Geophysical Survey Report

Bloys Grove Solar Farm

Swainsthorpe

For

Orion Heritage

On Behalf Of

EDF

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Abstract

Magnitude Surveys was commissioned to assess the subsurface archaeological potential of a c. 80.49ha area of land at Bloys Grove Solar Farm, Swainsthorpe, Norfolk. A fluxgate gradiometer survey was successfully completed, although c. 9.5ha could not be surveyed due to poor ground conditions. A series of probable enclosures, flanked by two possible trackways and containing anomalies indicative of internal features (such as pits and subdivisions), have been detected; these are considered likely to form part of the deserted medieval settlement at Kenningham. The survey also identified possible small kilns and raw material extraction of unknown date. Post-medieval agricultural activity is indicated by anomalies related to multiple former field boundaries, modern ploughing regimes and land drainage. Across the survey area, additional weak linear/curvilinear and discrete anomalies potentially indicate further cut archaeological features, although their origins remain uncertain as they exhibit little contrast with the magnetic background, which is influenced across the survey area by geological variation and the effects of modern agriculture. The impact of magnetic disturbance from modern activity is largely limited to field perimeters, although a line of power cables and a subsurface service introduce interference across the centre of the survey area.

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1. Introduction

1.1. Magnitude Surveys Ltd (MS) was commissioned by Orion Heritage on behalf of EDF to undertake a geophysical survey over a c. 80.49ha area of land at Bloys Grove Solar Farm, Swainsthorpe, Norfolk (TM210998).

1.2. The geophysical survey comprised quad-towed cart-mounted and hand-carried GNSS-positioned fluxgate gradiometer survey. Magnetic survey is the standard primary geophysical method for archaeological applications in the UK due to its ability to detect a range of different features. The technique is particularly suited for detecting fired or magnetically enhanced features, such as ditches, pits, kilns, sunken featured buildings (SFBs) and industrial activity (David *et al*., 2008).

1.3. The survey was conducted in line with the current best practice guidelines produced by Historic England (David *et al*., 2008), the Chartered Institute for Archaeologists (CIfA, 2020) and the European Archaeological Council (Schmidt *et al.,* 2015).

1.4. It was conducted in line with a WSI produced by MS (Swinbank, 2021).

1.5. The survey commenced on 22nd February 2021 and took 10 days to complete.

2. Quality Assurance

2.1. Magnitude Surveys is a Registered Organisation of the Chartered Institute for Archaeologists (CIfA), the chartered UK body for archaeologists, and a corporate member of ISAP (International Society for Archaeological Prospection).

2.2. The directors of MS are involved in cutting edge research and the development of guidance/policy. Specifically, Dr Chrys Harris has a PhD in archaeological geophysics from the University of Bradford, is a Member of CIfA and 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, is a Fellow of the Society of Antiquaries of London, 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, field and office staff have degree qualifications relevant to archaeology or geophysics and/or field experience.

3. Objectives

3.1. The objective of this geophysical survey was to assess the subsurface archaeological potential of the survey area.

4. Geographic Background

4.1. The survey area was centred c. 1km southwest of Swainsthorpe (Figure 1). Gradiometer survey was undertaken across multiple contiguous fields, predominantly under arable cultivation. The survey area was surrounded by further agricultural land, with a railway line forming the eastern boundary; it was bisected by Brickkiln Lane and an additional (unnamed) road (Figure 2). Due to poor ground conditions a total of c. 9.5ha could not be surveyed.

4.2. Survey considerations:

Survey Area	Ground Conditions	Further Notes
1	Arable field with wheat crop. Sloped gently down to the south and east.	Bounded by a discontinuous hedgerow to the north, northwest and south, by a line of young trees and a track to the east, by a wire fence and track to the south, and by a strip of unharvested crop and a stand of trees to the west. Overhead cables ran NE-SW across the western half, with pylons located on the northern and southern boundaries.
2	Arable field with stubble, and tall dry vegetation in the central third. Sloped gently down to the southwest.	Bounded by a discontinuous hedgerow, wire fence and railway line to the east, by established trees to the north and south, and by a line of young trees to the west.
3	Arable field with wheat crop. Sloped gently down into the centre from the north and south.	Bounded by a discontinuous hedgerow to the north, west and south, with an additional track along the western boundary and unnamed road along the southern boundary; bounded by a wire fence and steep bank to the railway line to the east.
4	Pasture field. Sloped gently down from the northwest corner.	Bounded by a hedgerow to the north, hedgerow and wire fence to the east, a drainage ditch to the south and an electric fence to the west. The railway line ran immediately outside the eastern boundary. Overhead cables ran NE-SW, with a pylon located in the centre-west.
5	Pasture field. Sloped gently down from the centre towards the east, west and south.	Bounded on all sides by an electric fence, with additional hedgerows to the north, west and south. Brickkiln Lane ran along the northern boundary and an unnamed road ran along the western boundary. Overhead cables ran NE-SW, with a pylon in the centre of the area.
6	Arable field with sugar beet crop. Sloped gently down to the east.	Bounded to the north, east and south by a discontinuous hedgerow, and to the west by an unnamed road. The railway line ran immediately outside the eastern boundary. Overhead cables ran NE-SW across the western end. Dense crop prevented survey of a small area on the eastern boundary, and a small stand of trees (with a metal drain) was located towards the eastern end of the area.

7	Flat arable field with young sugar beet crop.	Bounded on all sides by a discontinuous hedgerow, with a wire fence and steep bank to the railway line to the southeast, and an unnamed road to the southwest.
8	Arable field with stubble. Sloped gently down to the south and southeast.	Bounded by discontinuous hedgerows to the west (with an electric fence along the extreme western portion), by tracks to the northeast and east, and by Brickkiln Lane to the south. A stand of trees is located on the northern boundary. A square ditch and manure piles prevented the survey of small areas close to the southern boundary. Overhead cables ran NE-SW, with a pylon in the centre of the area.
9	Arable field with young bean crop. Sloped gently down to the south.	Bounded by a discontinuous hedgerow and track to the north and west, by a hedgerow to the south, and by a wire fence and steep bank to the railway line to the east.
10	Arable field with young wheat crop. Sloped down to the southeast.	Bounded by a track to the west and by hedgerows on all other sides. An unnamed road ran along the eastern boundary, and a drainage ditch along the southern edge. Overhead cables ran NE-SW, with a pylon in the centre-east of the area. The south-eastern corner and a small area in the north-eastern corner were unsurveyable due to deep plough furrows.
11		Not surveyable due to poor ground conditions.

4.3. The underlying geology comprises undifferentiated chalk of the Lewes Nodular, Seaford, Newhaven, Culver and Portsdown Chalk Formations. Superficial deposits consist of Lowestoft Formation diamicton across the survey area, with patches of sand and gravel of the Sheringham Cliffs and Happisburgh Glacigenic Formations in the north (British Geological Survey, 2021).

