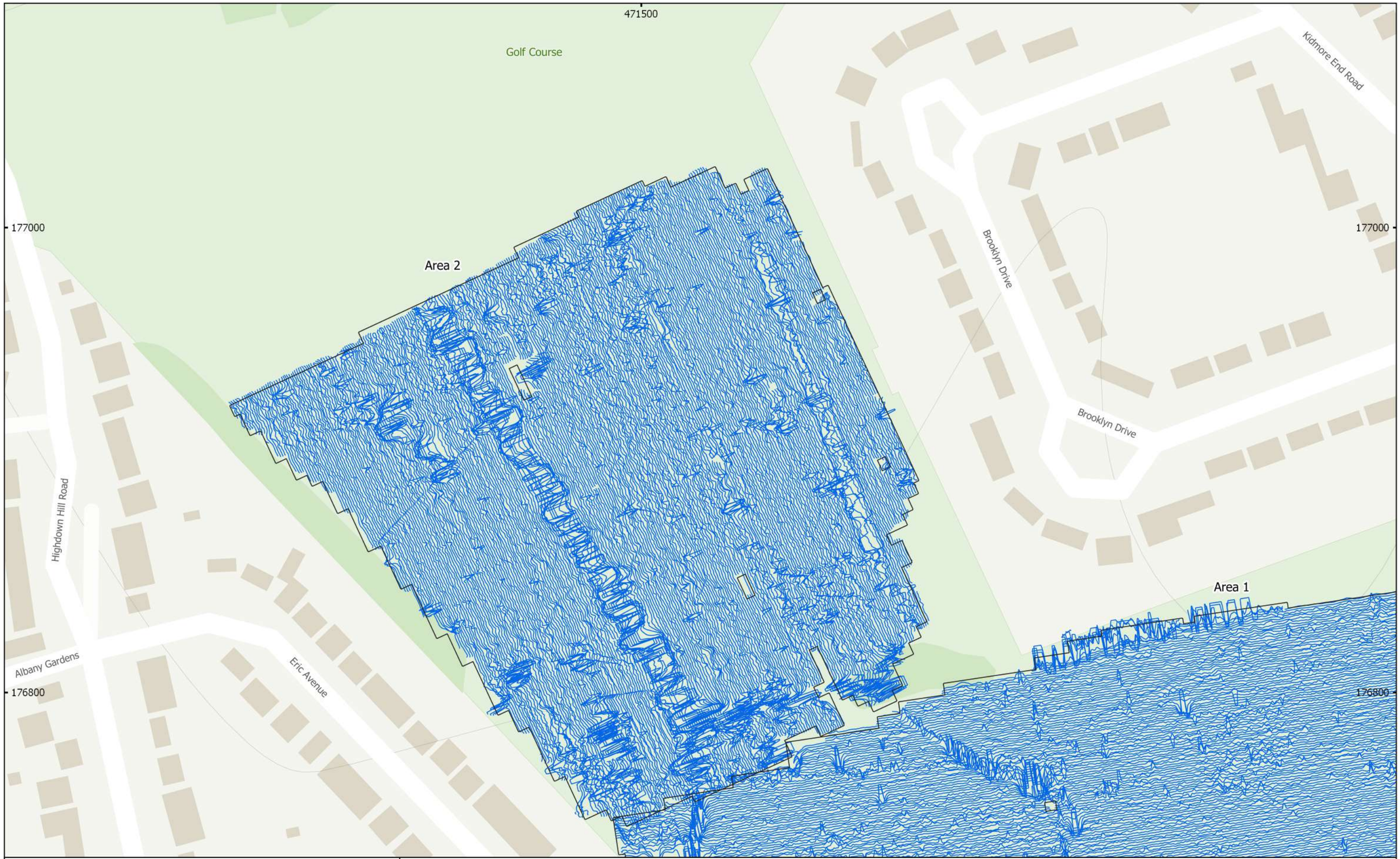


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Figure 9 - XY Trace Plot (North)
30nT/cm at 1:1,500 @ A3
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0 50 100 150 m

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MSSU661 - Reading Golf Club
Figure 10 - Magnetic Gradient (South)
1:1,500 @ A3
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MSSU661 - Reading Golf Club
Figure 11 - Magnetic Interpretation (South)
1:1,500 @ A3
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| | | | |
|---|---|---|---|
| Agricultural (Weak) | Natural (Strong) | Golf Course (Zone) | Service |
| Magnetic Disturbance | Natural (Weak) | Golf Course | Drainage Feature |
| Ferrous/Debris (Zone) | Undetermined (Strong) | Agricultural (Trend) | Ferrous (spike) |
| Natural (Zone) | Undetermined (Weak) | Ferrous (Trend) | |

