Cottam Solar Project
Cottam 1
Lincolnshire

Geophysical Survey

Summary

A geophysical (magnetometer) survey was undertaken on land consisting of approximately 875 hectares of land associated with Cottam 1 located surrounding the settlement of Coates, Lincolnshire. The majority of the anomalies recorded are agricultural including field drains, ridge and furrow cultivation, modern ploughing and former field boundaries. Archaeological and possible archaeological responses have been recorded in at least ten separate clusters which are likely to relate to settlement activity. Based on the geophysical survey, the archaeological potential of this site is deemed to be high in those ten areas and low elsewhere.

WYAS
Archaeological Services

Report Information

Client:	Cottam Solar Project Limited
Report Type:	Geophysical Survey
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County:	Lincolnshire
Grid Reference:	SK 9161 8453
Period(s) of activity:	?Romano-British/medieval/post-medieval/modern
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1 Introduction

Archaeological Services ASWYAS has been commissioned by Lanpro Services on behalf of their client, Cottam Solar Project Limited to undertake a geophysical survey in advance of the Cottam and West Burton Solar Scheme, North Lincolnshire. This survey relates to the Cottam 1 parcel of land, hereafter referred to as the 'study site'. This was undertaken in line with current best practice (CIfA 2020; Schmidt *et al.* 2015). The survey was carried out in June and between August and December 2021 to provide additional information on the archaeological resource of the study site.

Site location, topography and land-use

Cottam 2 consists of a single land parcel and covers an area of approximately 875ha centred at approximately SK 9161 8453 (Fig. 1).

The study site consists of arable land, and at the time of survey was under stubble, harrowed or a young crop. The study site covers many fields with the small settlement of Coates lying in the centre. The villages of Glentworth, Fillingham, Ingham, Cammeringham, Brattleby, Aisthorpe and Scampton lie to the east. The settlement of Thorpe in the Fallows lies to the south and Willingham by Stow, Normanby by Stow and Sturton by Stow to the west. The river Till meanders in a predominantly north/south direction across the western portion of the study site. The fields are generally large and typically have dividing hedgerows. The study site is generally level lying between 17m and 19m aOD (above Ordnance Datum).

Soils and geology

The recorded bedrock geology comprises mudstone, siltstone, limestone and sandstone of the Lias Group Formation, a sedimentary bedrock that formed approximately 172 to 204 million years ago in the Jurassic and Triassic Periods. Superficial deposits have been recorded as Till, comprising mid-Pleistocene Diamicton deposits formed up to 3 million years ago in the Quaternary Period (BGS 2022). Soils are described as slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils (Soilscape 18). Soils immediately adjacent to the River Till are described as loamy and clayey floodplain soils with naturally high groundwater (Soilscape 20) (CSAI 2022).

2 Archaeological Background

The archaeological background below is taken from an environmental impact assessment scoping report prepared by Lanpro Services (Crichton 2022) for Cottam sites 1-3. This included a review of monuments and events within the site boundary and also a 1km search area around the Cottam 1 study site.

The Cottam 1 study site in its entirety does not contain any designated heritage assets.

There are three Scheduled Monuments within the 1km search area from the boundaries of the study site; 'Thorpe medieval settlement' (NHLE 1016978) situated immediately adjacent to the southern edge of Area D, 'Coates medieval settlement and moated site' (NHLE 1016979) situated approximately 625m from the Cottam 1 study site at its nearest point, and the 'Site of a college and Benedictine Abbey, St Mary's Church' (NHLE 1012976), situated within the historic core of the village of Stow, around 740m to the west of the Cottam 1 study site at its nearest point.

Prehistoric and Roman periods (*c*. 9500 BC – *c*. AD 410)

Despite the lack or limited nature of previously recorded evidence for prehistoric and Roman period activity within the study site, the results of the geophysical survey from other areas of the Cottam Solar Project have identified previously unrecorded remains dating to these periods, and the presence of such remains within the study area cannot be discounted. If archaeological remains dating to the prehistoric or Roman periods are present in the study area, the significance of these would be vested in their evidential value and the potential contribution these could make to national and regional research agendas.

Early medieval and medieval periods (*c*. AD 410– *c*. 1540)

It is considered that there may be some limited potential for the survival of previously unrecorded remains relating to Early Anglo-Saxon period activity away from the pattern of settlements that may have emerged in the Middle to Late Anglo-Saxon periods. There is potential for the survival of evidence of Anglo-Saxon and medieval settlement within those parts of the study site that directly abut the shrunken settlements at Normanby by Stow to the west of Area F and to the north of Thorpe Le Fallows in Area D.

It is, however, likely that the study area remained in primarily agricultural use throughout the early medieval and medieval periods. Therefore, the majority of any potential buried archaeological features dating to the early or later medieval period within the study area are likely to relate to agricultural activity, such as ploughing, field boundaries and drainage, and would be considered to be of negligible significance.