4.4. The soils consist of slightly acidic loamy and clayey soils with impeded drainage (Soilscapes, 2021).

5. Archaeological Background

5.1. The following is a summary of a Historic Environment Desk-Based Assessment produced and provided by Orion Heritage, relating to the survey area and a 1km buffer zone (Redclift, 2021).

5.2. Fieldwalking within the survey area has recovered prehistoric flint flakes and Neolithic worked flints, while a Neolithic/Early Bronze Age polished flint axe head was found c. 220m east of the survey location. Geophysical survey and trial trenching on land to the immediate southwest of the survey area identified a 'substantial' enclosure dated on morphological grounds to the Middle Bronze Age, which contained Late Bronze/Early Iron Age pottery in the upper fills, but provided little evidence for later activity in this location (despite the proximity of the deserted medieval settlement at Kenningham).

5.3. Possible Roman activity on the site is represented by pot fragments found during field walking, and six Roman coins and a brooch recovered by metal detecting. The line of the Roman Pye Road passes c. 400 – 600m east of the eastern survey boundary and various crop marks suggest possible Iron Age or Romano-British activity (based on typology and finds). A Roman field system and pits have been excavated c. 920m north of the northern survey boundary, with pottery suggesting a 3rd-4th century focus of occupation.

5.4. The findspot of a Late Saxon brooch is recorded as the centre-north of the survey area, with a small number of other Middle and Late Saxon finds recovered by metal detectorists around Newton Flotman (c. 800m south of the survey area) and Swainsthorpe (c. 300m northeast); Swainsthorpe church contains Early Medieval elements in its nave and tower.

5.5. Fieldwalking has recovered medieval pottery sherds, brick and copper alloy vessel fragments from across the survey area. The deserted medieval settlement of Kenningham lies directly west of the area, and is partially visible as earthworks, although its full extent is not currently known. Its church is recorded in the Domesday survey, but it was demolished before the Reformation.

5.6. Map regression suggests the survey area formed part of the agricultural hinterlands of nearby settlements throughout the Post-Medieval period, with various minor field boundary changes occurring over the nineteenth and twentieth centuries. Fieldwalking finds from this period include pottery, clay pipe and CBM. The Eastern Union Railway Norwich to London railway line, built in the mid-19th century, lies immediately outside the eastern boundary of the survey area.

6. Methodology

6.1. Data Collection

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

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

6.1.3. Table of survey strategies:

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

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

6.1.4.1. MS' cart and hand-carried system comprised Bartington Instruments Grad 13 Digital Three-Axis Gradiometers. Positional referencing was through a multi-channel, multi-constellation GNSS Smart Antenna RTK GPS outputting in NMEA mode to ensure high positional accuracy of collected measurements. The RTK GPS is accurate to 0.008m + 1ppm in the horizontal and 0.015m + 1ppm in the vertical.

6.1.4.2. Magnetic and GPS data were stored on an SD card within MS' bespoke datalogger. The datalogger was continuously synced, via an in-field Wi-Fi unit, to servers within MS' offices. This allowed for data collection, processing and visualisation to be monitored in real-time as fieldwork was ongoing.

6.1.4.3. A navigation system was integrated with the RTK GPS, which was used to guide the surveyor. Data were collected by traversing the survey area along the longest possible lines, ensuring efficient collection and processing.

Data Processing

6.1.5. Magnetic data were processed in bespoke in-house software produced by MS. Processing steps conform to the EAC and Historic England guidelines for 'minimally enhanced data' (see Section 3.8 in Schmidt *et al.*, 2015: 33 and Section IV.2 in David *et al.,* 2008: 11).

Sensor Calibration – The sensors were calibrated using a bespoke in-house algorithm, which conforms to Olsen *et al*. (2003).

Zero Median Traverse – The median of each sensor traverse is calculated within a specified range and subtracted from the collected data. This removes striping effects caused by small variations in sensor electronics.

Projection to a Regular Grid – Data collected using RTK GPS positioning requires a uniform grid projection to visualise data. Data are rotated to best fit an orthogonal grid projection and are resampled onto the grid using an inverse distance-weighting algorithm.

Interpolation to Square Pixels – Data are interpolated using a bicubic algorithm to increase the pixel density between sensor traverses. This produces images with square pixels for ease of visualisation.

6.2.Data Visualisation and Interpretation

6.2.1. This report presents the gradient of the sensors' total field data as greyscale images, as well as the total field data from the lower sensors. The gradient of the sensors minimises external interferences and reduces the blown-out responses from ferrous and other high contrast material. However, the contrast of weak or ephemeral anomalies can be reduced through the process of calculating the gradient. Consequently, some features can be clearer in the respective gradient or total field datasets. Multiple greyscale images of the gradient and total field at different plotting ranges have been used for data interpretation. Greyscale images should be viewed alongside the XY trace plots. XY trace plots visualise the magnitude and form of the geophysical response, aiding anomaly interpretation.

6.2.2. Geophysical results have been interpreted using greyscale images and XY traces in a layered environment, overlaid against open street maps, satellite imagery, historical maps, LiDAR data, and soil and geology maps. Google Earth (2021) was also consulted, to compare the results with recent land use.

6.2.3. Geodetic position of results – All vector and raster data have been projected into OSGB36 (ESPG27700) and can be provided upon request in ESRI Shapefile (.SHP) and Geotiff (.TIF) respectively. Figures are provided with raster and vector data projected against OS Open Data.

7. Results

7.1. Qualification

7.1.1. Geophysical results are not a map of the ground and are instead a direct measurement of subsurface properties. Detecting and mapping features requires that said features have properties that can be measured by the chosen technique(s) and that these properties have sufficient contrast with the background to be identifiable. The interpretation of any identified anomalies is inherently subjective. While the scrutiny of the results is undertaken by qualified, experienced individuals and rigorously checked for quality and consistency, it is often not possible to classify all anomaly sources. Where possible, an anomaly source will be identified along with the certainty of the interpretation. The only way to improve the interpretation of results is through a process of comparing excavated results with the geophysical reports. MS actively seek feedback on their reports, as well as reports from further work, in order to constantly improve our knowledge and service.

7.2. Discussion

7.2.1. The geophysical results are presented in combination with satellite imagery and historical maps (Figures 4 & 6).

7.2.2. The gradiometer survey was successfully carried out over c. 70.99ha; 9.5ha could not be surveyed due to poor ground conditions and dense crop. The survey has detected probable archaeological features likely to be associated with the deserted medieval settlement at Kenningham, as well as clusters of possible kilns and extraction pits of unknown date. Additional weak linear/curvilinear and discrete anomalies may indicate further archaeological features, although their origin cannot be confidently identified. The survey also detected geological variation and post-medieval agricultural activity.

