Cambourne 2 Cambridge
Busway Options and Park and Ride Sites
Cambridgeshire

Geophysical Survey

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Client: Mott MacDonald Limited
Cambourne 2 Cambridge
Busway Options and
Park and Ride Sites
Cambridgeshire

Geophysical Survey

Summary
A geophysical (magnetometer) survey, covering approximately 22 hectares (of this first phase), was undertaken within fields along a proposed bus route and a park and ride site to the west of Cambridge. The survey area has detected anomalies of possible archaeological interest, consisting of linear ditches, enclosures, pits and areas of potential burning. Medieval ridge and furrow has been recorded throughout and a former field boundary has also been detected. Modern service pipes and areas of magnetic disturbance have also been recorded.

Therefore based on the geophysical survey, the archaeological potential of the site is considered to medium.
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1 Introduction

Archaeological Services WYAS (ASWYAS) were commissioned by Mott MacDonald Limited to undertake a geophysical (magnetometer) survey on land to the west of Cambridge, Cambridgeshire. This is in advance of a proposed new transport infrastructure. Guidance contained within the National Planning Policy Framework (DCLG 2012) was followed, in line with current best practice (CIIfA 2014; David et al. 2008). The survey was carried out between 12th – 21st March 2018.

Site location, topography and land-use

Several survey areas are located along the route of the A428 and the A1303. The survey areas are mostly within open farm land with scattered residential, light industrial and independent retail properties adjacent. The survey crosses 11 fields of mixed agriculture. The area totals approximately 22 ha (of this phase) from NGR TL369 600 to Cambridge TL 433 581.

Soils and geology

The bedrock geology of the western end of the survey area belongs to West Melbury Chalk formation, sedimentary rock formed approximately 94 to 101 million years ago in the cretaceous period with superficial deposits that formed up to 2 million years ago of the Oadby Member and are glacigenic in origin. The superficial deposits at the mid-point of the survey are not mapped although the bedrock geology stays the same. At the eastern side of the survey is mapped as mudstone of the Gault formation being sedimentary bedrock that formed approximately 101 to 113 million years ago. Here again superficial deposits are not recorded (BGS 2018). The soils of the area are described as lime-rich loamy and clayey soils with impleaded drainage (CSAI, 2018).

2 Archaeological Background

A preliminary Heritage Assets report had been produced by Atkins Ltd (2017). This outlines the quantity and date of known archaeological areas along the survey areas which range from Palaeolithic find spots through prehistoric settlements, Roman earthworks, settlements and possible villa sites. Early medieval remains appear limited to finds of Saxon coins and the origins of present day villages.

Medieval remains see more structures in the area either as a whole or with medieval parts surviving in standing buildings. Extant ridge and furrow count for most of the medieval earthworks although some relate to the known locations of medieval buildings (including a mill), defensive ditches, moated sites and possible civil war fortifications.
Post-medieval buildings are noted in the vicinity of the survey area either still standing or now demolished. Light industrial remains are characterised by extraction pits and isolated kilns.

Military sites are abundant in the area with RAF airfields, defensive structures and a cold war emergency planning centre at Shire Hall (MCB15106). An American Military Cemetery (MCB15262) is on the northern side of the A1303 adjacent to part of the survey area, which is also a registered Historic Park and Garden (list entry 1001573).

A combined geophysical survey and subsequent excavation was undertaken in 2010 (CAU 2010) ahead of the Coton to Bourn Proposed Water Pipe. The eastern part of this scheme, was undertaken to the south of the western extent of the proposed C2C scheme. It confirmed the location of ridge and furrow.

3 Aims, Methodology and Presentation

The main aim of the geophysical survey was to provide additional information and to gather sufficient information to establish the presence/absence, character, and extent, of buried archaeological remains within the specific survey area and to inform further strategies should they be necessary.

To achieve this, a magnetometer survey covering all available parts of the PDA 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 site grid was laid out using a Trimble VRS differential Global Positioning System (Trimble R6 model). The survey was undertaken using Bartington Grad601 magnetic gradiometers. These were employed taking readings at 0.25m intervals on zig-zag traverses 1.0m apart within 30m by 30m grids, so that 3600 readings were recorded in each grid. These readings were stored in the memory of the instrument and later downloaded to computer for processing and interpretation. Geoplot 3 (Geoscan Research) 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 shows a more detailed site location plan (not to scale) with an overall interpretation, Figure 3, also not to scale. The processed and minimally processed data, together with an interpretation of the survey results are presented in Figures 4 to 24 inclusive at a scale of 1:1250.

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 English Heritage (David et al. 2008) and by the Chartered Institute for Archaeologists (CIfA 2014). 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 Figs 4 to 24)

Ferrous anomalies

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.

Service pipes have been recorded running through Areas 2, 3, 6, 7 and 9, and will have masked any anomalies of interest, if present.

Areas of magnetic disturbance along the limits of the survey areas, on the whole are due to metal fencing within the field boundaries. Responses within Area 1 are associated with the water treatment works and the disturbance in the south of Area 10 is likely to be connected with the adjacent housing.
Geological anomalies
The survey has detected a number of low magnitude 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.

Agricultural anomalies
Throughout the proposed scheme there is Historic Environment Record (HER) data which suggests evidence of ridge and furrow. The geophysical survey evidence has recorded parallel linear trends throughout the survey area which are associated with the above mentioned ridge and furrow cultivation. Those detected in Areas 1-3 relate to cropmark evidence (monument ID: MCB11400, MCB11399) and also in Area 10 (monument ID: MCB11439). This is a small subset, as the HER records more ridge and furrow to the east of the surveyed area. The ridge and furrow may have Roman origins and reflect the hinterland of the settlement recorded to the east.