Post-medieval to present (*c*. 1540-present)

The study site has remained in agricultural use throughout the post-medieval period based on historic mapping. Any potential buried archaeological features dating to the post-medieval period would likely relate to agricultural activity, such as ploughing, field boundaries and drainage, and would be considered to be of negligible significance.

Two possible farmsteads are recorded on the western side of Area D on the HER (MLI118759; MLI116510), as well as on the First Edition Ordnance Survey map of 1885, together with another building to their north. These continued to exist until at least the 1950s, and it is possible that related sub-surface remains could survive, although it is considered that

if these were present, it would be unlikely that any such remains would be of greater than local significance.

3 Aims, Methodology and Presentation

The aims and objectives of the programme of geophysical survey were to gather sufficient information to establish the presence/absence, character and extent, of any archaeological remains within the study site and to inform an assessment of the archaeological potential of the site. To achieve this aim, a magnetometer survey covering all amenable parts of the study site was undertaken (see Fig. 2).

The general objectives of the geophysical survey were:

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

Magnetometer survey

The study site was surveyed using a cart-based survey, undertaken using an eight channel SenSYS MX V3 system containing eight FGM650 sensors. Readings are taken every 20MHz (between 0.05 and 0.1m). Data were recorded onto a device, using a Carlson GNSS Smart antenna, for centimetre accuracy. These readings were stored in the memory of the instrument and downloaded for processing and interpretation. DLMGPS and MAGNETO software, alongside bespoke in-house software was used to process and present the data. Further details are given in Appendix 1.

Reporting

A general site location plan, incorporating the 1:50000 Ordnance Survey (OS) mapping, is shown in Figure 1. Figure 2 displays the location of the study site at a scale of 1:12500. Figure 3 shows the location of survey areas A-C at a scale of 1:10000. Figure 4 shows the processed magnetometer data at a scale of 1:10000, whilst Figure 5 shows an overview of the interpretation at the same scale. Figure 6 shows the location of survey area D at a scale of 1:10000. Figure 7 shows the processed magnetometer data at a scale of 1:10000, whilst Figure 8 shows an overview of the interpretation at the same scale. Figure 9 shows the location of survey areas F-G at a scale of 1:10000. Figure 10 shows the processed magnetometer data at a scale of 1:10000, whilst Figure 11 shows an overview of the interpretation at the same scale. Processed and minimally processed data, together with interpretation of the survey results are presented in Figures 12 to 131 inclusive at a scale of 1:1500.

Technical information on the equipment used, data processing and survey methodologies are given in Appendix 1. Technical information on locating the survey area is provided in Appendix 2. Appendix 3 describes the composition and location of the archive. A copy of the completed OASIS form is included in Appendix 4.

The survey methodology, report and any recommendations comply with guidelines outlined by the European Archaeological Council (Schmidt *et al*. 2015) and by the Chartered Institute for Archaeologists (CIfA 2020). All figures reproduced from Ordnance Survey mapping are with the permission of the controller of Her Majesty's Stationery Office (© Crown copyright).

The figures in this report have been produced following analysis of the data in processed formats and over a range of different display levels. All figures are presented to most suitably display and interpret the data from this site based on the experience and knowledge of Archaeological Services staff.

4 Results and Discussion (see Figures 12 to 131)

Ferrous anomalies and magnetic disturbance

Ferrous anomalies, as individual 'spikes', or as large discrete areas 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 or material is common on rural sites, often being present as a consequence of manuring or tipping/infilling. There is no obvious pattern or clustering to their distribution in this survey to suggest anything other than a random background scatter of ferrous debris in the plough-soil.

Linear dipolar trends have been recorded in Areas C11, C15, C18, D16, D17, D30, D31 and G1 which relate to service pipes.

Magnetic disturbance and short lengths of dipolar trends (**F1**) along the western boundary of Area C11 (Sector 8) may be associated with demolition rubble, although there is no evidence for a building on historic mapping. Instead, they may be associated with dumped ferrous materials.

Large areas of magnetic disturbance have been recorded in Areas C11, C21 C22 and C27 which is likely to be a result of 'green manuring'. The green waste is produced from organic and biodegradable household waste as a fertiliser and soil conditioner. Up to 0.25% of this material, however, can be from non-organic waste including metal fragments and batteries (Gerrard *et al*. 2015).

Magnetic disturbance along the limits of the survey areas is due to metal fencing within the field boundaries and adjacent farm buildings.

Geological anomalies

The survey has detected anomalies that have been interpreted as geological in origin. It is thought that the responses have been detected because of the variation in the composition and depth of the deposits of superficial material in which they derive.

Sinuous responses (**G1** and **G2**) in Areas F1 and F2 (Sector 35) may be associated with a former water course or palaeochannel as they are located close to the river Till.

