Rosefield Solar Farm

Environmental Statement

Volume 4
Appendix 9.2: Geophysical Survey Report

APFP Regulation 5(2)(a)

Planning Act 2008

Infrastructure Planning
(Applications: Prescribed Forms
and Procedure) Regulations 2009

EN010158/APP/6.4
September 2025
Rosefield Energyfarm Limited

Executive Summary

This Geophysical Report was commissioned on behalf of Rosefield Energyfarm Ltd (the Applicant) to undertake a geophysical (magnetometer) survey on land between Calvert Green and Granborough, Buckinghamshire, where the Client intends to submit a Development Consent Order Application for the construction, operation (including maintenance) and decommissioning of a solar photovoltaic development and energy storage, together with associated infrastructure and an underground cable connection to the National Grid East Claydon Substation. The purpose of this report is to provide information about the nature and possible interpretation of any magnetic anomalies identified within the Order Limits and to therefore determine the likely presence/absence and extent of any buried archaeological features.

A geophysical survey has identified 14 areas of archaeological activity (AAA's) in four separate and clearly defined parts of the Site. In the west of the Site, in Block B (Parcel 1), two groups of enclosures approximately 0.4 kilometres (km) apart have been identified on the high ground of Knowl Hill (AAA1 and AAA2). Just over 1km further east in Block F (the Interconnecting Cable Corridor between Parcel 1 and 2) (AAA3) a large rectilinear enclosure complex clearly indicative of settlement activity and covering over 5 hectares (ha) has been recorded: the settlement likely continues to the west and south beyond the Order Limits. A further kilometre east in Block D (Parcel 2) two enclosures, a trackway and two ring ditch features have been recorded (AAA4) although this area is part of a wider parcel of land no longer included within the Order Limits. The archaeological potential of these three AAA's is assessed as high.

The final, and most extensive area of archaeological activity, is in the north-eastern corner of the Site in Block E (Parcel 3 and Interconnecting Cable Corridor between Parcel 2 and 3) where clusters of features have been identified bordering Claydon Brook and/or adjacent to the postulated line of the Roman road that links Akeman Street at Fleet Marston and Thornborough (AAA5 to AAA14 inclusive). No evidence for the road specifically has been recorded by the survey although its presence is given further credence by the concentration of activity recorded in the north-eastern corner of Block E and by records of Roman findspot concentrations recorded through fieldwalking 0.5km to the south. The features in Block E are again indicative of enclosure and occupational activity and together with the results of an earlier geophysical survey and trial trenching indicate that the archaeological potential of the north eastern part of the Site in Block E is high to very high.

Other individual features, such as ring ditches and isolated enclosures have also been identified by the survey and there are also other disparate anomalies in all blocks that have been classified as of uncertain origin where there is no morphology or pattern suggestive of any significant activity but for which an archaeological origin cannot be dismissed. The archaeological potential in and around these anomalies/features is assessed as moderate.

Several areas of medieval or post-medieval ridge and furrow ploughing have also been recorded across all the survey areas. Other non-archaeological anomalies, including those caused by recent agricultural activity such as modern ploughing, land drainage, hedgerow removal and the infilling of former ponds are ubiquitous. Several service pipes are identified and numerous anomalies due to variation in the bedrock, superficial deposits and soils are also noted. In these areas where no anomalies of

obvious or possible archaeological origin have been recorded (most of the Site) the archaeological potential is assessed as low.

It should, however, be stated that the bedrock mudstone geology may not be particularly conducive for clear results, and this may explain the low magnitude and discontinuous nature of some of the anomalies. Consequently, it is considered possible that there may be archaeological features present (particularly those that may be small, shallow or discrete) that could not be detected by the survey, although it is considered likely that the location and extent of any settlement activity has been identified by the survey. Nevertheless, the survey has identified archaeological remains not previously known or recorded on the Buckinghamshire Historic Environment Record as well as clarifying the extent of other previously known heritage assets, thereby enhancing the archaeological record and providing information which will help inform future archaeological mitigation works and aid in refining design proposals.

Table of Contents

LIST OF ILLUSTRATIONS

1 Introduction

1.1. Background

1.1.1. This Geophysical Survey Report has been prepared on behalf of Rosefield Energyfarm Limited (the Applicant) to set out the results of the geophysical (magnetometer) survey on land between Calvert and Granborough, Buckinghamshire (Illus 1), in relation to the Development Consent Order Application for the construction, operation (including maintenance), and decommissioning of Rosefield Solar Farm (hereafter referred to as the 'Proposed Development').

1.2. The Order Limits

1.2.1. The extent of the Order Limits are shown in **Location, Order Limits and Grid Coordinate Plans [EN010158/APP/2.1]** and the Proposed Development is described in full in **ES Volume 1, Chapter 3: Proposed Development Description [EN010158/APP/6.1]** and shown spatially on the **Works Plans [EN010158/APP/2.3].**

1.3. The Proposed Development

1.3.1. The Proposed Development comprises the construction, operation (including maintenance), and decommissioning of solar photovoltaic ('PV') development and energy storage, together with associated infrastructure and an underground cable connection to the National Grid East Claydon Substation.

1.3.2. The Proposed Development would include a generating station with a total exporting capacity exceeding 50 megawatts ('MW').

1.3.3. The location of the Proposed Development is shown on **ES Volume 3, Figure 1.1: Location Plan [EN010158/APP/6.3]**. The Proposed Development would be located within the Order Limits (the land shown on the **Works Plans [EN010158/APP/2.3]** within which the Proposed Development can be carried out). The Order Limits plan is provided as **ES Volume 3, Figure 1.2: Order Limits [EN010158/APP/6.3]**. Land within the Order Limits is known as the 'Site'.

1.4. Context

1.4.1. This geophysical survey report will be submitted as part of the DCO Application for the Proposed Development. The results have been used to help inform the layout of the Proposed Development and will also inform the archaeological mitigation strategy, if required. The scheme of work was undertaken in accordance with the requirements of the National

Planning Policy Framework **[Ref. 1]** and with a Written Scheme of Investigation for Geophysical Survey (WSI) (**Annex 1**).

1.4.2. The WSI was produced to the standards laid down in the European Archaeological Council's (EAC) guideline publication **[Ref. 2]** and the Chartered Institute for Archaeologists' (CIfA) Standard and Guidance for Archaeological Geophysical Survey **[Ref. 3]**. The survey was also carried out in line with the same best practice guidelines.

1.4.3. The survey was carried out in 10 no. mobilisations between September 2023 and February 2025 to accommodate different crop windows, access requirements and variations to the scope and extent of the Proposed Development.

1.5. Site Location, Topography and Land-Use

1.5.1. This report covers the survey of six discrete areas. These are Blocks B, C, D, E, and two Interconnecting Cable Corridors areas (Blocks F and G), which were surveyed to help identify the optimum cable route between blocks. These correspond to the following areas set out in the **ES Volume 3, Figure 1.2: Order Limits [EN010158/APP/6.3]**:

- Block B – Parcel 1;
- Block C – Parcel 1a;
- Block D – Parcel 2;
- Block E – Parcel 3, Interconnecting Cable Corridor between Parcel 2 and 3, and Grid Connection Cable Corridor;
- Block F – Interconnection Cable Corridor between Parcel 1 and 2; and
- Block G – Internal Access Corridor between Parcel 1 and 1a.

1.5.2. Block A was descoped before the survey commenced.

1.5.3. These six blocks collectively comprise the geophysical survey area (GSA), and include the land included within the Order Limits, an area of approximately 675ha. An additional 30ha (mostly part of Block D) were descoped after having already been surveyed although the data from this area is still included within the report.

1.5.4. In total, approximately 705 ha has been surveyed. Eleven fields were not surveyed where access was restricted, or ground conditions unsuitable; this area totals approximately 28 ha. Field numbering includes a prefix indicating which block the field is within (B, C etc.). Areas added to the Proposed Development as part of the cable search areas (or at the same time as this) have the prefix 'SA'.

1.5.5. Block B, centred at NGR 470188, 224396, is located immediately south of School Hill Road, just east of the village of Calvert Green, on the other side of High Speed Rail 2 (HS2). It is bound in the south by Sheephouse Wood and Decoypond Wood, and to the east and west by arable land. Block B comprises 23 arable fields (Fields B1 to B23) and covers 196ha. The highest point within the landscape, Knowl Hill, is located within Block B at 115 metres (m) Above Ordnance Datum (AOD). From this point the land slopes down to its lowest point of 88m AOD in the north eastern corner of the block.

1.5.6. Block C is the smallest of the six blocks. It is centred at NGR 470892, 223539 and comprises three arable fields (C1 to C3), an area of approximately 17ha. Block C is located south east of Block G, approximately 2.1km south east of Calvert Green. It is bound on the east and west by woodland (Sheephouse and Home respectively), and to the north and south by arable land. Topographically, Block C slopes down slightly from north to south from 100m AOD to 90m AOD. It is bisected by a public right of way running from north to south.

1.5.7. Block D, centred at NGR 475122 225149, comprising 30 fields (D3 to D19, excluding D5, D26-D37, D44 & D45) and covering approximately 205ha. The village of Botolph Claydon and Orchard Way Road bound this block in the north with Claydon Road similarly in the north east. Runt's Wood and Finemere Wood bound Block D in the west and south respectively, with farmland to all other directions. This block has two high points: one to the south of Botolph Claydon at 123m AOD, and one in the south at 137m AOD. The lowest point of the block is at 98m AOD.

1.5.8. Block E lies approximately 1km east of East Claydon, centred at NGR 475122 225149. It comprises 25 arable and pastural fields (E10 and E11, E2- to E23, SA35, SA 37 to SA39, SA41 to SA43, SA 45 and SA46, SA48 to SA53, SA55 and SA57 to SA59 and is 191 hectares in area. It is bound in the north by National Grid East Claydon Substation, in the east by Claydon Brook, and elsewhere by agricultural land. Topographically, the land in Block E is generally flat ranging between 87m AOD and 95m AOD.