A former field boundary can be seen in Area 2 and corresponds to old mapping dating from 1888 (NLS 2018).

Possible archaeological anomalies
Anomalies that have been categorised as possible archaeology have been located throughout the survey areas.

Curving ditch like responses (P1) have been located to the northeast of Area 2 and along with linear response (P2) to the east, have the potential to create an enclosure of an undetermined date. A linear response to the north, in Area 1, may also be related but due to the magnetic disturbance it is difficult to determine if this is the case. Immediately to the east of these anomalies lies HER monument ID MCB24832, described as Iron Age to Roman features. It is therefore possible that these features are related to the detected anomalies. Within Area 2 several linear trends can be seen but do not form any patterns and may be related to modern day agricultural practice.

A ditch like linear response (P3) can be seen in the north of Area 5, whilst an archaeological origin is preferred, this anomaly is likely to be a continuation of an old field boundary seen to the west (NLS 2018).

A number of anomalies have been recorded in Areas 5, 6 and 7. These consist of a possible enclosure (P4) and several linear ditches (P5, P7). It is unfortunate that a service pipe bisects these anomalies which has masked the middle section of P5. A magnetically weaker response (P6) has been recorded on the southern survey extents of Area 6 and could possibly form a small enclosure.
Further possible archaeological anomalies can be seen in Area 10, consisting of ditches (P8, P10) and pits (P9). The possible pits are tentative as they are located close to an area of magnetic disturbance. It is also possible that they are of a geological or natural origin.

Anomalies within Area 11 consist of areas of higher magnitude, rather than isolated anomalies, although a handful have been depicted. This may relate to areas of burning or a scattering of burnt materials. Whilst this may be an indication of a hearth or location, it is possible that these responses are modern in origin or are a continuation of the strip of woodland to the south, but this is not depicted on any available old mapping.

5 Conclusions

The survey area has detected anomalies of possible archaeological interest in the forms of ditches, pits and enclosures. As there is no corroborative evidence to these responses and the narrow sampling strategy of the scheme’s linear nature, the interpretations are cautious even though the surrounding areas are archaeologically rich.

Medieval ridge and furrow cultivation has been recorded throughout the linear scheme, indicative of the area and recorded by previous geophysical surveys and tested via excavation. A former field boundary has also been detected within Area 2 (Figs 4-6).

Modern responses such as services pipes, magnetic disturbance and isolated ferrous debris can be seen throughout.

Even though the landscape is archaeologically rich within the portion of the scheme which has been surveyed, overall, the archaeological potential of the survey area is considered to be medium.
Fig. 1. Site location
Fig. 2. Survey location showing greyscale magnetometer data (not to scale @ A3)
Fig. 3. Overview interpretation of magnetometer data (not to scale @ A3)
Fig. 4. Processed greyscale magnetometer data; Sector 1 (1:1250 @ A3)
Fig. 5. XY trace plot of minimally processed magnetometer data; Sector 1 (1:1250 @ A3)
Fig. 4. Processed greyscale magnetometer data; Sector 1 (1:1250 @ A3)
Fig. 7. Processed greyscale magnetometer data; Sector 2 (1:1250 @ A3)
Area 3

Fig. 8. XY trace plot of minimally processed magnetometer data; Sector 2 (1:1250 @ A3)
Area 3

Fig. 9. Interpretation of magnetometer data; Sector 2 (1:1250 @ A3)
Fig. 10. Processed greyscale magnetometer data; Sector 3 (1:1250 @ A3)
Fig. 11. XY trace plot of minimally processed magnetometer data; Sector 3 (1:1250 @ A3)
Area 4

Fig. 12. Interpretation of magnetometer data; Sector 3 (1:1250 @ A3)
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Fig. 18. Interpretation of magnetometer data; Sector 5 (1:1250 @ A3)
Fig. 19. Processed greyscale magnetometer data; Sector 6 (1:1250 @ A3)

Area 10

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Fig. 20. XY trace plot of minimally processed magnetometer data; Sector 6 (1:1250 @ A3)
Area 10

Fig. 21. Interpretation of magnetometer data; Sector 6 (1:1250 @ A3)
Area 11

Fig. 22. Processed greyscale magnetometer data; Sector 7 (1:1250 @ A3)

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Fig. 23. XY trace plot of minimally processed magnetometer data; Sector 7 (1:1250 @ A3)
Fig. 24. Interpretation of magnetometer data; Sector 7 (1:1250 @ A3)
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 a Bartington Grad601 magnetic gradiometer was used taking readings on the 0.1nT range, at 0.25m intervals on zig-zag traverses 0.5m apart within 30m by 30m square grids. The instrument was checked for electronic and mechanical drift at a common point and calibrated as necessary. The drift from zero was not logged.

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.

The results and subsequent interpretation of data from geophysical surveys should not be treated as an absolute representation of the underlying archaeological and non-archaeological remains. Confirmation of the presence or absence of archaeological remains can only be achieved by direct investigation of sub-surface deposits.
Appendix 2: Survey location information

An initial survey station was established using a Trimble VRS differential Global Positioning System (Trimble R6 model). The data was geo-referenced using the geo-referenced survey station with a Trimble RTK differential Global Positioning System (Trimble R6 model). 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 CS6 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 Cambridge Historic Environment Record).
Appendix 4: Oasis form
Bibliography


Cook, S 2010 *Coton to Bourn Booster Pipeline Project Number 911 Cambridge Archaeological Unit,* unpublished.