7.2.3. In general, the survey data demonstrate a moderately 'quiet' magnetic background, with strong interference from modern activity largely confined to field perimeters. However, a line of overhead cables runs northeast-southwest across the survey area: five pylons are located within or on the survey boundary and cause significant local interference, while the effect of the power cables is visible as a band of dense speckling. Both elements may prevent the identification of weaker anomalies in these areas. A subsurface service has been detected running across Area 8, with a similar consequence (Figure 4). It should be noted that, apart from these areas of strong magnetic interference, the majority of anomalies exhibit only minimal magnetic contrast with their surroundings. The degree of relative magnetic enhancement of a feature will be influenced by a variety of factors, including the nature of the underlying geology and intensity of human occupation; the confident recognition of anomalies of archaeological origin has been complicated in this case by their similarity (of strength, scale, morphology and orientation) to 'background' anomalies, in particular those caused by superficial geology and modern agriculture (see Sections 7.2.7 and 7.2.8).

7.2.4. In the southwest of the survey area (Area 10), a group of anomalies indicate a probable series of rectilinear enclosures and associated discrete cut features (Figure 6). It is likely that these features form part of the deserted medieval settlement recorded at Kenningham (see Section 5.5). Nineteenth-century mapping marks the locations of a

former church and Kenningham Hall on the higher ground of the valley side, c. 150m and 330m west of the survey boundary respectively. Possible earthwork remains are discernible in LiDAR data and on satellite imagery extending towards the survey area, although none are visible within Area 10 itself. While it is noted that a 'substantial' Bronze Age enclosure is also recorded at the solar farm west of Area 10 (see Section 5.2), the morphology and layout of the geophysical anomalies suggest a toft and croft-type arrangement, with parallel plot divisions and narrow double-ditched access routes located the north and south. Each 'plot' contains multiple discrete anomalies. Weaker and more fragmentary anomalies may indicate a continuation of activity to the east of the modern road (Area 6), however, these are less distinct and the full extent of any activity here remains uncertain.

7.2.5. In the fields to the north and south of Brickkiln Lane (Areas 5, 8 and 9), a number of discrete anomalies have been interpreted as relating to possible kilns (i.e. pottery/CBM or limekilns) or similar *in situ* high temperature burning. These anomalies have been identified from their relatively high magnitude and distinctive form (visible in the XY trace plots) (Figures 9, 15 and 21). The feasibility of this explanation is reinforced by their location on till deposits that have previously been successfully exploited - as evidenced by the road name Brickkiln Lane (Figure 6), which leads to a brickworks marked on late 19th-/early 20th-century mapping (see Sections 4.3 and Figure 6). Discrete anomalies nearby may relate to associated auxiliary structures or pits.

7.2.6. The possibility that the anomalies relate to kilns is further supported by their location in close proximity to multiple anomalies that are likely to relate to disused (backfilled) extraction pits. Numerous extant examples of such features are present across the survey area and its surrounding, as recorded on historical maps, visible in satellite imagery/LiDAR data, and noted on the ground at the time of survey. The majority of these anomalies show limited magnetic enhancement and are likely to have been backfilled with local material, although a concentration of strong magnetic anomalies (Area 2) may indicate the location of a similar pit that has been backfilled with ferrous debris (Figure 4). While a backfilled chalk or clay pit is very similar, in geophysical terms, to a backfilled natural depression or dissolution feature, the Possible Extraction category has been used to highlight those that are more regular in shape, have more clearly defined edges and/or are comparatively isolated from broader areas of geological variation.

7.2.7. The results support historical mapping evidence for the agricultural use of the survey area over recent centuries (see Section 5.6). A number of former field boundaries have been detected, the locations of which correspond closely to those marked on OS and tithe maps (Redclift, 2021). Additional linear anomalies, with similar magnetic form, are likely to indicate unmapped boundaries (see Section 7.3.2.8); while their origin is undatable from the magnetic data, most fit well in the general pattern of the post-medieval boundaries. The detection of multiple ploughing regimes in most areas has hindered interpretation in places, where these trends have contributed to background 'texture' against which very weak archaeological anomalies have little contrast. The prevalence of these anomalies may also suggest the possibility of plough damage to subsurface features, in which case

apparently discrete magnetic anomalies may relate to truncated parts of larger features (e.g. Area 10).

7.2.8. Geological and pedological variations are particularly noticeable as sinuous bands of enhancement, many of which correlate with slight depressions and possible former drainage channels in the undulating landscape. A widespread 'speckled' effect is also attributable to the natural background and is characteristic of the glaciofluvial superficial deposits in this area (see Section 4.3) that typically contain unsorted materials and inclusions with contrasting magnetic properties. Probable fissuring and dissolution of the underlying chalk has been detected across large parts of the survey area and is manifest as a faintly discernible reticulated pattern. It should be noted that many of these anomalies are very similar to anthropogenic anomalies that could reasonably be anticipated in this area, hence the use of the Undetermined classification where necessary.

7.3.Interpretation

7.3.1. General Statements

7.3.1.1. Geophysical anomalies will be discussed broadly as classification types across the survey area. Only anomalies that are distinctive or unusual will be discussed individually.

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

7.3.1.3. **Ferrous/Debris (Spread)** – A ferrous/debris spread refers to a concentration of multiple discrete, dipolar anomalies usually resulting from highly magnetic material such as rubble containing ceramic building materials and ferrous rubbish.

7.3.1.4. **Magnetic Disturbance** – The strong anomalies produced by extant metallic structures, typically including fencing, pylons, vehicles and service pipes, have been classified as 'Magnetic Disturbance'. These magnetic 'haloes' will obscure weaker anomalies relating to nearby features, should they be present, often over a greater footprint than the structure causing them.

7.3.1.5. **Undetermined** – Anomalies are classified as Undetermined when the origin of the geophysical anomaly is ambiguous and there is no supporting contextual evidence to justify a more certain classification. These anomalies are likely to be the result of geological, pedological or agricultural processes, although an archaeological origin cannot be entirely ruled out. Undetermined anomalies are generally distinct from those caused by ferrous sources.

7.3.2. Magnetic Results - Specific Anomalies

7.3.2.1. **Probable/Possible Archaeology (Strong/Weak) Area 10: Possible Deserted Medieval Settlement** – This group of anomalies (extending over c. 0.95ha) is located in the northern half of Area 10 and consists of linear and discrete anomalies typical of those caused by cut features such as ditches and pits with magnetically enhanced fill (Figures 19-21). Two possible tracks or boundaries,

running east-west, are suggested by pairs of parallel linear anomalies (each pair c. 4-8m wide). These 'tracks' are c. 48m apart at the western end, widening to c. 60m apart in the east. Although their western end is partially obscured by magnetic interference, they may extend beyond the survey boundary, perhaps tying into extant field boundaries. It is not clear how they relate to boundaries marked on the 1818 Ordnance Surveyors Drawing in this approximate location (Redclift, 2021: fig. 6).