1.5.9. Block F, centred at NGR 471891, 224048, lies approximately 1km south of Middle Claydon and is located between Block B to the west and Block D to the east. It comprises seven arable and pasture fields (SA12 to SA16 SA26 and SA33) and is approximately 49ha in area. It is bound to the north by agricultural land south of Orchard Way Road, to the south by agricultural land and Home Wood and to the east and west by further agricultural land. Topographically, the land slopes down from east to west from 120m AOD to 90m AOD.

1.5.10. Block G is situated between Block D to the north west and Block C to the south and is centred at NGR 470852, 23422. It comprises six pasture fields (SA4 to SA10) and is 24ha in area and is located 3km south east of

Botolph Claydon and is surrounded by agricultural fields. To the west of Block G is Claydon Road, agricultural fields to the north, east and south along with a farmyard to the east. Topographically, Block G is generally flat ranging between 89m AOD and 93m AOD.

1.6. Geology and Soils

1.6.1. The bedrock geology varies little across the Site there being three different formations of sedimentary mudstone all formed during the Jurassic period. Block B, Block C and Block G are located on Stewartby Member Mudstone, formed between 166.1 and 163.5 million years ago, Block D overlies mudstone of the West Walton Formation, formed between 163.5 and 157.3 million years ago, and the north-eastern section of Block D is located on mudstone Peterborough Member which was formed at the same time as West Walton Formation. Block E, Block F and sections of Block G, are on mudstone of the Weymouth Member which was also formed at the same time as West Walton Formation **[Ref. 4]**.

1.6.2. There are no superficial deposits recorded over most of the Site but pockets of superficial glacial clay, silt, and sand, as well as glaciofluvial sand and gravel deposits formed between 2.588 and 11.8 thousand years ago and 860 and 116 thousand years ago respectively during the Quaternary period, are recorded in the centre of Block B on the crest of Knowl Hill. Till (diamicton), sedimentary deposits formed between 860 and 116 thousand years ago during the Quaternary period, are recorded in Block D around Botolph Claydon and in the south east of Block F. Bands of alluvium (clay, silt, sand and gravel), are recorded along the eastern edge of Block E, bordering Claydon Brook and the western edge of Block C, which also borders a watercourse **[Ref. 4]**.

1.6.3. The soils are mostly classified in Soilscape 18, being described as slowly permeable seasonally wet slightly acidic but base-rich loamy and clayey soils. Part of Block B is covered by lime-rich, clayey soils with impeded drainage (Soilscape 9) and the north of Block E is covered by loamy and clayey floodplain soils with naturally high groundwater (Soilscape 20) **[Ref. 5]**.

2. Archaeological Background

2.1. Archaeological Background

2.1.1. The archaeological background below is abstracted from the Archaeological Desk-Based Assessment and Setting Assessment (**ES Volume 4, Appendix 9.1 [EN010158/APP/6.4]**): the full list of known (designated and undesignated) heritage assets within the survey area and the wider desk-based assessment search area is presented in the gazetteer comprising Annex B in **ES Volume 4, Appendix 9.1 [EN010158/APP/6.4]**. The heritage assets that are located in the GSA are detailed below and shown on **Illus 6**.

2.1.2. There are 27 non-designated heritage assets within the Order Limits although most comprise above ground structures or features. These comprise:

- An area of Iron Age to Romano-British settlement activity (HA1);
- The route of a Roman road (MBC6013);
- Four field systems of medieval or post-medieval date associated with settlements outside the Order Limits, comprised of earthwork and buried ridge and furrow (HA2, HA3, HA4, HA5);
- A field system of post-medieval date comprising extant hedgerows (HA6);
- Non-registered parts of parkland associated with Claydon House (MBC20416);
- Three farms dating to the post-medieval period (HA7, HA8, HA9);
- The sites of nine other post-medieval farm buildings (field barns or outfarms) (HA10, HA11, HA12, HA13, HA14, HA15, HA16, HA17, HA18);
- The route of the Aylesbury to Buckingham branch of the Metropolitan Railway (MBC14921);
- The site of the Grandborough Road Station buildings (MBC14922);
- Two post-Medieval extractive pits (MBC45160 and MBC45161);
- two former 17th century ponds (MBC10753; MBC21469), and
- A WWII ammunition dump (MBC45140).

2.1.3. There are two heritage assets of likely Iron Age date within the Order Limits (as defined in **ES Volume 4, Appendix 9.1 [EN010158/APP/6.4]**). The first comprises an area of Iron Age to Romano-British enclosures, pits and ditches (MBC45205, ADBA - HA1) identified during a geophysical survey for a separate application. These features were subsequently

confirmed by trial trenching as being of 1st – 2nd century date, and therefore during the Iron Age to Roman transition period. These features are in Block E, or immediately adjacent to it.

2.1.4. The second asset, also identified by a geophysical survey and unrelated to the current Proposed Development, and likely to date to the Iron Age/Romano-British period have been recorded to the north of Sheephouse Wood in Block B (MBC44779). These comprised linear anomalies possibly indicative of enclosures or former field system boundaries.

2.1.5. The **ES Volume 4, Appendix 9.1 [EN010158/APP/6.4]** concluded that there was considerable evidence for settlement activity identified in the HER during geophysical surveys in and around Block E which suggested a high potential for previously unknown archaeological remains of Iron Age date to survive here.

2.1.6. On a county level, Buckinghamshire was subject to a high level of activity during the Roman period. The area was inhabited by the Catuvellauni and the closest Roman town to the GSA was Magiovinium in Milton Keynes approximately 15km to the north east.

2.1.7. An Archaeological Notification Area (ANA) covering the Roman Road between Akeman Street and Thornborough (DBC9626) runs through Block E and is also recorded by the HER (MBC6013), a section of this Roman road south of Block E is designated as a separate ANA (DBC9483).

2.1.8. Another ANA covering an area of concentrated Roman finds uncovered while fieldwalking is also located in Block E (DBC8591). Geophysical survey has indicated the possible extent of these Roman remains and trenching has confirmed that they date to the 1st to 2nd century, the full extent of this asset is identified as HA1 (see above).

2.1.9. There is further evidence of Roman activity in the north-western part of Block B which comprises four pottery and metalwork find spots (MBC10751; MBC10752; MBC40233; MBC40259).

2.1.10. In the 19th century the Aylesbury to Buckingham line was constructed which runs through Block E (MBC14921).

2.1.11. There is one known heritage asset of modern date within the GSA, a World War II roadside ammunition dump in Block B (MBC45140).

3. Aims, Methodology & Presentation

3.1. Aims and Objectives

3.1.1. The principal aim of the geophysical survey was to gather information to establish the presence/absence, character, and extent of any archaeological remains within the GSA. This will enable an assessment to be made of the impact of the Proposed Development on any sub-surface archaeological remains if present, and thereby inform any further investigation strategies, as appropriate.

3.1.2. The specific archaeological objectives of the geophysical survey were:

- to provide information about the nature and possible interpretation of any magnetic anomalies identified;
- to therefore determine the likely presence/absence and extent of any buried archaeological features; and
- to prepare a report summarising the results of the survey.

3.2. Methodology

3.2.1. Magnetic survey methods rely on the ability of a variety of instruments to measure very small magnetic fields associated with buried archaeological remains. A feature such as a ditch, pit or kiln can act like a small magnet, or series of magnets, that produce distortions (anomalies) in the earth's magnetic field. In mapping these slight variations detailed plans of sites can be obtained, as buried features often produce reasonably characteristic anomaly shapes and strengths **[Ref. 6]**. Further information on soil magnetism and the interpretation of magnetic anomalies is provided in **Annex 2**.

3.2.2. Magnetometry is the most widely used geophysical survey technique in archaeology as it can quickly evaluate large areas and, under favourable conditions, identify a wide range of archaeological features including infilled cut features such as large pits, gullies and ditches, hearths, and areas of burning, and kilns and brick structures. It is therefore good at locating settlements of all periods, prehistoric field systems and enclosures, and areas of industrial or modern activity, amongst others. It is less successful in identifying smaller features such as post-holes and small pits (except when using a non-standard sampling interval), unenclosed (prehistoric) settlement sites and graves and burial grounds. However, magnetometry is by far the single most useful technique and was assessed as the best non-intrusive evaluation tool for this Site.

3.2.3. The survey was carried out in six mobilisations between September 2023 and February 2025 by Headland Archaeology.

3.2.4. The survey was undertaken using four Bartington Grad601 sensors mounted at 1 metre (m) intervals (1m traverse interval) onto a rigid frame. The system was programmed to take readings at a frequency of 10Hz (allowing for a 10-15 centimetre (cm) sample interval) on roaming traverses (swaths) 4m apart. These readings were stored on an external weatherproof laptop and later downloaded for processing and interpretation. The system was linked to a Trimble R12 Real Time Kinetic (RTK) differential Global Positioning System (dGPS) outputting in NMEA mode to ensure a high positional accuracy for each data point.

3.2.5. Hand carried survey was also undertaken using four and five sensor arrays deploying Sensys FGM650/10 sensors mounted at 1m intervals (1m traverse interval) onto a rigid frame. The system was programmed to take readings at a frequency of 100Hz (allowing for a 1-2cm sample interval) on roaming traverses (swaths) 4m apart. These readings were stored on an external weatherproof laptop and later downloaded for processing and interpretation. The system was linked to a Leica GS18 Real Time Kinetic (RTK) differential Global Positioning System (dGPS) outputting in NMEA mode to ensure a high positional accuracy for each data point. MonMX (Sensys Ltd) software was used to collect and export the data.

3.2.6. MLGrad601 and MultiGrad601 (Geomar Software Inc.) and DATAMONITOR 4 (Institut Dr. Foerster GmbH & Co. KG) software was used to collect and export the data. Anomaly GeoSurvey v1.12.3 (Lichenstone Geoscience) and QGIS v.3.28.5 software was used to process and present the data respectively.