Agricultural anomalies

At least 64 former field boundaries (**FB1** – **FB64**) have been recorded throughout the study site. All of these boundaries correspond to historic mapping dating from 1905 and are still visible on the historic map published in 1956 (NLS 2022).

Field drains can be seen within most of the fields. They are of differing magnetic strength which is likely to be associated with the construction material of the drains. Those that are particularly strong such as in Area C2 (Sector 7) and Areas D10 – D12 (Sector 22) are likely to be of a fired clay construction.

Medieval or post-medieval ridge and furrow cultivation has been recorded within a number of the areas.

Other parallel linear trends can be seen within all areas and are associated with modern ploughing. Only a selection of these have been highlighted on the interpretation diagrams to show the direction of the plough lines.

Uncertain anomalies

A handful of anomalies within the dataset have been interpreted as having an uncertain origin. Linear responses **U1** and **U2** in Area C4 (Sector 6) are likely to represent former field boundaries pre-dating available historic mapping.

A number of responses (**U3**) in Area C5 (Sector 8) have been difficult to interpret. They are on a different alignment to the ploughing trends and therefore may be of an archaeological origin. It is also possible that they represent desiccation cracks within the topsoil.

A curving weak dipolar trend (**U4**) in Area C11 (Sector 10) has the magnetic signature similar to a field drain but due to its form it is likely to be a former boundary pre-dating historic mapping. It also stops at FFB19 which adds weight to the former boundary interpretation.

A number of linear trends (**U5**) have been recorded in the west of Area C21 (Sectors 11 and 13) and are generally magnetically strong. Some of these trends are parallel to former

boundaries and therefore may also be attributed to further boundaries, indicating smaller field divisions. Another interpretation is that they are field drains.

Linear parallel trends (**U6**) in Area C26 (Sector 17) are likely to be field drains but as only three have been recorded, an uncertain interpretation has been given. They may also represent service trenches for non-magnetic pipes.

Pit-like anomalies and trend (**U7**) have been recorded in Area D4 (Sector 19). The pit-like responses have a strong magnetic signature and may be of some archaeological interest although an interpretation is unknown as no other archaeological responses have been recorded in the vicinity. The trend may represent a former field boundary as the ridge and furrow in this area is confined to the south of the trend.

A rectilinear area of increased response (**U8**) in Area E4 (Sector 33) lies on a former boundary (not recorded within the dataset) and may represent an in-filled pond or even structural remains.

A broad weak sinuous response (**U9**) in Area F2 (Sector 37) is suggestive of a former water course but due to the proximity of the archaeological features to the immediate east an archaeological origin cannot be dismissed.

Archaeological and possible archaeological anomalies

A complex system of enclosures, ditches and pits (**A1**) have been recorded in Area C28 (Sector 15) and almost certainly represents settlement activity of multiple phases due to the overlapping features. The complex measures at least 300m by 140m and is likely to extend into the field in the south.

Linear trend **P1** in Area C6 (Sector 8) extends southwards from a former boundary (**FFB17**). This is likely to be another boundary but as it not shown on historic mapping, it may have some archaeological interest.

Linear trend **P2** in Area C7 (Sector 8) also may indicate a former boundary as **P1** above. It runs through a pond marked on the digital mapping but nothing was noted in the field.

Another area of likely settlement activity (**A2**) has been recorded in Area D1 (Sector 18) and shows a series of enclosures with internal features including a ring ditch. It is likely that the settlement encroaches into Area D2 to the east as ditch-like features **P3** can be seen (these have been downgraded due to magnetic disturbance in that area). The settlement measures at least 100m by 120m with a possible trackway along the western edge. The ring ditch measures approximately 8m in diameter.

A magnetically weak circular response (**P4**) has been recorded along the northern limits of Area D6 (Sector 20) and may represent a ring ditch. It measures approximately 15m in diameter.

Linear trends and ditches (**A3**) in Area D14 (Sector 23) appear to form a series of enclosures. They are not as well defined as some of the other archaeological responses that have been recorded due to the increased ferrous spikes within this area and modern ploughing trends.

Broken ditch-like response **P5** in the southeast of Area D33 (Sector 29) may have an archaeological response. It is likely that the ridge and furrow in the area has cut through the response.

Archaeological and possible archaeological responses (**A4** and **A5**) in Areas F1 and F2 (Sector 35) lie within and to the east of Normanby by Stow shrunken medieval village (HER number MLI52445). It is highly likely that these responses are of a medieval date and associated with the village. Parallel linear trends (**P6**) to the east of **A4** suggest further responses associated with the medieval village, however they are magnetically weak and therefore have been given a possible archaeological origin. Further parallel linear trends (**P7**) to the east of **A5** can also be given the same interpretation as **P6.** These lie on the same alignment as the ridge and furrow but may be associated with a trackway.