7.3.2.2. **Probable/Possible Archaeology (Strong/Weak) Area 10** - The area between the 'tracks' appears to be divided into at least four parallel plots, although the potential dividing anomalies are only discernible across the southern two-thirds of this distance and it is uncertain whether this corresponds with their original extent or reflects later subsurface damage. While it is not possible to determine phasing from the data, one of the north-south linear anomalies may form a continuation of a linear anomaly that reappears more clearly south of [**10a**] (Figure 20), where it appears to relate to an unmapped field boundary (given its straightness and orientation). The anomaly located north of [**10a**] is categorised as Possible (rather than Probable) Archaeology to account for this difference in confidence. A number of anomalies suggestive of additional internal divisions have been identified, although a closer interpretation is made difficult by the impact of later ploughing in the area. Similarly, while many of the discrete subcircular anomalies are likely to relate to individual features, the degree of plough truncation is unknown.

7.3.2.3. **Possible Archaeology (Weak) Areas 10 and 6** – To the north and northeast of the probable archaeology detected in Area 10, a number of narrow, weak linear anomalies have been identified that may indicate the extension of associated subsurface features into these areas ([**10b**] and [**6a**]) (Figures 19-24). These anomalies are considerably weaker than those in the 'main' area of occupation (and further obscured by the effect of the overhead power lines), and a geological or agricultural origin cannot be ruled out. However, given the limited magnetic enhancement seen across much of the survey area, they may also be consistent with additional archaeological features. A penannular anomaly with a diameter of c. 15m is located on the northern edge of Area 10 [**10c**]. It is possible that this indicates a circular feature (such as a ring ditch or stackstand), although it is notable that it has its similar dimensions to those of a large circular anomaly interpreted as a natural dissolution feature c. 225m to the southwest (Figure 20).

7.3.2.4. **Possible Archaeology (Strong/Weak) Area 8** – To the north of Brickkiln Lane, two clusters of discrete subcircular anomalies c. 2-4m in diameter have been identified from the greyscales and XY trace plots ([**8a**] and [**8b**]) (Figures 13-15). While it is possible that they result from buried ferrous debris or particularly concentrated natural ferrous mineralisation, the form of the stronger magnetic responses in these clusters, together with their distribution and spatial association with possible extraction pits (see Section 7.3.2.7), suggest they may indicate high temperature craft/industrial work, specifically clamp-type kilns or

similar, that have retained a thermoremanent magnetism. At [**8a**], one such anomaly could indicate lime or clay processing activity within the outline of a possible extraction pit (although it may also be explained by ferrous debris within the fill material). Weaker anomalies in the clusters may relate to associated features (e.g. storage pits or preparation floors) or deposits (e.g. burnt material or waster dumps).

7.3.2.5. **Possible Archaeology (Strong) Area 9** – In the southwest of Area 9, [**9a**], an isolated, relatively strong rectangular anomaly (c. 3x4m) has been interpreted as a possible kiln (Figure 8), based on its morphology (Figure 7) and form (Figure 9). A similar, slightly weaker, anomaly has been tentatively identified c. 85m to the northeast. While these anomalies are well defined, they are located within an area of relatively pronounced natural variation and modern agricultural activity that makes anomalies of potential archaeological origin difficult to distinguish as such; it is possible that some nearby anomalies classified as Undetermined are archaeology and/or relate to associated activity.

7.3.2.6. **Possible Archaeology (Strong) Area 5** – At the western end of Area 5, [**5a**], two strong circular anomalies, c. 5m in diameter, have been identified and tentatively interpreted as possible kiln-type features (Figure 19-21). They occur on the edge of a pronounced band of geological anomalies and in an area with a slightly 'noisier' magnetic background, but are very noticeable in the data. While their narrow XY trace form may suggest they are caused by modern ferrous sources in the topsoil, they have been highlighted as possible thermoremanent anomalies, perhaps indicative of partially ploughed out high temperature structures.

7.3.2.7. **Possible Extraction** – A number of possible disused extraction pits have been detected across the southern part of Area 8 (Figures 13 and 16). The majority of these are irregular, or subrectangular in plan and weakly enhanced, with somewhat diffuse edges and a slight magnetic halo. They range in size from c. 3 to 15m across and some correlate closely with crop marks on satellite imagery or slight depressions visible in LiDAR data. This classification has also been used to indicate magnetic enhancement surrounding larger pits (i.e. remaining depressions) noted at the time of survey. At [**8c**] (Figures 16-8), a rectangular anomaly located against the area boundary, comprises multiple discrete, strong dipolar signals; in the context of the wider results, this is likely to indicate a former extraction pit that has been backfilled with ferrous debris.

7.3.2.8. **Agricultural (Weak/Strong/Spread)** – Linear anomalies, distributed across the survey area, have been interpreted as former field boundaries. The majority consist of narrow, straight anomalies, showing only minimal magnetic enhancement; in places (such as those running east-west in Area 8, or north-south in Area 4), they are difficult to differentiate from the strongest plough trends. In contrast, others (e.g. running north-south in Area 1 or forming a corner enclosure on the western edge of Area 8) comprise collections of small dipolar anomalies indicative of ferrous material. Their interpretation is supported by Ordnance Survey and tithe mapping (Redclift, 2021), which show field boundaries

in corresponding locations. A number of the probable boundaries in Areas 9, 8, 3, 7 and 10 do not appear on, and may predate, the available historical mapping, but are geophysically similar and appear to fit well to subdivide the extant and recent fields.

7.3.2.9. **Agricultural (Trend)** – The data contain narrow, weak parallel trends, occurring in multiple directions across most survey areas, that can be attributed to modern ploughing. In the interests of clarity, only a representative sample of these have been illustrated. This category has also been used for individual, narrow linear anomalies that may well relate to drainage features, but lack clearer diagnostic features to differentiate them from the direct results of cultivation practices (see Section 7.3.2.10).

7.3.2.10. **Drainage Features** – Characteristic linear anomalies composed of multiple small dipolar signals, indicative of ceramic land drains, have been detected. This category has also been assigned where weak linear positive anomalies demonstrate a clear herringbone pattern.

7.3.2.11. **Undetermined (Strong/Weak)** – A number of linear/curvilinear and discrete anomalies have been detected, the origins of which remain uncertain. The main groups occur in the north-western corner of Area 1, the north-western corner of Area 9, the south-eastern corner of Area 8 and the northwest of Area 6 (Figures 4 and 6). While these may be the result of natural variations or agricultural practices, an archaeological cause cannot be ruled out. Across the survey area, a number of strong discrete anomalies have also been categorised as Undetermined. It is possible that they relate to areas of burning, although a similar anomaly could be caused by ferrous debris.

7.3.2.12. **Natural (Strong/Weak/Zone)** – Where anomalies interpreted as having geological origins are relatively discrete, they have been categorized as Natural, whereas a classification of Natural (Zone) has been applied to indicate broader or less clearly defined areas of enhancement. The former includes amorphous areas of weak enhancement, with diffuse edges, which combine into broader bands.