3.3. Data Presentation and Technical Detail

3.3.1. A Site location plan is shown in **Illus 1** at a scale of 1:50,000. **Illus 2** to **Illus 5** inclusive are Site condition photographs. **Illus 6** shows the six block areas, and the location and direction of the Site condition photographs, at 1:25,000.

3.3.2. **Illus 7** shows the greyscale data across the Site and the 13 overview areas into which the Site has been subdivided. **Illus 8** also shows the overview areas together with the distribution of the anomalies of archaeological potential, including the designated 14 areas of archaeological activity location (AAA's), both graphics also at a scale of 1:25,000.

3.3.3. **Illus 9** to **34** provide overviews of the processed magnetometer data and interpretation respectively (Overview 1 through to Overview 13 inclusive), at a scale of 1:4,800. Fully processed (greyscale) data, minimally processed (XY trace plot) data and interpretative plans are then presented by Sector, at 1:2,400, in **Illus 35** to **Illus 139**. **Illus 140** to **Illus 181** present

the data and interpretation of the fourteen designated areas of archaeological activity at a scale of 1:1,000.

3.3.4. Technical information on the equipment used, data processing and magnetic survey methodology is given in **Annex 2**. **Annex 3** details the survey location information and **Annex 4** describes the composition and location of the Site archive. Data processing details are presented in **Annex 5**. A copy of the OASIS entry (Online Access to the Index of Archaeological Investigations) is reproduced in **Annex 6**.

3.3.5. The survey methodology, report and any recommendations comply with the Written Scheme of Investigation (**Annex 1**), guidelines outlined by Europae Archaeologia Consilium **[Ref. 2]** and by the Chartered Institute for Archaeologists **[Ref. 3]**.

3.3.6. All illustrations using OS base mapping have been reproduced with the permission of the controller of His Majesty's Stationery Office (© Crown copyright).

3.3.7. The Illustrations in this report have been produced following analysis of the data in 'raw' (minimally processed) and processed formats and over a range of different display levels. All illustrations are presented to display and interpret the data to best effect. The interpretations are based on the experience and knowledge of Headland management and reporting staff.

4. Results & Discussion

4.1. Site Conditions

4.1.1. Magnetometer survey is generally recommended over any sedimentary bedrock but the 'average response' on mudstones may be variable and can be poor **([Ref. 7]**; Table 4). Nevertheless, magnetometry was still the most appropriate non-intrusive geophysical technique for evaluating the GSA, taking account of the limitations noted in **Section 3.2** and above.

4.1.2. Surface conditions were mixed due to poor weather during the survey with several fields partially or completely waterlogged (**Illus 2** to **Illus 5** inclusive). Six fields were not surveyed due to unsuitable ground conditions and restricted access where livestock could not be moved due to a suspected Tuberculosis B outbreak. Despite the poor ground conditions, the data quality was generally good with only minimal post-processing required. No other problems were encountered during the survey.

4.1.3. The magnetic background varies across the six blocks with discernible differences between areas where superficial deposits are recorded and those where none are recorded. This variation ranges from a more homogenous background with fewer discrete anomalies, to distinct bands where many discrete and linear and sinuous anomalies have been identified.

4.1.4. Against this magnetic background, anomalies of various origin have been recorded, although some of the responses are low magnitude or discontinuous and therefore not easy to discern. The range of anomalies recorded, including those of likely archaeological origin, confirms that there was sufficient magnetic contrast, for the detection of archaeological features, notwithstanding the limitations of magnetometer survey to identify the types, sizes, and period of archaeological features as described in **Section 3.2** and keeping in mind the generally average to poor response to magnetometer survey on the different mudstone formations underlaying the six survey blocks. The results of the survey therefore likely provide a reasonably good indication of the archaeological potential of the GSA.

4.1.5. The anomalies are discussed below according to their interpreted origin.

4.2. Anomalies of Ferrous or Modern Origin

4.2.1. Ferrous anomalies, characterised as individual 'spikes', are typically caused by ferrous (magnetic) material, either on the ground surface or in the plough-soil. Little importance is normally given to such anomalies, unless there is any supporting evidence for an archaeological

interpretation, as modern ferrous debris is common on most sites, often being introduced into the topsoil during manuring or by tipping or infilling.

4.2.2. Bands or small areas of magnetic disturbance recorded along the field edges are most likely to be due to the accumulation of ferrous debris around field margins or to ferrous material in the boundary itself. Some larger areas of magnetic disturbance, such as those recorded in the north of D1 (**Illus 79**), identify spreads of buried ferrous material likely associated with agricultural or modern practices such as infilling or demolition, and are not considered to have any archaeological potential.

4.2.3. 18 no. high magnitude dipolar linear anomalies (**Illus 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32** and **34** – SP1 to SP21 inclusive), and one low magnitude, sometimes negative linear anomaly (**Illus 115** and **Illus 121** – SP10) are caused by buried service pipes.

4.2.4. Five areas of magnetic disturbance corresponding to former buildings recorded on the OS 1830s-1880s county layers historic mapping have been identified: FBG 1 is in the centre of B4 (**Illus 46**), FBG2 is in the south of B20 (**Illus 58**), FBG3 is in the north of D33 (**Illus 91**), FBG4 is in the east of B18 (**Illus 64**) and FBG5 is in the south of SA16 (**Illus 76**). These areas of magnetic disturbance present an elevated magnetic response due to the fired building material (bricks) used in the construction of these former structures being mixed into the topsoil following demolition.

4.2.5. Four further areas of magnetic disturbance recorded in Block D and Block E (D27, D10, E23 and E11), locate sites of former ponds (**Illus 88**, **Illus 121**, **Illus 112** and **Illus 133** - (FP1 to FP4 respectively)) as recorded on the Ordnance Survey 1830s-1880s county layers and later historic mapping. Magnetic (fired) material used to infill the ponds is the cause of the high magnitude response, probably building rubble.

4.2.6. The former route of the 19th century Aylesbury to Buckingham railway line is fossilised in the landscape forming the boundary between several fields in Block E. The railway manifests in the data as a linear spread of magnetic disturbance either side of the boundary separating E22 to the west and E21 in the east (**Illus 34**), and along the western boundaries of E11 (**Illus 32**), E20 (**Illus 26**) and the eastern boundaries of SA51, SA52 and SA53 (**Illus 26**).

4.2.7. In Block E (**Illus 31** and **Illus 32**) interference from low slung overhead electricity cables is evident in the data (**Illus 128** to **Illus 130**). There is also disturbance around extant pylons, such as in E11 and E23 (**Illus 131** to **Illus 136**). These areas of heavy disturbance may be masking the response from any archaeological feature, if present, in these affected areas.

4.2.8. The sub-surface remains of former pylons, such as in E10 (**Illus 128** to **Illus 130**), is evidenced by the four distinct magnetic 'spike' responses arranged in a square, with these responses being due to the remains of the four struts supporting each corner of the former structure.

4.3. Agricultural Anomalies

4.3.1. Ten linear anomalies of varying magnitude (**Illus 58, Illus 61, Illus 88, Illus 79, Illus 136, Illus 133, Illus 73, Illus 76, Illus 115** and **Illus 118** - FB1 to FB10 inclusive) each locate former field boundaries recorded on the Ordnance Survey 1830s-1880s county layers and later historic mapping.

4.3.2. A plethora of agricultural anomalies are recorded within the GSA, the most common of which are parallel series of low magnitude and curvilinear anomalies. These denote the orientation of modern ploughing or older, medieval or post-medieval ridge and furrow cultivation techniques. Evidence for ridge and furrow cultivation is most extensive in Block B (B12, B15 and B16 - **Illus 44** to **Illus 46** and **Illus 50** to **Illus 52**) and throughout Block E (**Illus 31** and **Illus 32**).

4.3.3. In the west of SA13 in Block F, are an arrangement of enhanced, discrete sub-circular anomalies (**Illus 53** to **Illus 55**) as well as several linear features. These anomalies are associated with the former extent of Home Wood, with the enhanced anomalies likely the result of infilling of tree boles or the burning out of stumps.

4.3.4. Other low magnitude linear anomalies recorded intermittently across the GSA, are caused by field drains.

4.4. Anomalies of Geological Origin

4.4.1. The magnetic background across the GSA manifests largely as evenly dispersed, uniform, discrete anomalies derived from the mudstone bedrocks and the soils which overlay them. Although several bedrock geologies are present within the GSA, they are all mudstone (Stewartby Member, West Walton Formation, and Weymouth Member).

4.4.2. A more homogenous magnetic background recorded in SA55 (**Illus 128** to **Illus 130**) is due a band of alluvium (clay, silt, sand and gravel) recorded on the north side of Claydon Brook. An arcing band of much higher readings also on the north side of the watercourse is likely an infilled meander (**Illus 130**).

4.4.3. The magnetic background does vary greatly throughout the GSA, with these variations correlating with the small pockets of recorded superficial deposits. Where there are alluvial deposits, the magnetic background is homogenous (smoother in appearance), with fewer discrete anomalies,

whereas where there are glacial and glaciofluvial deposits sinuous and curvilinear anomalies are recorded as well as defined areas of dense discrete anomalies. Examples of these are recorded in D16 and D18 in Block E (**Illus 29** and **Illus 30**) and in B11, B12 and B14 in Block B (**Illus 44** to **Illus 46**).

4.5. Anomalies of Uncertain Origin

4.5.1. Anomalies of varying extent, shape and magnetic signal are identified across the survey blocks. These anomalies present as isolated and clustered discrete responses anomalies as well as linear and curvilinear responses. These anomalies have been interpreted as of uncertain origin on the basis that they cannot be confidently interpreted in any other category.

4.5.2. Discrete anomalies, such as those recorded in the north and south of B4 (**Illus 43** and **Illus 46**), in the east of D45 (**Illus 115**), in the north SA15 and the north west of SA26 (**Illus 76**), in the east of SA35 (**Illus 118**) and the north of SA39 (**Illus 124**) have a magnetic signature above the general geological background, and are usually broader in extent and shape.