Archaeological and possible archaeological responses (**A6**) in Area F2 (Sector 37) are associated with an incomplete pattern of anomalies likely to be associated with settlement. It is almost certain that the anomalies continue into the field to the south.

Two sides of a possible enclosure (**A7**) have been recorded in Area F4 (Sector 36) extending to the northern boundary of the area. Anomalies that have been interpreted as possible archaeology adjacent to the enclosure are likely to be associated but have been downgraded due to the difference in magnetic strength.

A magnetically weak circular response (**P8**) has been recorded in the south of Area F3 (Sector 35) and may represent a ring ditch. It measures approximately 18m in diameter.

A group of linear responses and enclosures (**A8**) can be seen in the northwest of Area G1 (Sector 38) and cover an area of approximately 210m by 80m. The responses vary in magnetic strength and definition but can be seen above the ploughing trends.

Linear trend **P9** in Area G1 (Sector 38) possibly relates to a former boundary, predating the available historic mapping. It may be contemporary with the ridge and furrow to the immediate east.

Within Area G4 (Sector 40) two groups of rectilinear enclosures (**A9** and **A10**) have been recorded. The responses at **A9** comprise a series of overlapping enclosures, ditches, pits and

circular features which as a complex measures approximately 130m by 320m. Responses **A10** are not as extensive as **A9** and cover an area of approximately 160m by 110m.

5 Conclusions

The geophysical survey has detected a number of magnetic anomalies associated mainly with an agricultural landscape including former field boundaries, medieval/post-medieval ridge and furrow cultivation, modern ploughing and land drains. Archaeological and possible archaeological responses have been recorded within the study over ten different defined areas. These comprise linear ditches and trends, rectilinear enclosures and circular trends, indicative of settlement activity over a probable Romano-British to medieval time period.

Magnetic disturbance within the dataset can be attributed to adjacent tracks and metal fencing within field boundaries and also ‘green manuring’ in some of the fields. Service pipes have also been recorded.

Based on the geophysical survey, the archaeological potential of the study site is deemed to be high where there are the ten areas of activity and low elsewhere.

Appendix 1: Magnetic survey - technical information

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 haemetite. 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. Areas of human occupation or settlement can then be identified by measuring the magnetic susceptibility of the topsoil because 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 topsoils, subsoils and rocks 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 and the fermentation and bacterial effects associated with rubbish decomposition. The area of enhancement is usually quite large, mainly due to the tendency of discard areas to extend beyond the limit of the occupation site itself, and spreading by the plough.

Types of Magnetic Anomaly

In the majority of 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 present as a consequence of 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 fencing and buried pipes can also cause the same disturbed response. A modern origin is usually assumed unless there is other supporting information.

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 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.

Methodology: Gradiometer Survey

The main method of using the fluxgate gradiometer for commercial evaluations is referred to as ***detailed survey*** and requires the surveyor to walk at an even pace carrying the instrument within a grid system. A sample trigger automatically takes readings at predetermined points, typically at 0.25m intervals, on traverses 1m apart. These readings are stored in the memory of the instrument and are later dumped to computer for processing and interpretation.

During this survey an eight channel Sensys MX V3 system containing eight FGM650 sensors was also used which was towed across the area using an ATV. Readings were taken every 20MHz (between 0.05 and 0.1m). Data was be recorded onto a device, using a Carlson GNSS Smart antenna, for centimetre accuracy. These readings were stored in the memory of the instrument and downloaded for processing and interpretation.

The gradiometer data have been presented in this report in processed greyscale format. The data in the greyscale images have been interpolated and selectively filtered to remove the effects of drift in instrument calibration and other artificial data constructs and to maximise the clarity and interpretability of the archaeological anomalies.

Appendix 2: Survey location information

Data were recorded onto a device, using a Carlson GNSS Smart antenna. The accuracy of this equipment is better than 0.01m. The survey grids 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 co-ordinates are measured off hard copies of the mapping rather than using the digital co-ordinates.

Archaeological Services WYAS cannot accept responsibility for errors of fact or opinion resulting from data supplied by a third party.

Appendix 3: Geophysical archive

The geophysical archive comprises:-

- an archive disk containing compressed (WinZip 8) files of the raw data, report text (Microsoft Word 2000), and graphics files (Adobe Illustrator CS2 and AutoCAD 2008) files; and
- a full copy of the report.

At present the archive is held by Archaeological Services WYAS although it is anticipated that it may eventually be lodged with the Archaeology Data Service (ADS). Brief details may also be forwarded for inclusion on the English Heritage Geophysical Survey Database after the contents of the report are deemed to be in the public domain (i.e. available for consultation in the Lincolnshire Historic Environment Record).

Appendix 4: Oasis form

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