8. Conclusions

8.1. A fluxgate gradiometer survey has been undertaken over c. 70.99ha of land southwest of Swainsthorpe, Norfolk. Strong magnetic interference caused by modern ferrous structures, such as services or fencing, was largely confined to field perimeters, with the exception of that caused by a subsurface service (detected running across Area 8) and a line of pylons and overhead cables (running northeast-southwest across the whole survey area). The limited interference and moderately 'quiet' magnetic background has enabled the detection of weak anomalies of anthropogenic (including archaeological) and natural origin. However, the nature of the geological deposits in this area, as well as the detected effects of modern agriculture, may have inhibited identification of some minimally enhanced archaeological features.

8.2. A group of anomalies have been identified in Area 10 that are likely to relate to the deserted medieval settlement at Kenningham, immediately west of the survey area. This appears to include trackways defined by double ditches, a series of adjacent plot divisions, and multiple discrete (or truncated) cut features and suggests toft and croft-type occupation. The original extent of the features is unclear, but weak, fragmentary magnetic anomalies in Area 6 may indicate associated features to the east of the modern road.

8.3. Clusters of anomalies in fields to the north and south of Brickkiln Lane (Areas 8 and 5, with an outlier in Area 9) may indicate extraction and processing of raw materials. Anomalies have been identified that possibly relate to small kiln-type structures or similar *in situ* high temperature craft/industrial activity. Their interpretation is supported by complementary evidence for such activities in the wider landscape (e.g. extant clay/chalk/gravel pits, placename evidence and mapped industrial complexes).

8.4. Additional linear and discrete anomalies, identified in groups and in isolation across the survey area, may indicate additional archaeological cut features or burning, however, due to their minimal magnetic contrast and similarity to anomalies caused by natural variation and modern activity, their origin remains uncertain and they have been categorised as Undetermined.

8.5. The agricultural use of this land in recent centuries is suggested by the detection of numerous former field boundaries; the majority correlate with features depicted on historical mapping, while others have been interpreted as such as a result of similar geophysical characteristics and morphology/alignment within the known pattern of post-medieval boundaries. Multiple modern ploughing regimes and land drains have also been detected across the area.

8.6. Throughout the data, natural variations are most prominent as sinuous bands of enhanced material as well as zones of 'speckling' and areas of weak polygonal reticulation. Anomalies of these types are typical of the glaciofluvial superficial deposits and underlying chalk recorded in this area.

9. Archiving

9.1. MS maintains an in-house digital archive, which is based on Schmidt and Ernenwein (2013). This stores the collected measurements, minimally processed data, georeferenced and un-georeferenced images, XY traces and a copy of the final report.

9.2. MS contributes reports to the ADS Grey Literature Library upon permission from the client, subject to any dictated time embargoes.

10. Copyright

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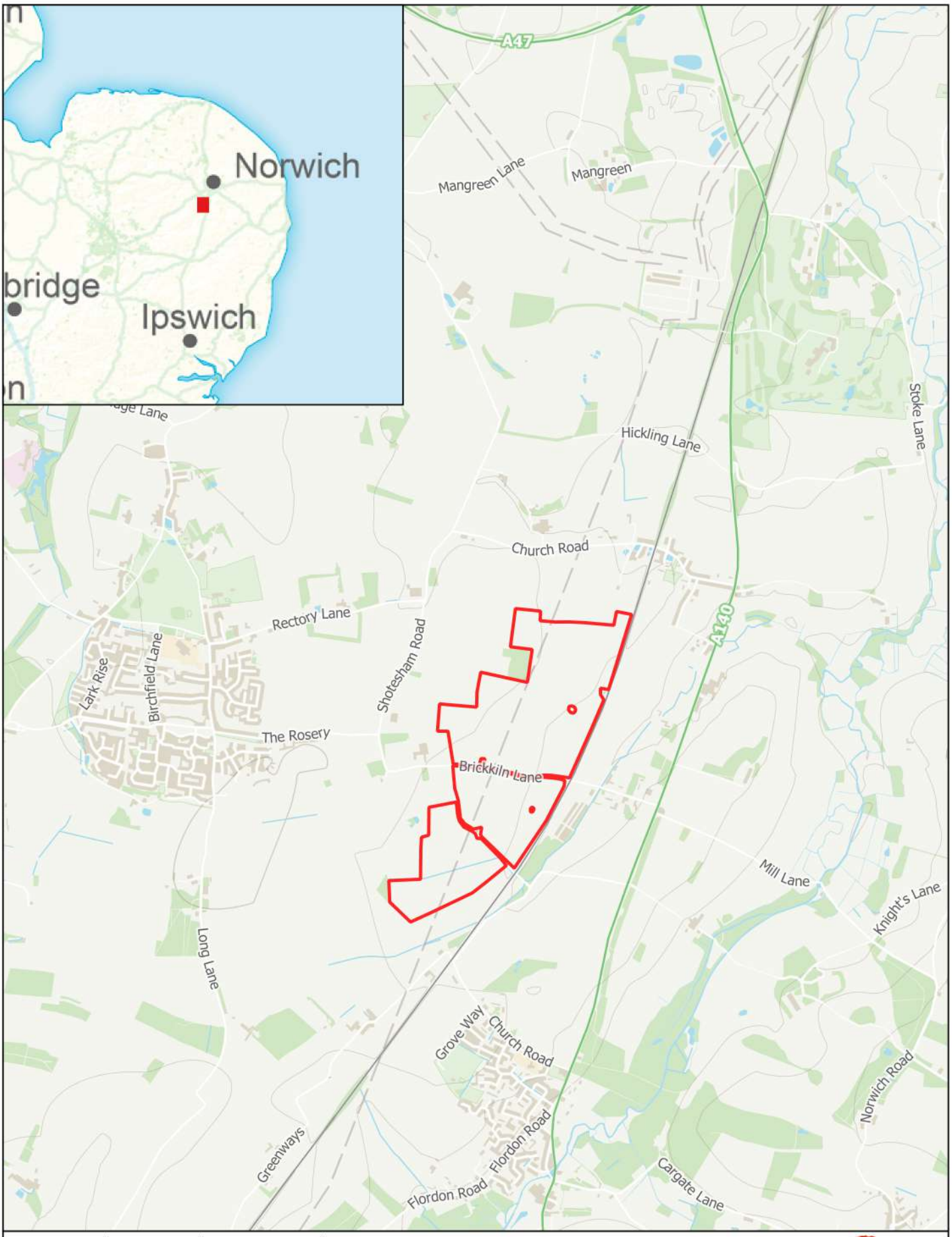
12. Project Metadata

MS Job Code	MSTM870
Project Name	Bloys Grove Solar Farm, Swainsthorpe
Client	Orion Heritage
Grid Reference	TM210998
Survey Techniques	Magnetometry
Survey Size (ha)	80.49ha
Survey Dates	2021-02-22 to 2021-03-05
Project Lead	Leanne Swinbank, BA ACIfA
Project Officer	Leanne Swinbank, BA ACIfA
HER Event No	TM210998
OASIS No	magnitud1-419304
Report Version	1.0