4.5.3. Linear or rectilinear anomalies such as those recorded in B12 (**Illus 46** and **Illus 52**), B14 (**Illus 40** and **Illus 46**) and B16 (**Illus 52**), D31 (**Illus 91** and **Illus 97**) and SA57 (**Illus 103**) may be parallel or oblique to existing field boundaries and current or former cultivation trends but lack any supporting context which otherwise might allow a more confident interpretation to be made. With these anomalies, a modern, geological or agricultural origin is considered more likely than an archaeological origin. Nevertheless, an archaeological cause cannot be wholly dismissed.

4.6. Anomalies of Possible or Probable Archaeological Origin

4.6.1. 14 areas of archaeological activity (AAA's) have been identified across the Site. An AAA is described as a (usually) broad area where a pattern and density of anomalies/features (whose extent can be clearly defined) is clearly indicative of archaeological (usually settlement) activity.

4.6.2. Individual features may also be classified as an AAA based on their proximity to other more extensive areas of activity. Examples include the three enclosures included as AAA7, AAA8 and AAA9 (**Illus 26** and **Illus 32**) which are located north west, west and north respectively of the extensive settlement area covering much of the north east part of the Site in Block E (AAA10, AAA11, AAA12 and AAA13 – **Illus 32**).

AAA1 (Illus 140-142)

4.6.3. A large, partial rectangular enclosure, covering approximately 1.5ha and characterised by a faintly positive magnetic signal has been identified in

the centre of Field B11, Block B, immediately east of Shrubs Wood. Located next to a spring and in a topographically favourable location, being an elevated point in the landscape at Knowl Hill, the enclosure is orientated along an approximately north south to east west axis and is part of a group of enclosures aggregated as EG1. Two irregularly shaped enclosures crosscut this larger enclosure along its northern extent: these are connected to one another and the crosscutting suggests they pertain to a different chronology than that of the larger enclosure. The larger of the two intersecting enclosures exhibits a particularly enhanced signal which may result from intense or prolonged occupation. Within it are strongly positive linear and discrete anomalies which likely relate to the enclosure's internal features such as subdivisions and pits. A series of strongly enhanced discrete anomalies lie also immediately outside of this larger irregular enclosure: while it is possible these could represent further features associated with these enclosures, it is also possible these relate to the natural background.

AAA2 (Illus 143-145)

4.6.4. Faint linear anomalies have been identified about 375m east of EG1, in the east of Field B17, Block B, and form a second group of possible, partial enclosures (EG2). This group covers an area of about 1.4ha and includes single and double ditches as well as a series of internal linear and discrete anomalies which possibly represent pits and further features associated with EG2. While the ditches display a faintly positive magnetic signal, the discrete anomalies are strongly positive. The largest of these discrete anomalies, measuring about 15m by 8m and located in the south east of the group, shows a particularly strong signal. This may indicate an area where magnetically enhanced materials have been accumulated, perhaps resulting from industrial activity.

AAA 3 (Illus 146-148)

4.6.5. A large focus of probable archaeological activity has been identified in the centre and south of Field SA26, Block F (EG3). This comprises a rectilinear complex, covering an area of over 5ha and continuing westwards and southwards beyond the boundaries of the GSA. The complex, which is likely indicative of a settlement, is aligned on a general north east to south west and north west to south east axis, and a possible trackway (TW?2) crosses it in its centre-south portion. To the west of TW?2, the complex has a more regular morphology while, to the east of it, the linear anomalies become sparser and appear to align following a slightly different, north east to south west orientation. A few discrete anomalies exhibiting a particularly strong enhancement have been identified both to the west and east of TW?2 and could possibly relate to burning activity. Ridge and furrow cultivation trends are recorded crossing the area on a roughly north east to south west orientation.

AAA4 (Illus 149-151)

4.6.6. Located in the west of Field D2, Block D, linear anomalies indicative of a possible double-ditched trackway TW?1 have been identified. On either side of the trackway, further linear anomalies have been identified, some of which form partial enclosures E1 and E2. Within enclosure E1, two possible ring ditches RD4 and RD5 have also been identified.

AAA5 and AAA6 (Illus 152-157)

4.6.7. A series of interconnected linear ditch-like responses covering an area of approximately 5ha define a series of enclosures and/or field system, trackways and ditches across the western half of Field E23, Block E. Six separate broadly rectilinear enclosures/partial-enclosures are recorded by the data (E4-E9) across the field. High magnitude discrete responses within E6 could record localised burning and/or possible extraction, though the general pattern and density of features is suggestive of a field system rather than settlement activity.

4.6.8. At their nearest point the features identified as AAA5 and AAA6 lay approximately 475m south east of a Roman road that links Akeman Street at Fleet Marston and Thornborough (Margary Road 162, 203400000) and two records of Roman findspot concentrations recorded through fieldwalking.

AAA7 (Illus 158-160)

4.6.9. A very faint single, apsidal enclosure (E24) measuring approximately 60m in diameter is recorded north of centre within Field SA57 in Block E centred at NGR 474645, 225785. Only one discrete pit-like anomaly of possible archaeological origin is identified adjacent to the enclosure. It remains unclear whether E24 is associated with linear trends of uncertain and possible archaeological origin (RD?7 and E?25) recorded approximately 150m and 200m to the south west and north east respectively.

4.6.10. The enclosure lies approximately 350m west of a Roman road that links Akeman Street at Fleet Marston and Thornborough (Margary Road 162, 203400000) though no direct association can be inferred from the survey data.

AAA8 (Illus 161-163)

4.6.11. Three sides of an isolated rectilinear enclosure (E23) measuring approximately 45m in diameter are recorded in Field SA58, Block E centred at NGR 474605, 225475. Four discrete pit-like anomalies recorded around the enclosure ditches are similar in strength to the natural background variation and therefore possibly of natural origin.

4.6.12. The enclosure lies approximately 425m west of a Roman road that links Akeman Street at Fleet Marston and Thornborough (Margary Road 162, 203400000) though no direct association can be inferred from the survey data.

AAA9 (Illus 164-166)

4.6.13. A sub-circular enclosure (E22) measuring approximately 35m in diameter is recorded in the north eastern part of Field SA55, Block E centred at NGR 475635, 226120. The enclosure has a clear entrance on the western side and contains two pit-like anomalies of possible archaeological origin. The feature lies immediately east of a series of linear ditch-like trends of possible archaeological origin and north of a cluster of ditch-like and discrete responses also of possible archaeological origin located immediately of north of Claydon Brook (see AAA10). It is considered likely the activity recorded here marks a continuation of the likely settlement activity recorded south of the brook (AAA11 - AAA13).

AAA10-AA13 (Illus 167-178)

4.6.14. A foci of likely settlement activity comprising enclosures, ditches and pit-like features spans an area of approximately 12ha across Fields E10 and E11 south of Claydon Brook, centred at NGR 475325, 225536. As many as eleven separate and/or adjoining regular and irregular shaped enclosures (E10-E20) are identified with concentrations recorded in the north western part of E11 and southern half of E10. One discrete anomaly with a high amplitude response and distinct magnetic signature indicative of burning (B1) is recorded towards the eastern boundary of E11 (AAA13). The anomaly responses are however generally quite faint and less distinct in places likely due to the truncating effects of modern and historic (ridge and furrow) cultivation and modern drainage evidenced by a regular pattern of field drains in E11.

4.6.15. The purported line of a Roman road that links Akeman Street at Fleet Marston and Thornborough (Margary Road 162, 203400000) crosses the south west corner of E11 aligned roughly north west/south east in the approximate location of the pylon base. No evidence for the road specifically is recorded by the survey, however its presence is perhaps inferred by the concentration of activity recorded across E10 and E11 (AAA10 - AAA13). Two records of Roman findspot concentrations recorded through fieldwalking are noted in the Buckinghamshire HER approximately 550m to the south. A previous geophysical survey and subsequent trial trenching have also confirmed Iron Age/Romano-British activity in the immediate vicinity (see **Section 2.1.3** and **2.1.5** to **2.1.8** inclusive)

4.6.16. It is considered likely archaeological features continue under the overhead powerlines which have caused interference with the magnetometer sensors effectively masking any responses from weaker archaeological features in the north of E10 and western part of E11. The full extent of the archaeological features in the north of E10 south of Claydon Brook are also likely not identifiable within the limits of the survey area, which do not extend to the present field boundaries.

AAA14 Illus (179-181)

4.6.17. A single rectilinear enclosure (E21) aligned north/south/east/west has been identified in SA51 with a clear entrance on the eastern side. Several possible pit-like responses have been recorded both within and immediately adjacent to the enclosure, which is centred at NGR 474940, 225380. Numerous linear and curvilinear anomalies to the north, south and east of E21 hint at further archaeological activity, However, these responses are of much lower amplitude than those defining the enclosure and have no clear morphology, so an archaeological interpretation is considered tentative. The much stronger responses and effects of the ridge and furrow cultivation in this field has also made a confident interpretation difficult.

4.6.18. As well as the defined areas of archaeological activity several isolated individual anomalies/features have been recorded that don't obviously form part of a wider or more extensive archaeological cluster. The isolated features include five possible ring ditch anomalies, identified in the south of B20 (**Illus 61** – RD?1), the north west of D30 (**Illus 91** – RD?2), the south of D3 (**Illus 79** – RD?3), the north west of SA50 (**Illus 112** – RD?6) and the north west of SA53 (**Illus 103** – RD?7).

4.6.19. Several possible enclosure anomalies are also identified in SA53 and SA57 in proximity to RD?7 (**Illus 158** and **Illus 161** – E23 to E26 inclusive). All these anomalies are discontinuous either due to a lack of contrast between the fill of the cut feature and the mudstone bedrock or to differential plough damage.