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0 50 100 150 m

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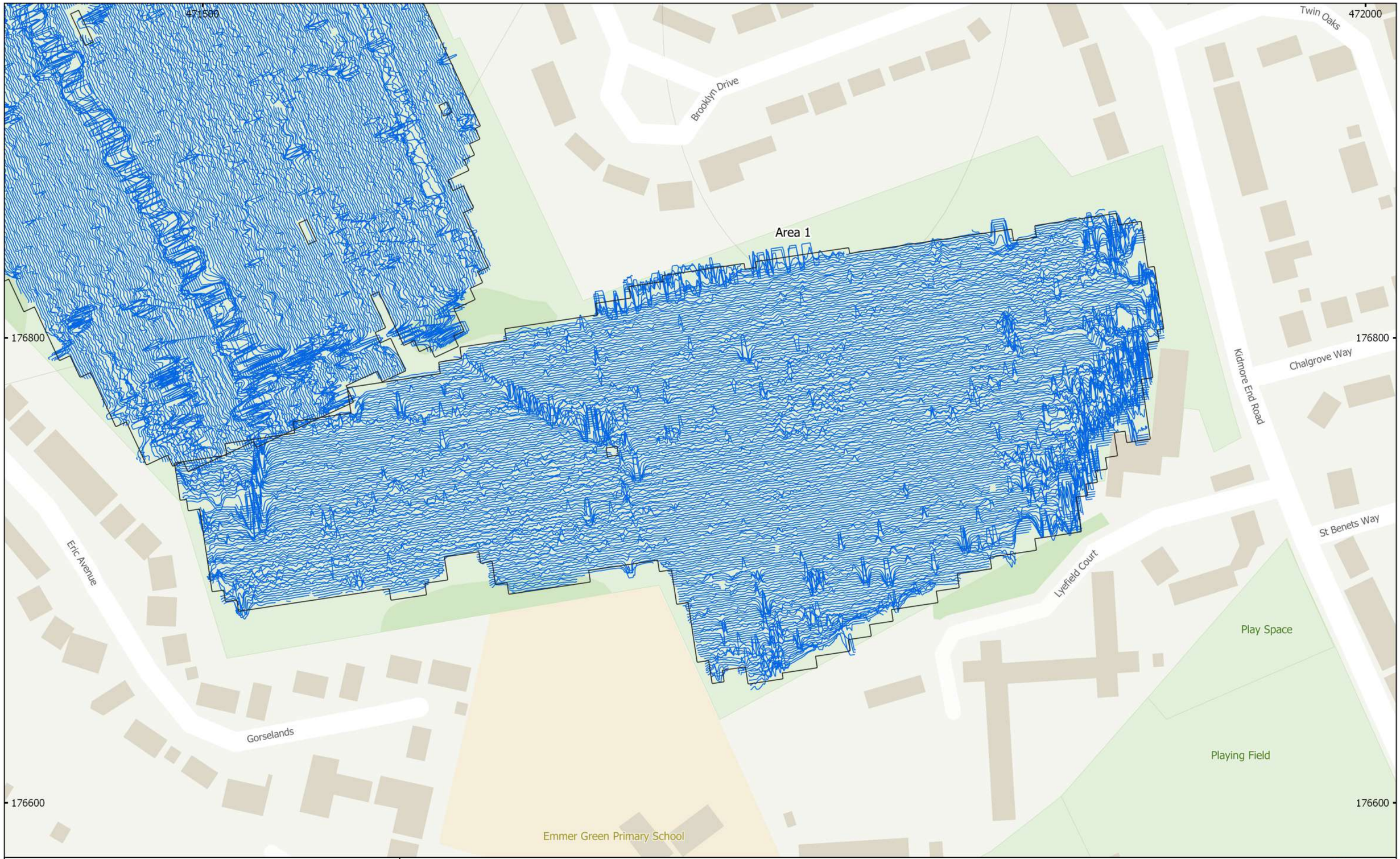


MSSU661 - Reading Golf Club
Figure 12 - XY Trace Plot (South)
30nT/cm at 1:1,500 @ A3
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