13. Document History

Version	Comments	Author	Checked By	Date
0.1	Initial draft for Project Lead to Review	HB	LS	17 March 2021
0.2	Draft following Project Lead corrections. Sent for Director approval.	HB	PSJ	18 March 2021
1.0	No client corrections. Issued as final.	N/A	LS	23 March 2021



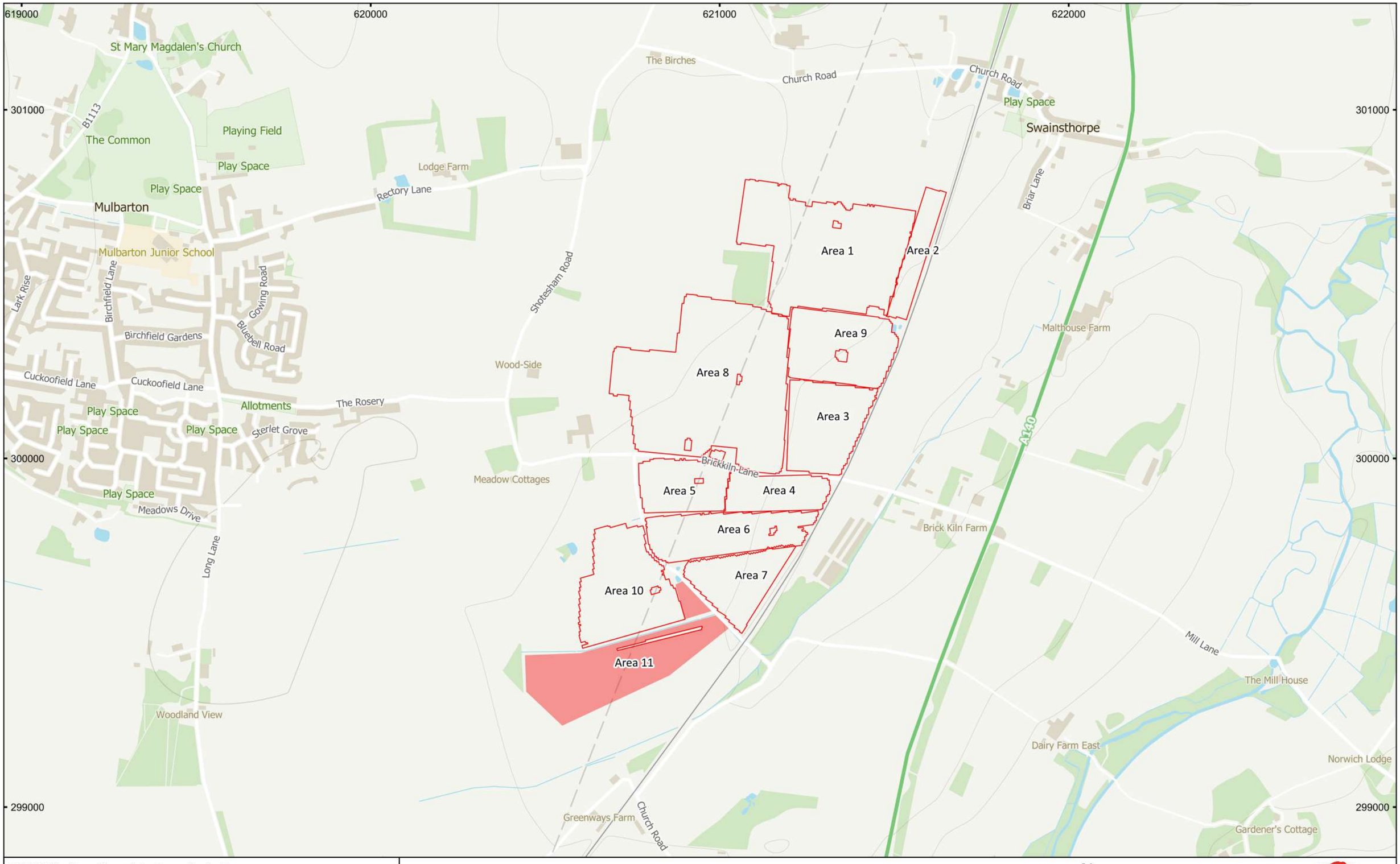
MSTM870 - Bloys Grove Solar Farm, Swainsthorpe
Figure 1 - Site Location
1:25,000 @ A4

Site Boundary

N

0 0.5 1 km

magnitude surveys



MSTM870 - Bloys Grove Solar Farm, Swainsthorpe
Figure 2 - Location of Survey Areas
1:10,000 @ A3

Survey Extents
Not Surveyable

N

0 250 500 750 m

magnitude surveys

621000

621500

300500

300500

Shotesham Road

Area 1

Area 2

Area 3

Area 8

Area 9

Bloy's Grove

MSTM870 - Bloys Grove Solar Farm, Swainsthorpe
Figure 3 - Magnetic Total Field (Lower Sensor) (Overview) (North)
1:3,000 @ A3

48,997 nT 49,005

A140

N

0 50 100 150 m

magnitude surveys

621000

621500

300500

300500

Area 1

Area 2

Area 3

Area 8

Area 9

Bloy's Grove

S.P

M.P

MSTM870 - Bloys Grove Solar Farm, Swainsthorpe
Figure 4 - Magnetic Interpretation Over Historical Maps and Satellite Imagery (Overview) (North)
1:3,000 @ A3

- Archaeology Possible (Strong)
- Archaeology Possible (Weak)
- Possible Extraction
- Agricultural (Strong)
- Agricultural (Weak)
- Agricultural (Spread)
- Natural (Weak)
- Natural (Zone)
- Undetermined (Strong)
- Undetermined (Weak)
- Magnetic Disturbance
- Ferrous/Debris (Spread)
- Overhead Cables
- Agricultural (Trend)
- Service
- Drainage Feature
- Ferrous (Spike)

A140

N

0 50 100 150 m

magnitude surveys

MSTM870 - Bloys Grove Solar Farm, Swainsthorpe
Figure 5 - Magnetic Total Field (Lower Sensor) (Overview) (South)
1:3,000 @ A3

48,997 nT 49,005

A140

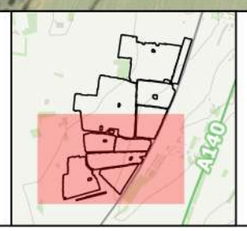
N

0 50 100 150 m

magnitude surveys

MSTM870 - Bloys Grove Solar Farm, Swainsthorpe
Figure 6 - Magnetic Interpretation Over Historical Maps and Satellite Imagery (Overview) (South)
1:3,000 @ A3