5. Conclusion

5.1.1. The survey has identified clusters of potential archaeological activity in four separate and clearly defined areas of the Site. In the west of the Site, in Block B, two groups of enclosures approximately 0.4m apart have been identified on the high ground of Knowl Hill (AAA1 and AAA2). Just over 1km further east in Block F (AAA3) a large rectilinear enclosure complex clearly indicative of settlement activity and covering over 5ha has been recorded: the settlement likely continues to the west and south beyond the Order Limits. A further kilometre east in Block D two enclosures, a trackway and two ring ditch features have been recorded (AAA4) although this area is part of a wider parcel of land no longer within the Order Limits. The archaeological potential of these three AAA's is assessed as high.

5.1.2. The final, and most extensive area of archaeological activity, is in the north eastern corner of the Site in Block E where clusters of features have been identified bordering Claydon Brook and/or adjacent to the postulated line of the Roman road that links Akeman Street at Fleet Marston and Thornborough (AAA5 to AAA14 inclusive). No evidence for the road specifically has been recorded by the survey although its presence is given further credence by the concentration of activity recorded in the north eastern corner of Block E and by records of Roman findspot concentrations recorded through fieldwalking 0.5km to the south. The features in Block E are again indicative of enclosure and occupational activity and together with the results of an earlier geophysical survey and trial trenching (see **Section 2.1.3**) indicate that the archaeological potential of the north eastern part of the Site in Block E is high to very high.

5.1.3. Other individual features, such as ring ditches and isolated enclosures have also been identified by the survey and there are also other disparate anomalies in all blocks that have been classified as of uncertain origin where there is no morphology or pattern suggestive of any significant activity but for which an archaeological origin cannot be completely dismissed. The archaeological potential in and around these anomalies/features is assessed as moderate.

5.1.4. Several areas of medieval or post-medieval ridge and furrow ploughing have also been recorded across all the survey areas. Other non-archaeological anomalies including those caused by recent agricultural activity such as modern ploughing, land drainage, hedgerow removal and the infilling of former ponds are ubiquitous. Several service pipes are identified and numerous anomalies due to variation in the bedrock, superficial deposits and soils are also noted. In these areas where no anomalies of obvious or possible archaeological origin have been recorded (most of the Site) the archaeological potential is assessed as low.

5.1.5. It should, however, be stated that the bedrock mudstone geology may not be particularly conducive for clear results, and this may explain the low magnitude and discontinuous nature of some of the anomalies. Consequently, it is considered possible that there may be archaeological features present (particularly those that may be small, shallow or discrete) that could not be detected by the survey, although it is considered likely that the location and extent of any settlement activity has been identified by the survey. Nevertheless, the survey has identified archaeological remains not previously known or recorded on the Buckinghamshire Historic Environment Record as well as clarifying the extent of other previously known heritage assets, thereby enhancing the archaeological record and providing information which will help inform future archaeological mitigation works and aid in refining design proposals.

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Annex 1: Written Scheme Of Investigation For Geophysical Survey

RSFB23

Land between Calvert Green and Granborough, Buckinghamshire

Written Scheme of Investigation for Geophysical Survey

Client: RSK Environment Ltd

v.1.2

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HEADLAND ARCHAEOLOGY

1 INTRODUCTION

1.1 This Written Scheme of Investigation (WSI) has been prepared by Headland Archaeology in advance of a geophysical (magnetometer) survey on land at several sites between Calvert Green and Granborough, Buckinghamshire.

1.2 The results of the geophysical survey will be submitted in support of a planning application for the possible future development of the land and may also inform future archaeological strategy and site selection, if required.

1.3 The scheme of work will be undertaken in accordance with the requirements of the National Planning Policy Framework (MHCLG 2019).

1.4 The WSI is produced to the standards laid down in the European Archaeological Council's guideline publication EAC Guidelines for the Use of Geophysics in Archaeology (*Europae Archaeologia Consilium* 2016), the Chartered Institute for Archaeologists (CIfA) Standard and Guidance for Archaeological Geophysical Survey (CIfA 2014) and in line with the Brief for Archaeological Geophysical Survey (Bedford Borough Council 2020).

2 DESCRIPTION OF THE SITE

2.1 The Proposed Development Area (PDA – Illus 1) comprises four blocks of agricultural land totalling 475 hectares. The details of each block are described in the table below:

Area	Location (Centre)	Size (ha)	Bedrock Geology	Superficial Geology (where recorded)	Soils
Block B	NGR 470188 224396	182	Stewartby Member Mudstone & West Walton Formation Mudstone (southern quadrant)	Glacial and glaciofluvial clay, silt, sand, and gravel	Soilscape 18 (western edge) Soilscape 9 (east)
Block C	NGR 470937 222914	15	Stewartby Member Mudstone	Glacial clay silt and sand (western edge)	Soilscape 18
Block D	NGR 472811 222700	227	West Walton Formation Mudstone & Weymouth Member Mudstone (northeast quadrant)	Glacial clay silt and sand (western edge); mid-pleistocene diamicton (centre)	Soilscape 18
Block E	NGR 475122 225149	51	Weymouth Member Mudstone	Alluvial clay, silt, sand, and gravel	Soilscape 18 (eastern edge)

2.2 Soilscape 18 is described as slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils; Soilscape 9 is described as lime-rich loamy and clayey soils with impeded drainage (Cranfield University 2021)

2.3 The general topography across the Proposed Development Areas is characterised by a gently rolling landscape, and the land use is a patchwork of woodland and agricultural fields. The western boundary of the Proposed Development Areas lies within the eastern edge of the River Ray Valley, and the source is located at the base of the Conduit and Quainton Hills south-east of the Proposed Development Areas. Claydon Brook is situated within the centre of the Proposed Development Areas and flows northward where it joins Padbury Brook, and then connects to the River Great Ouse north of the Proposed Development Areas. The bedrock deposits that underlie the Proposed Development Areas are all part of the Ancholme Group which is formed of sedimentary bedrock of Jurassic date. There are superficial deposits pockets of glacial, glaciofluvial and till deposits of quaternary date throughout the Site, and alluvial deposits located within the northern areas of the Site.

3 ARCHAEOLOGICAL BACKGROUND

3.1 The following is a summary of the historical and archaeological background, reproduced from a draft WSI created by AECOM (2022) and provided by the client. It has been compiled using the Buckinghamshire Historic Environment Record (HER) database and comprises heritage assets (both features and findspots) dating from the Bronze Age to the modern periods. A 1km study area surrounds the geophysical investigation areas and the HER data has been collated from records within this 1km study area.

3.2 There are no sites, find spots or heritage assets recorded within the study area of Palaeolithic, Mesolithic, Neolithic, or Iron Age date.

3.3 A single find of Bronze Age date is recorded within the study area, 980m to the north-west of block E. A potential silver ingot (**MBC40909**) was recorded by the Portable Antiquity Scheme (PAS).

3.4 Roman artefacts have been located throughout the study area, with Roman pottery (**402600000, 402600001, 611400000, 611401000**), two Roman coins (**MBC31075, MBC31081**), and Roman metalwork (**402600000, 402600001 MBC39969**) found with no obvious concentration patterns.

3.5 A hoard of Roman coins and a vessel were located within Block B within the westernmost field (**MBC40233, MBC40259**). There is a Roman road located to the north-east of the Proposed Development Area and within the south-western corner of Block E, identified as Margary Road 162 (**203400000**). This road is located between Akeman Street at Fleet Marston and Thornborough, and there is a possible extension to the Alchester-Towcester Road. These sections of Roman road are Archaeological Notification Areas.

3.6 The Proposed Development Area is situated within a landscape that contains heritage assets of medieval date, and there are a variety of features including occupational and agricultural evidence. There is evidence of moated structures and manors within the study area (**33800000, 528200000, 34503000, 75703000, 258500000**), indicating that this landscape was agriculturally exploited. Two of these manor sites are identified as Archaeological notification areas. These heritage assets are the earthwork remains of the medieval moated grange of Biggin, and also the medieval moated site and settlement earthworks of Hogshaw. Further evidence within the study area includes ridge and furrow (**0633600000, 0633700000, 0634000000, 0633600000, 0634000000**).

3.7 Several areas of ridge and furrow are present across all four Sites. Block E has an area of ridge and furrow covering its northern half, and Block D has a small area within its south-west corner. These areas of ridge and furrow are identified as Archaeological Notification Areas. Other features are boundary ditches, earthworks and gullies, as well as a well (**0781100000, 0010300000, 0244800000, 249400000, MBC43617 MBC43621, MBC43628**). Occupational evidence within the study area includes evidence for deserted medieval village (DMV) and shrunken medieval village (SMV) features (**75702000, 732900000, 34500000, 0160300000**) including evidence for house platforms(**33801000, 34500000, 0034501000, 34501001, 849700000, 75700000, 995100000, 732900000, 33902000, 249200000, 249300000, 249401000**). The shrunken medieval village earthworks at Granborough and earthworks of shrunken medieval village at East Claydon are both Archaeological Notification Areas.

3.8 Other evidence in the study area include the sites of four windmills, one of which is an Archaeological Notification Area (**34501002, 432000000, 528300000, 691400000**), a trackway (**0690702000**), a bridge (**0075706000**) and ecclesiastical structures (**75701001, 71701000, 71700000, 0034502001, 0034502000**), with the medieval parish church of St Mary, East Claydon also being an Archaeological Notification Area. Find spots of medieval metalwork have also been located within the study area (**MBC31091, MBC31581, MBC39581, 10200000**).

3.9 There is evidence for post-medieval rural settlement and agricultural activity within the study area, as well a small-scale industrial activity and the presence of new railway links. There are a number of ponds and enclosures located within the study area showing that the landscape continued to be exploited for agricultural use (**413900000, 0732800000, 293600000, 293602000, 0293900000, 0402601000, 413900000, 0075701000, 0075704000, 0732700000**), with one pond and enclosure identified as Archaeological Notification Areas. **Heritage asset 293602000** is located within the easement area of the cable route located 220m to the west of Block D.

3.10 A large change to the landscape came with the construction of the railways and there were several branch lines established within the study area (**578800000, 579000000, 1481200000, 1484900000, 578800001, 578800002, 579001000**). There is evidence of industry within the study area, including a brickworks and a clay pit, as well as a watermill, located on the northern edge of Block E (**448900000, 448901000, 0511200000, 906200000**).

3.11 Occupation features within the Proposed Development include landscaped parkland, a HA-HA wall, and house platforms (**202203004, 293601000, 0202203000, 258502000**), and the 18th and 19th century landscaped park at Claydon House, which is an Archaeological Notification Area. Copper alloy and coins from this period have also been located within the study area (**MBC40617, MBC40923**).

3.12 Modern features have been located within the study area, including three war memorials (**0739000000, 0739100000, 0746100000**), a railway (**579100000, 579101000**) and a brickworks (**0906100000**).

3.13 Throughout the study area there are seven features which are of unknown date. There are three ponds and a dam feature (**0402601001, 0024700000, 0010300000, 0402601000**). **0402601000** is located within Block B within the westernmost field. A Holloway feature (**0737000000**), and two earthwork features (**24700000, 10300000**) are located within the study area.

4 OBJECTIVES

4.1 The principal objectives of the programme of geophysical survey are to gather information to establish the presence/absence, character and extent of any

archaeological remains within the PDA, and to inform a planning application and any further investigation strategies.

4.2 The aims of the survey are:

- to provide information about the nature and possible interpretation of any magnetic anomalies identified;
- to therefore determine the likely presence/absence and extent of any buried archaeological features; and
- to produce a comprehensive site archive and report.

5 PROJECT TEAM

5.1 The project will be managed for Headland Archaeology by Peter Turner (Project Manager). The field team will comprise of at least one Supervisor.

5.2 The project team will familiarise themselves with the background to the site and will be aware of the project's aims and methodologies.

5.3 Headland Archaeology (UK) Ltd is a Registered Archaeological Organisation and abides by the Codes of Conduct and Approved Practice and Standards of the Chartered Institute for Archaeologists. The company has all the necessary technical and personnel resources for the satisfactory completion of the survey.

6 INSURANCE & COPYRIGHT

6.1 Headland Archaeology (UK) Ltd is fully indemnified and all necessary insurances can be presented on request.

6.2 Copyright will be retained by Headland Archaeology (UK) Ltd. Headland will licence the client and other bodies as necessary for use in matters relating to the project and for use of the project archive by the relevant museum. This licence will also extend to non-commercial use.

7 HEALTH & SAFETY

7.1 All of Headland's work is undertaken in accordance with current H&S legislation. A risk assessment and method statement will be prepared prior to the commencement of fieldwork. All staff will wear appropriate PPE.

8 METHOD

8.1 A geophysical (magnetometer - gradiometer) survey will be carried out across all parts of the PDA, excluding any buildings and woodland which are unsuitable for magnetometer survey.

8.2 The survey will be undertaken using four Bartington Grad601 sensors mounted at 1m intervals (allowing for a 1m traverse interval) onto a rigid carrying frame. The system will be programmed to take readings at a frequency of 10Hz (allowing for a 10-15cm sample interval) on roaming traverses spaced 4m apart. These readings will be stored on an external weatherproof laptop and later downloaded for processing and interpretation. MLGrad601 and MultiGrad601 (Geomar Software Inc.) software will be used to collect and export the data. Terrasurveyor V3.0.35.0 (DWConsulting) software will be used to process and present the data.

8.3 The magnetometer system will be linked to a Trimble R8s and R2 Real Time Kinetic (RTK) differential Global Positioning System (dGPS) outputting in NMEA mode to ensure a high positional accuracy of each data point.

8.4 A series of temporary sight markers will be established within each survey area using a Trimble dGPS system. The markers will guide the operator and ensure full coverage with the magnetometer system.

8.5 At the start of each day the magnetometer will be left idle whilst switched on for approximately 30 minutes to allow the instrument to acclimatise to the site conditions. The instrument will thereafter be balanced when necessary and at least twice during the day.

8.6 The survey is expected to commence in September 2023. The overall duration of the survey will be dictated by the harvest times of the various crop types within the PDAs, the numbers of survey teams available for deployment, access, and ground conditions. A draft report will be issued to the Client within an agreed period following completion on site.

8.7 Any photographs taken during the survey for archive purposes will consist of high-quality digital images of at least 12 megapixels taken using a DSLR camera of the survey area or areas. It shall be accompanied by a photographic register detailing as a minimum location, and direction of shot. Digital photographs intended for archive purposes will comply with the latest best practice – i.e. high quality non-proprietary raw files (DNG) or TIFF images. Working shots illustrating ground conditions and areas unsuitable for survey will be included within the report but will not form part of the archive.

8.8 It is not expected that surface finds be picked up during the course of the survey unless they contribute significantly to the project objectives or are of particular intrinsic interest. Finds of "treasure" will be reported to the Coroner and treated in accordance with the Treasure Act procedures. Any non-treasure finds recovered will be retained and removed from the site for initial assessment and cataloguing. They will be washed (where appropriate), marked, sorted and packed in accordance with the approved recording system and the practices and guidance described in Preparation of Archaeological Archives: Selection, Retention and Dispersal of Archaeological Collections (2010) and the CIFA documents Standard and Guidance for the collection, documentation, conservation and research of archaeological materials (2014).

9 REPORTING AND ARCHIVE

9.1 On completion of the survey, a report will be produced containing all relevant information including (but not necessarily limited to):

- site code/project number; dates for fieldwork visits; grid references; location plan, and a plan showing the limits of the survey area;
- a non-technical summary of the reason for, aims and main results of the survey;
- an introduction to outline the circumstances leading to the commission of the project and any restrictions encountered;
- the aims and objectives of the survey;
- the methodology used;

- a summary and synthesis of the archaeological results in relation to the methods used together with a confidence rating and the perceived importance in local, regional or national context. This shall be supported by a survey location plans and plots of minimally processed (X-Y traceplot) and fully processed (greyscale) data at a minimum scale of 1:2,500 with larger scale (1:1,000) plots of all areas of clear archaeological potential. Each plan/plot will have a bar scale and accurately orientated north arrow; Survey locations, all greyscale plots of the processed data and interpretative plots will be georeferenced and supplied in .dwg or .shp formats along with the submission of the survey report so that these can be added to the HER digital material together;

- OASIS fieldwork summary;

- references to all primary and secondary sources consulted.

9.2 All figures will be reproduced from Ordnance Survey mapping with the permission of the controller of His Majesty's Stationery Office (© Crown copyright).

9.3 The project will be archived in-house in accordance with recent good practice guidelines (http://guides.archaeologydataservice.ac.uk/g2gp/Geophysics_3). The data will be stored in an indexed archive and migrated to new formats when necessary (see attached Data Management Plan).

9.4 One bound copy of the final publication and a digital copy, in PDF format, will be supplied to Buckinghamshire HER. A further copy will accompany the archive. The report will be submitted within 1 month from the end of the fieldwork in the form of a digital PDF/A copy supplied to the Historic Environment Team.

9.5 Following informal approval, one copy of the approved survey report in digital form should be submitted to the HER via the OASIS website within two weeks of approval.

9.6 In addition, Headland Archaeology will make their work accessible to the wider research community by submitting digital data and copies of the report online to OASIS (see above).

9.7 An OASIS No. for this site will be obtained on finalisation of the report

10 MONITORING

10.1 A standard working day will involve driving to site, condition surveys of the survey area, survey area setting out and detailed geophysical survey. Data will be sent back to the office on a regular basis and progress reports provided to the client.

Key Contacts

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Steve Nicholson, Health and Safety Coordinator 01525 648018

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Ministry of Housing, Communities and Local Government (MHCLG) 2019 National Planning Policy Framework https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/740441/National_Planning_Policy_Framework_web_accessible_version.pdf 30/05/2023

Europae Archaeologia Consilium (EAC) 2016 AC Guidelines for the Use of Geophysics in Archaeology: Questions to Ask and Points to Consider (Namur, Belgium) https://historicengland.org.uk/images-books/publications/eac-guidelines-for-use-of-geophysics-in-archaeology/ accessed 30/05/2023

Natural Environment Research Council (NERC) 2023 British Geological Survey http://www.bgs.ac.uk/ accessed 30/05/2023

12 DATA MANAGEMENT PLAN

Section 1: Project Administration

Project ID / OASIS ID
OASIS ID = TBC Site Code = RSFB23
Project Name
Land between Calvert Green and Granborough, Buckinghamshire
Project Description
Geophysical (magnetometer) Survey – c.475 hectares of agricultural land. Aim is to inform a planning application
Project Funder / Grant reference
Client Funded – RSK Environment Ltd.
Project Manager
Peter Turner – Project Manager
Principal Investigator / Researcher
Peter Turner – Project Manager
Data Contact Person
Sam Harrison – Senior Manager responsible for IT
Date DMP created
2023-05-31
Date DMP last updated
-
Version
1.0
Related data management policies
http://guides.archaeologydataservice.ac.uk/g2gp/Contents EAC Guidelines for the use of geophysics in archaeology 2016

Section 2: Data Collection

What data will you collect or create?
Fluxgate Gradiometer data is collected in the field in proprietary format and converted to XYZ format ready for import to processing software and archiving purposes. Vector

data will be stored in DWG format, this will include the minimally processed XY trace plots and interpretation. Raster images will be stored as Tiff and TFW files. The report will be uploaded to OASIS as PDF/A format.

Type	Format	Estimated Volume
Text/Documents	PDF/A	1 x PDF
Vector Graphics	DWG	2 x DWG
GIS	TIFF+TFW	<10 files

How will the data be collected or created?

Data Standards / Methods

Data collected to the following guidance: European Archaeological Council's guideline publication EAC Guidelines for the Use of Geophysics in Archaeology (*Europae Archaeologia Consilium* 2016), the Chartered Institute for Archaeologists (CIfA) Standard and Guidance for Archaeological Geophysical Survey (CIfA 2014). Data is collected utilising Bartington Sensors and Data Loggers using MulitGrad software from Geomar.