- Archaeology Probable (Strong)
- Archaeology Probable (Weak)
- Archaeology Possible (Strong)
- Archaeology Possible (Weak)
- Possible Extraction
- Agricultural (Weak)
- Natural (Strong)
- Natural (Weak)
- Natural (Zone)
- Undetermined (Strong)
- Undetermined (Weak)
- Magnetic Disturbance
- Ferrous/Debris (Spread)
- Overhead Cables
- Agricultural (Trend)
- Service
- Drainage Feature
- Ferrous (Spike)



N

0 50 100 150 m

magnitude surveys

300800

300600

300400

Area 9

Area 1

621200

621200

Area 8

MSTM870 - Bloys Grove Solar Farm, Swainsthorpe
Figure 7 - Magnetic Gradient (Northwest)
1:1,500 @ A3

-1 nT 2

A140

N

0 25 50 75 m

magnitude surveys

300800

300600

300400

621200

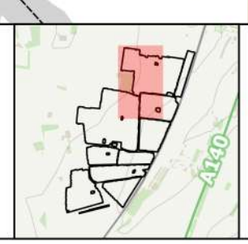
621200

Area 1

9a

MSTM870 - Bloys Grove Solar Farm, Swainsthorpe
Figure 8 - Magnetic Interpretation (Northwest)
1:1,500 @ A3

- Archaeology Possible (Strong)
- Possible Extraction
- Agricultural (Weak)
- Agricultural (Spread)
- Natural (Weak)
- Natural (Zone)
- Undetermined (Strong)
- Undetermined (Weak)
- Magnetic Disturbance
- Ferrous/Debris (Spread)
- Overhead Cables
- Agricultural (Trend)
- Service
- Drainage Feature
- Ferrous (Spike)



N

0 25 50 75 m

magnitude surveys

300800

300600

300400

Area 9

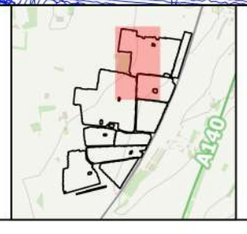
Area 1

621200

624200

Area 8

MSTM870 - Bloys Grove Solar Farm, Swainsthorpe
Figure 9 - XY Trace Plot (Northwest)
30nT/cm at 1:1,500 @ A3



N

0 25 50 75 m

magnitude surveys

300800
300600
300400
621600
621600
621400
621400
Area 1
Area 2
Area 9
Area 9
MSTM870 - Bloys Grove Solar Farm, Swainsthorpe
Figure 10 - Magnetic Gradient (Northeast)
1:1,500 @ A3

-1
nT
2
A140
N
0
25
50
75 m
magnitude surveys

300800
300600
300400
621600
621600
621400
621400
Area 2
Area 9
Area 1

MSTM870 - Bloys Grove Solar Farm, Swainsthorpe
Figure 11 - Magnetic Interpretation (Northeast)
1:1,500 @ A3

- Archaeology Possible (Strong)
- Possible Extraction
- Agricultural (Weak)
- Agricultural (Spread)
- Natural (Weak)
- Natural (Zone)
- Undetermined (Strong)
- Undetermined (Weak)
- Magnetic Disturbance
- Ferrous/Debris (Spread)
- Agricultural (Trend)
- Drainage Feature
- Ferrous (Spike)

A140

N

0 25 50 75 m

magnitude surveys

300800

300600

300400

621600

621600

Area 2

Area 1

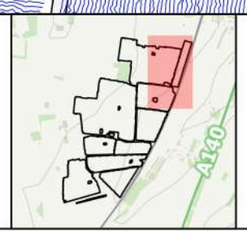
Area 9

Area 9

621400

621400

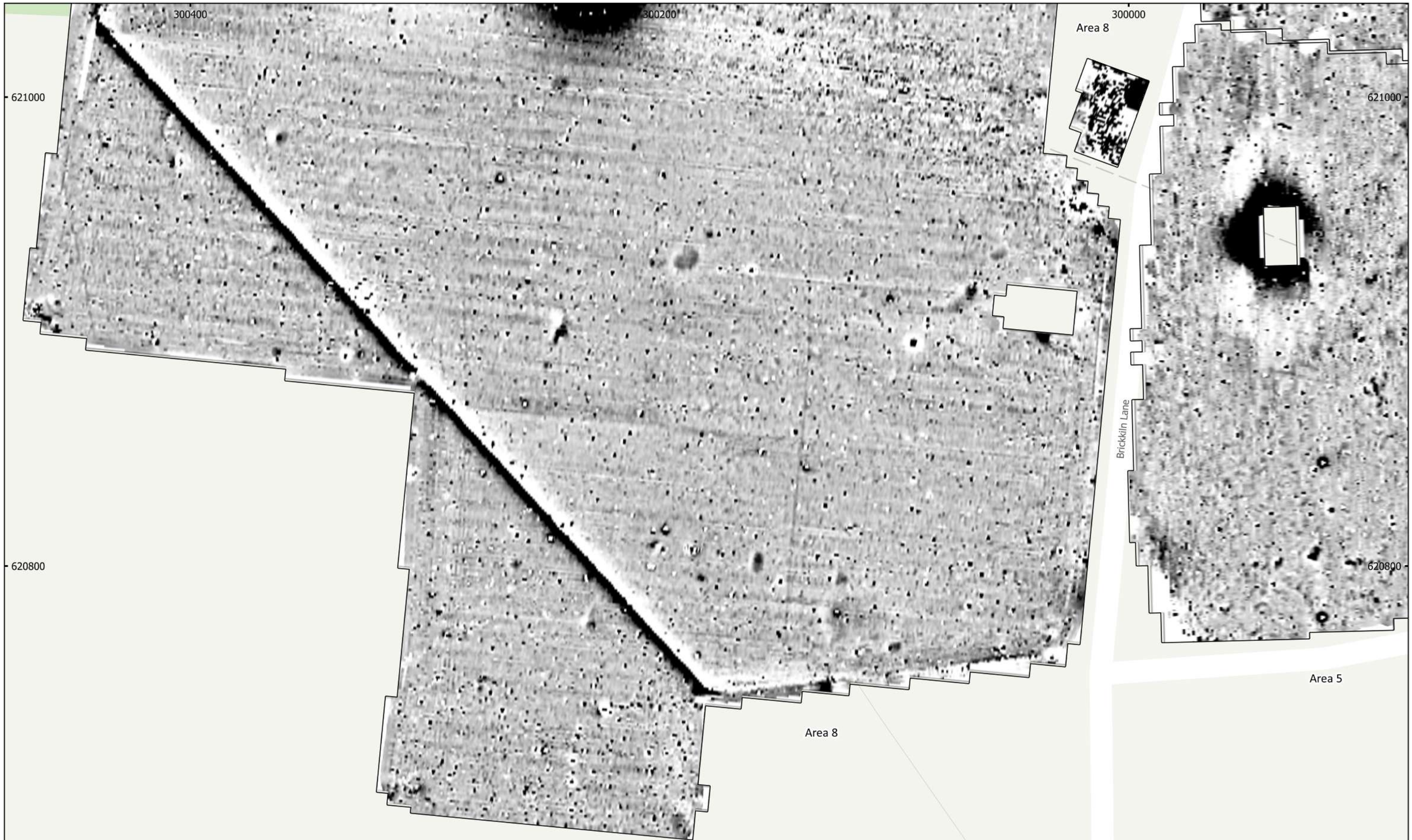
MSTM870 - Bloys Grove Solar Farm, Swainsthorpe
Figure 12 - XY Trace Plot (Northeast)
30nT/cm at 1:1,500 @ A3