Data Storage

The working project archive will be stored in a project specific folder or data specific folder on the internal organisational server. The internal organisation server is backed up twice daily to maintain an up to date security copy of the organisation wide data. • Project folders are named following established organisational procedures. • Data collected will be downloaded and raw data will be stored in the appropriate folder. File naming conventions following established organisational procedures, based on ADS file naming guidance, and include version control management. All files included as part of this project archive will include an organisational identifier (PA), the Site Code (SBRO), the file descriptor (eg ProjectDesign) and Version number (eg v2).
File naming conventions following established organisational procedures, based on ADS file naming guidance, and include version control management.

Quality Assurance

Instruments used in the collection of data are calibrated prior to use and checked to ensure they are in full working order.
All site records and data collected will be reviewed during project delivery to ensure data is accurate and secure.
Data collection and management are reviewed regularly as part of the organisational Quality Policy (SHEQ-Q-C03 Quality ManualV3.2). This includes a review of internal project folders to ensure our organisational data management standards are being met.

Section 3: Documentation and metadata

What documentation and metadata will accompany the data?

Data collected will include standard formats which maximise opportunities for use and reuse in the future.
A Collection Level Metadata Summary is included in all standard archaeological projects and will be completed as the project is delivered. A working copy will be kept on the organisational server in the Project Folder. The Collection Level Metadata Summary brings together the overarching project details and includes a register of data types and number of objects included in the archive, along with all other archive components.
Metadata tables for each data type will be populated as the project progresses and will use the standard format for each data type as recommended by ADS, who are the intended repository for the digital data archive.

Full metadata as required by the ADS when depositing will be created.

Section 4: Ethics and legal compliance

How will you manage any ethical, copyright and Intellectual Property Rights (IPR) issues?
Copyright will be retained by Headland Archaeology (UK) Ltd. Headland will licence the client and other bodies as necessary for use in matters relating to the project and for use of the project archive by the relevant museum. This licence will also extend to non-commercial use.

Section 5: Data Security: Storage and Backup

How will the data be stored, accessed and backed up during the research?
Headland Archaeology IT is managed by an external data management provider, who is also responsible for the management and verification of our daily back-ups and who supports access to security copies as needed. Data is backed up to Cloud based services daily.

Section 6: Selection and Preservation

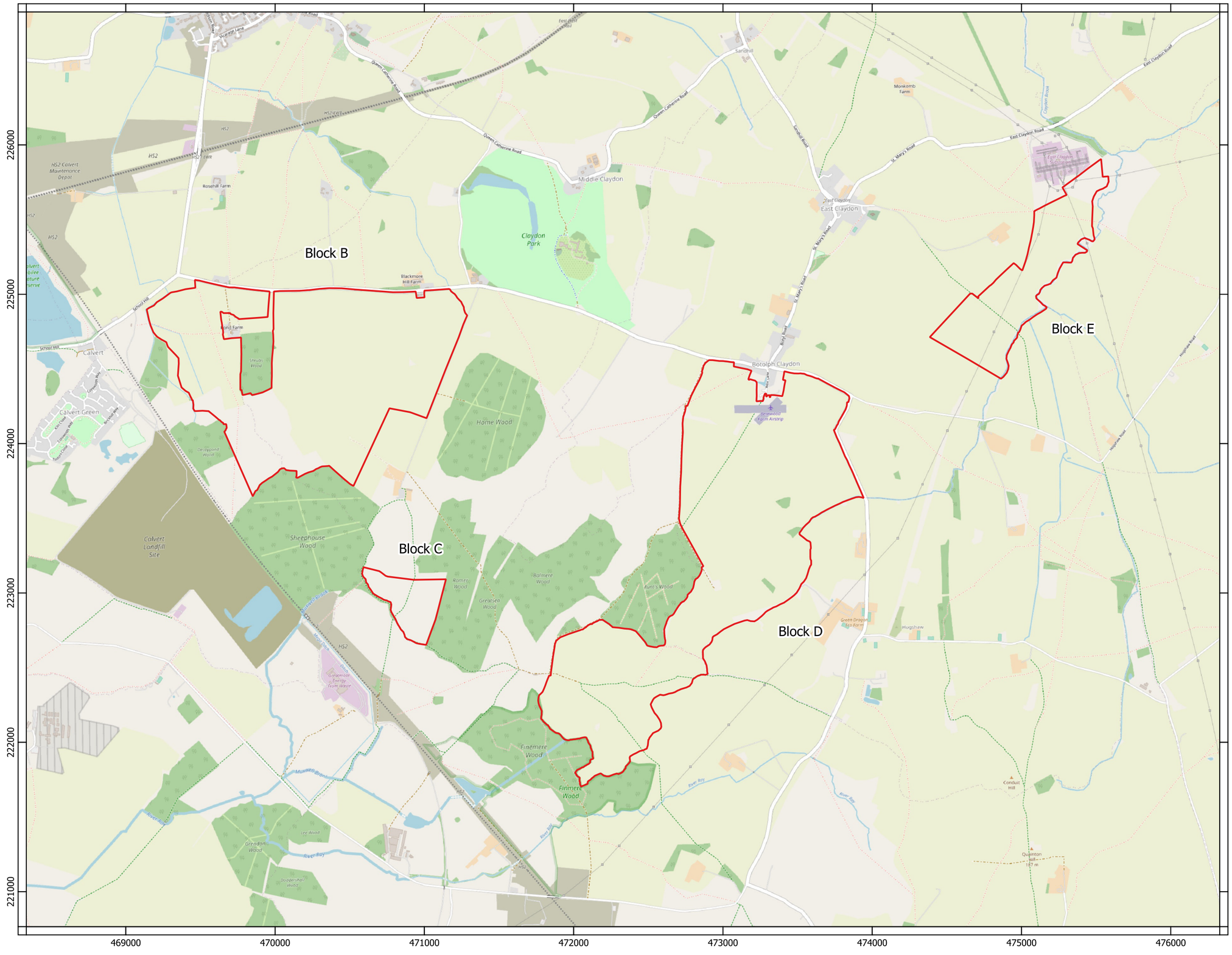
Which data should be retained, shared, and/or preserved?
Data that is required to be archived will be retained when the project is complete. The data archive will be ordered, with files named and structured in a logical manner, and accompanied by relevant documentation and metadata
What is the long-term preservation plan for the dataset?
The digital archive will be deposited with the Archaeology Data Service, which is a certified repository with Core Trust Seal. The cost of which is unknown until the final archive is created.
Have you contacted the data repository?
No - quantity of data currently unknown Headland Archaeology regularly archive geophysical surveys with the ADS, following the standard procedures.
Have the costs of archiving been fully considered?
Yes – but quantity of data currently unknown

Section 7: Data Sharing

How will you share the data and make it accessible?
A summary of the project will be included on the OASIS Index of Archaeological Investigation and the museum and digital archive repository and will be updated when the project has finished. The final report is expected to be completed within 12 months of the completion of fieldwork. The location (s) of the final Archaeological Archive will be added to OASIS when appropriate. The ADS will disseminate the digital elements of the Archaeological Archive online under a creative commons licence and the dataset will receive a unique identifier (DOI).
Are any restrictions on data sharing required?
A temporary embargo may be required on the sharing of the project results to the wider public. Once the project is in the public domain the embargo will be removed.

Section 8: Responsibilities

Who will be responsible for implementing the data management plan?
The Project Manager will be responsible for implementing the DMP. Data capture, metadata production and data quality is the responsibility of the Project Team, assured by the Project Manager. Storage and backup of data in the field is the responsibility of the field team. Once data is incorporated into the project server, storage and backup is managed by an external company. Data archiving is undertaken by the project team



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Annex 2: Magnetometer Survey

ANNEX 2 MAGNETOMETER SURVEY

Magnetic susceptibility and soil magnetism

Iron makes up about 6% of the earth's crust and is mostly present in soils and rocks as minerals such as maghaemite and haematite. These minerals have a weak, measurable magnetic property termed magnetic susceptibility. Human activities can redistribute these minerals and change (enhance) others into more magnetic forms so that by measuring the magnetic susceptibility of the topsoil, areas where human occupation or settlement has occurred can be identified by virtue of the attendant increase (enhancement) in magnetic susceptibility. If the enhanced material subsequently comes to fill features, such as ditches or pits, localised isolated and linear magnetic anomalies can result whose presence can be detected by a magnetometer (fluxgate gradiometer).

In general, it is the contrast between the magnetic susceptibility of deposits filling cut features, such as ditches or pits, and the magnetic susceptibility of the topsoil, subsoil, and rock, into which these features have been cut, which causes the most recognisable responses. This is primarily because there is a tendency for magnetic ferrous compounds to become concentrated in the topsoil, thereby making it more magnetic than the subsoil or the bedrock. Linear features cut into the subsoil or geology, such as ditches, that have been silted up or have been backfilled with topsoil will therefore usually produce a positive magnetic response relative to the background soil levels. Discrete feature, such as pits, can also be detected.

The magnetic susceptibility of a soil can also be enhanced by the application of heat. This effect can lead to the detection of features such as hearths, kilns, or areas of burning.

Types of magnetic anomaly

In most instances anomalies are termed 'positive'. This means that they have a positive magnetic value relative to the magnetic background on any given site. However, some features can manifest themselves as 'negative' anomalies that, conversely, means that the response is negative relative to the mean magnetic background.

Where it is not possible to give a probable cause of an observed anomaly a '?' is appended.

It should be noted that anomalies interpreted as modern in origin might be caused by features that are present in the topsoil or upper layers of the subsoil. Removal of soil to an archaeological or natural layer can therefore remove the feature causing the anomaly.

The types of response mentioned above can be divided into five main categories that are used in the graphical interpretation of the magnetic data:

Isolated dipolar anomalies (iron spikes)

These responses are typically caused by ferrous material either on the surface or in the topsoil. They cause a rapid variation in the magnetic response giving a characteristic 'spiky' trace. Although ferrous archaeological artefacts could produce this type of response, unless there is supporting evidence for an archaeological interpretation, little emphasis is normally given to such anomalies, as modern ferrous objects are common on rural sites, often being introduced into the topsoil during manuring.

Areas of magnetic disturbance

These responses can have several causes often being associated with burnt material, such as slag waste or brick rubble or other strongly magnetised/fired material. Ferrous structures such as pylons, mesh or barbed wire and buried pipes can also cause the same disturbed response. A modern origin is usually assumed unless there is other supporting information.

Lightning-induced remnant magnetisation (LIRM)

LIRM anomalies are thought to be caused in the near surface soil horizons by the flow of an electrical current associated with lightning strikes. These observed anomalies have a strong bipolar signal which decreases with distance from the spike point and often appear as linear or radial in shape.

Linear trend

This is usually a weak or broad linear anomaly of unknown cause or date. These anomalies are often caused by agricultural activity, either ploughing or land drains being a common cause.

Areas of magnetic enhancement/positive isolated anomalies

Areas of enhanced response are characterised by a general increase in the magnetic background over a localised area whilst discrete anomalies are manifest by an increased response (sometimes only visible on an XY trace plot) on two or three successive traverses. In neither instance is there the intense dipolar response characteristic exhibited by an area of magnetic disturbance or of an 'iron spike' anomaly (see above). These anomalies can be caused by infilled discrete archaeological features such as pits or post-holes or by kilns. They can also be caused by pedological variations or by natural infilled features on certain geologies. Ferrous material in the subsoil can also give a similar response. It can often therefore be very difficult to establish an anthropogenic origin without intrusive investigation or other supporting information.

Linear and curvilinear anomalies

Such anomalies have a variety of origins. They may be caused by agricultural practice (recent ploughing trends, earlier ridge and furrow regimes or land drains),

natural geomorphological features such as palaeochannels or by infilled archaeological ditches.

Annex 3: Survey Location Information

ANNEX 3 SURVEY LOCATION INFORMATION

An initial survey base station was established using a Trimble VRS differential Global Positioning System (dGPS). The magnetometer data was georeferenced using a Trimble RTK differential Global Positioning System (Trimble R10 model).

Temporary sight markers were laid out using a Trimble VRS differential Global Positioning System (Trimble R8s model) to guide the operator and ensure full coverage. The accuracy of this dGPS equipment is better than 0.01m.

The survey data were then super-imposed onto a base map provided by the client to produce the displayed block locations. However, it should be noted that Ordnance Survey positional accuracy for digital map data has an error of 0.5m for urban and floodplain areas, 1.0m for rural areas and 2.5m for mountain and moorland areas. This potential error must be considered if coordinates are measured off hard copies of the mapping rather than using the digital coordinates.

Headland Archaeology cannot accept responsibility for errors of fact or opinion resulting from data supplied by a third party.

Annex 4: Geophysical Survey Archive

ANNEX 4 GEOPHYSICAL SURVEY ARCHIVE

The geophysical archive comprises an archive disk containing the raw data in XYZ format, a raster image of each greyscale plot with associate world file, and a PDF of the report.

The project will be archived in-house in accordance with recent good practice guidelines (http://guides.archaeologydataservice.ac.uk/g2gp/Geophysics_3). The data will be stored in an indexed archive and migrated to new formats when necessary.

Annex 5: Data Processing

ANNEX 5 DATA PROCESSING

The gradiometer data has been presented in this report in processed greyscale and minimally processed XY trace plot format.

Data collected using RTK GPS-based methods cannot be produced without minimal processing of the data. The minimally processed data has been interpolated to project the data onto a regular grid and de-striped to correct for slight variations in instrument calibration drift and any other artificial data.

A high pass filter has been applied to the greyscale plots to remove low frequency anomalies (relating to survey tracks and modern agricultural features) to maximise the clarity and interpretability of the archaeological anomalies.

The data has also been clipped to remove extreme values and to improve data contrast.

Annex 6: Oasis Archive

OASIS Summary for headland1-535947

OASIS ID (UID)	headland1-535947
Project Name	Geophysical Magnetometry Survey at Rosefield Solar Farm
Sitename	Rosefield Solar Farm
Sitecode	RSFB23
Project Identifier(s)	P23-148
Activity type	Geophysical Survey, Magnetometry Survey, MAGNETOMETRY SURVEY
Planning Id	
Reason For Investigation	Planning requirement
Organisation Responsible for work	Headland Archaeology (UK) Ltd
Project Dates	03-Sep-2023 - 28-Feb-2025
Location	Rosefield Solar Farm NGR : SP 72356 24080 LL : 51.91056788914066, -0.949550175235037 12 Fig : 472356,224080
Administrative Areas	Country : England County/Local Authority : Buckinghamshire Local Authority District : Buckinghamshire Parish : Grendon Underwood Parish : Calvert Green Parish : Granborough Parish : Winslow Parish : East Claydon Parish : Hogshaw Parish : Middle Claydon Parish : Quainton Parish : Steeple Claydon

Project Methodology	The survey was undertaken using Four Bartington Grad601 sensors mounted at 1metre (m) intervals (1m traverse interval) onto a rigid frame. The system was programmed to take readings at a frequency of 10Hz (allowing for a 10-15 centimetre (cm)m sample interval) on roaming traverses (swaths) 4m apart. These readings were stored on an external weatherproof laptop and later downloaded for processing and interpretation. The system was linked to a Trimble R12 Real Time Kinetic (RTK) differential Global Positioning System (dGPS) outputting in NMEA mode to ensure a high positional accuracy for each data point. Hand carried survey was also undertaken using four and five sensor arrays deploying Sensys FGM650/10 sensors mounted at 1m intervals (1m traverse interval) onto a rigid frame. The system was programmed to take readings at a frequency of 100Hz (allowing for a 1-2cm sample interval) on roaming traverses (swaths) 4m apart. These readings were stored on an external weatherproof laptop and later downloaded for processing and interpretation. The system was linked to a Leica GS18 Real Time Kinetic (RTK) differential Global Positioning System (dGPS) outputting in NMEA mode to ensure a high positional accuracy for each data point. MonMX (Sensys Ltd) software was used to collect and export the data. MLGrad601 and MultiGrad601 (Geomar Software Inc.) and DATAMONITOR 4 (Institut Dr. Foerster GmbH & Co. KG) software was used to collect and export the data. Anomaly GeoSurvey v1.12.3 (Lichenstone Geoscience) and QGIS v.3.28.5 software was used to process and present the data respectively.

Project Results	The geophysical survey has identified 14 areas of archaeological activity (AAA's) in four separate and clearly defined parts of the Site. In the west of the Site , in Block B, two groups of enclosures approximately 0.4 kilometres (km) apart have been identified on the high ground of Knowl Hill (AAA1 and AAA2). Just over 1 km further east in Block F (AAA3) a large rectilinear enclosure complex clearly indicative of settlement activity and covering over 5 hectares (ha) has been recorded: the settlement likely continues to the west and south beyond the Site boundary. A further kilometre east in Block D two enclosures, a trackway and two ring ditch features have been recorded (AAA4) although this area is part of a wider parcel of land no longer included within the proposed development area. The archaeological potential of these three AAA's is assessed as high. The final, and most extensive area of archaeological activity, is in the north-eastern corner of the Site in Block E where clusters of features have been identified bordering Claydon Brook and/or adjacent to the postulated line of the Roman road that links Akeman Street at Fleet Marston and Thornborough (AAA5 to AAA14 inclusive). No evidence for the road specifically has been recorded by the survey although its presence is given further credence by the concentration of activity recorded in the north-eastern corner of Block E and by records of Roman findspot concentrations recorded through fieldwalking 0.5 km to the south. The features in Block E are again indicative of enclosure and occupational activity and together with the results of an earlier geophysical survey and trial trenching indicate that the archaeological potential of the north-eastern part of the site in Block E is high to very high. Other individual features, such as ring ditches and isolated enclosures have also been identified by the survey and there are also other disparate anomalies in all blocks that have been classified as of uncertain origin where there is no morphology or pattern suggestive of any significant activity but for which an archaeological origin cannot be dismissed. The archaeological potential in and around these anomalies/features is assessed as moderate. Several areas of medieval or post-medieval ridge and furrow ploughing have also been recorded across all the survey areas. Other non-archaeological anomalies, including those caused by recent agricultural activity such as modern ploughing, land drainage, hedgerow removal and the infilling of former ponds are ubiquitous. Several service pipes are identified and numerous anomalies due to variation in the bedrock, superficial deposits and soils are also noted. In these areas where no anomalies of obvious or possible archaeological origin have been recorded (most of the Site) the archaeological potential is assessed as low. It should, however, be stated that the bedrock mudstone geology may not be particularly conducive for clear results, and this may explain the low magnitude and discontinuous nature of some of the anomalies. Consequently, it is considered possible that there may be archaeological features present (particularly those that may be small, shallow or discrete) that could not be detected by the survey, although it is considered likely that the location and extent of any settlement activity has been identified by the survey.
Keywords	Ditched Enclosure - UNCERTAIN - FISH Thesaurus of Monument Types Ring Ditch - UNCERTAIN - FISH Thesaurus of Monument Types Ridge And Furrow - UNCERTAIN - FISH Thesaurus of Monument Types Field System - UNCERTAIN - FISH Thesaurus of Monument Types Trackway - UNCERTAIN - FISH Thesaurus of Monument Types Pit - UNCERTAIN - FISH Thesaurus of Monument Types Ditch - UNCERTAIN - FISH Thesaurus of Monument Types
Funder	Private or public corporation Rosefield Energy Farm Ltd

HER	Buckinghamshire HER - unRev - STANDARD
Person Responsible for work	Peter Turner
HER Identifiers	
Archives	

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Rosefield
Solar Farm

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Planning Inspectorate Scheme Ref: EN010158