N

0 25 50 75 m

magnitude surveys



MSTM870 - Bloys Grove Solar Farm, Swainsthorpe
Figure 13 - Magnetic Gradient (Centre West)
1:1,500 @ A3

-1 nT 2

A140

N

0 25 50 75 m

magnitude surveys

300400
300200
300000
621000
620800
8b
8a
5a
Brickkiln Lane
Area 8
Area 8
Area 5

MSTM870 - Bloys Grove Solar Farm, Swainsthorpe
Figure 14 - Magnetic Interpretation (Centre West)
1:1,500 @ A3

- Archaeology Possible (Strong)
- Archaeology Possible (Weak)
- Possible Extraction
- Agricultural (Strong)
- Agricultural (Weak)
- Agricultural (Spread)
- Natural (Weak)
- Natural (Zone)
- Undetermined (Strong)
- Undetermined (Weak)
- Magnetic Disturbance
- Ferrous/Debris (Spread)
- Overhead Cables
- Agricultural (Trend)
- Service
- Drainage Feature
- Ferrous (Spike)

A140

N

0 25 50 75 m

magnitude surveys

300400
300200
300000
Area 8
621000
621000
620800
620800
Brickkiln Lane
Area 8
Area 5

MSTM870 - Bloys Grove Solar Farm, Swainsthorpe
Figure 15 - XY Trace Plot (Centre West)
30nT/cm at 1:1,500 @ A3

A140

N

0 25 50 75 m

magnitude surveys

621000
621200
621400
300200
300200
Area 9
Area 3
Area 8
300000
300000
Brickkiln Lane
Area 4

MSTM870 - Bloys Grove Solar Farm, Swainsthorpe
Figure 16 - Magnetic Gradient (Centre East)
1:1,500 @ A3

-1 nT 2

A140

N

0 25 50 75 m

magnitude surveys

621000
621200
621400
300200
300000
8c
Area 3
Area 4
Brickkiln Lane

MSTM870 - Bloys Grove Solar Farm, Swainsthorpe
Figure 17 - Magnetic Interpretation (Centre East)
1:1,500 @ A3

- Possible Extraction
- Agricultural (Weak)
- Natural (Strong)
- Natural (Weak)
- Natural (Zone)
- Undetermined (Strong)
- Undetermined (Weak)
- Magnetic Disturbance
- Ferrous/Debris (Spread)
- Overhead Cables
- Agricultural (Trend)
- Drainage Feature
- Ferrous (Spike)

A140

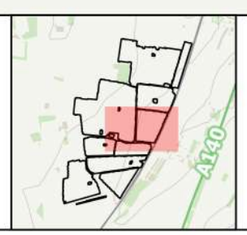
N

0 25 50 75 m

magnitude surveys

621000
621200
621400
300200
300200
Area 9
Area 3
Area 8
300000
300000
Brickkiln Lane
Area 4

MSTM870 - Bloys Grove Solar Farm, Swainsthorpe
Figure 18 - XY Trace Plot (Centre East)
30nT/cm at 1:1,500 @ A3



N
0 25 50 75 m

magnitude surveys

300000

299800

299600

620800

620600

Brickkiln Lane

Area 5

Area 6

Area 7

Area 10

MSTM870 - Bloys Grove Solar Farm, Swainsthorpe
Figure 19 - Magnetic Gradient (Southwest)
1:1,500 @ A3

-1 nT 2

A140

N

0 25 50 75 m

magnitude surveys

300000

299800

299600

620800

620800

Brickkiln Lane

5a

6a

Area 5

10a

10b

10c

620600

620600

MSTM870 - Bloys Grove Solar Farm, Swainsthorpe
Figure 20 - Magnetic Interpretation (Southwest)
1:1,500 @ A3

- Archaeology Probable (Strong)
- Archaeology Probable (Weak)
- Archaeology Possible (Strong)
- Archaeology Possible (Weak)
- Possible Extraction
- Agricultural (Weak)
- Natural (Weak)
- Natural (Zone)
- Undetermined (Strong)
- Undetermined (Weak)
- Magnetic Disturbance
- Ferrous/Debris (Spread)
- Overhead Cables
- Agricultural (Trend)
- Service
- Ferrous (Spike)

A140

N

0 25 50 75 m

magnitude surveys

300000

299800

299600

620800

620600

Brickkiln Lane

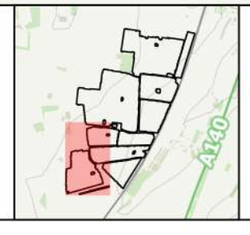
Area 5

Area 6

Area 7

Area 10

MSTM870 - Bloys Grove Solar Farm, Swainsthorpe
Figure 21 - XY Trace Plot (Southwest)
30nT/cm at 1:1,500 @ A3



N

0 25 50 75 m

magnitude surveys

300000
299800
299600
621200
621000
Area 4
Area 6
Area 7
Area 8
Brickkiln Lane
MSTM870 - Bloys Grove Solar Farm, Swainsthorpe
Figure 22 - Magnetic Gradient (Southeast)
1:1,500 @ A3

-1
nT
2
A140
N
0
25
50
75 m
magnitude surveys

300000
299800
299600
621200
621000
Area 6
Area 7
Brickkiln Lane
A140

MSTM870 - Bloys Grove Solar Farm, Swainsthorpe
Figure 23 - Magnetic Interpretation (Southeast)
1:1,500 @ A3

- Possible Extraction
- Agricultural (Weak)
- Natural (Strong)
- Natural (Weak)
- Natural (Zone)
- Undetermined (Strong)
- Undetermined (Weak)
- Magnetic Disturbance
- Ferrous/Debris (Spread)
- Overhead Cables
- Agricultural (Trend)
- Drainage Feature
- Ferrous (Spike)

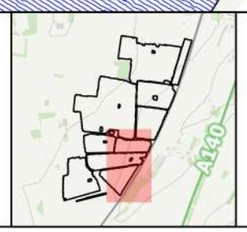
N

0 25 50 75 m

magnitude surveys

300000
299800
299600
621200
621000
Area 4
Area 6
Area 7
Area 8
Brickkiln Lane

MSTM870 - Bloys Grove Solar Farm, Swainsthorpe
Figure 24 - XY Trace Plot (Southeast)
30nT/cm at 1:1,500 @ A3



N
0 25 50 75 m

magnitude surveys