STRATASCAN

Geophysical Survey Report

A14 Improvements: Ellington to Fen Ditton, Cambridgeshire

for

WS Atkins Heritage

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J1875

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Document Title:	**Geophysical Survey Report** **A14 Improvements: Ellington to Fen Ditton, Cambridgeshire**
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FIGURES

1 SUMMARY OF RESULTS

Detailed magnetic survey carried out north of Bar Hill, Cambridgeshire, located a complex area of linear and discrete anomalies relating to cut features of archaeological origin. The complexity of linear anomalies and their relatively high magnitude suggests settlement over a long period incorporating several phases of construction or reconstruction. Curving linear elements within the site would be consistent with occupation in the prehistoric and/or early Romano-British period.

2 INTRODUCTION

2.1 Background synopsis

Stratascan were commissioned by WS Atkins Heritage to undertake a geophysical survey of an area adjacent to the A14 in Cambridgeshire as part of an Environmental Impact Assessment. The assessment was commissioned as a study of implications of various route options on the Ellington to Fen Ditton section of A14 road improvements.

2.2 Site location

The site is located north of Bar Hill, Cambridgeshire and south of New Close Farm at OS ref. TL 385 643.

2.3 Description of site

The survey area is approximately 10 ha of flat agricultural land. The site was split into a northern section referred to in this report as Area 1 and a larger southern section, Area 2. Area 1, approximately 1ha of pasture, was surveyed initially with Area 2 surveyed at a later date due to an arable crop cover. Excavation work carried out along the western side of Area 2 at the time of survey prevented access to a small section.

2.4 Geology and soils

The underlying geology in the south of the site is Cretaceous Lower Greensand and in the north Jurassic Ampthill Clay and Kimmeridge Clay (British Geological Survey South Sheet, Fourth Edition Solid, 2001). The overlying soils are known as Hanslope soils which are typical calcareous pelosols. These consist of slowly permeable calcareous clayey soils (Soil Survey of England and Wales, Sheet 4 Eastern England).

2.5 Site history and archaeological potential

No specific details were available to Stratascan. Assessment of the archaeological potential of the area has been carried out by the client. This has revealed from aerial photography a series of overlapping compounds, paddocks and enclosures. Pottery finds from the site support a late Iron Age to early Romano-British date.

2.6 Survey objectives

The objective of the survey was to locate any features of possible archaeological significance in order to inform an Environmental Impact Assessment being carried out by the client.

2.7 Survey methods

Detailed magnetic survey (gradiometry) was used as an efficient and effective method of locating archaeological anomalies. More information regarding this technique is included in the Methodology section below.

3 METHODOLOGY

3.1 Date of fieldwork

The fieldwork was carried out over six days on the 1st of June (Area 1) and from the 13th to the 17th of September 2004 (Area 2). Weather conditions during the survey were mixed.

3.2 Grid locations

The location of the survey grids has been plotted in Figure 2 together with the referencing information. Grids were set out using a Leica 705auto Total Station and referenced to suitable topographic features around the perimeter of the site.

3.3 Survey equipment

The magnetic survey was carried out using dual FM256 Fluxgate Gradiometers, manufactured by Geoscan Research and a dual sensor Grad601-2 Magnetic Gradiometer manufactured by Bartington Instruments Ltd. The FM256 gradiometers are suspended on a frame CF6. One gradiometer acts as a master trigger that controls the second slave gradiometer. The instruments each consist of two fluxgates mounted 0.5m vertically apart, and very accurately aligned to nullify the effects of the Earth's magnetic field. Readings relate to the difference in localised magnetic anomalies compared with the

general magnetic background. The Grad601-2 consists of two high stability fluxgate gradiometers suspended on a single frame. Each sensor has a 1m separation between the sensing elements giving a strong response to deep anomalies.

3.4 Sampling interval, depth of scan, resolution and data capture

3.4.1 Sampling interval

Readings were taken at 0.25m centres along traverses 1m apart. This equates to 3600 sampling points in a full 30m x 30m grid.

3.4.2 Depth of scan and resolution

The FM256 has a typical depth of penetration of 0.5m to 1.0m. This would be increased if strongly magnetic objects have been buried in the site. The collection of data at 0.25m centres provides an appropriate methodology balancing cost and time with resolution.

3.4.3 Data capture

The readings are logged consecutively into the data logger which in turn is daily down-loaded into a portable computer whilst on site. At the end of each job, data is transferred to the office for processing and presentation.

3.5 Processing, presentation of results and interpretation

3.5.1 Processing

Processing is performed using specialist software known as *Geoplot 3.* This can emphasise various aspects contained within the data but which are often not easily seen in the raw data. Basic processing of the magnetic data involves 'flattening' the background levels with respect to adjacent traverses and adjacent grids. 'Despiking' is also performed to remove the anomalies resulting from small iron objects often found on agricultural land. Once the basic processing has flattened the background it is then possible to carry out further processing which may include low pass filtering to reduce 'noise' in the data and hence emphasise the archaeological or man-made anomalies.

The following schedule shows the basic processing carried out on all processed gradiometer data used in this report:

1. *Despike* (useful for display and allows further processing functions to be carried out more effectively by removing extreme data values)

Geoplot parameters:
X radius = 1, y radius = 1, threshold = 3 std. dev.
Spike replacement = mean

2. *Zero mean grid* (sets the background mean of each grid to zero and is useful for removing grid edge discontinuities)

   Geoplot parameters:
   Threshold = 0.25 std. dev.

3. *Zero mean traverse* (sets the background mean of each traverse within a grid to zero and is useful for removing striping effects)

   Geoplot parameters:
   Least mean square fit = off

3.5.2 Presentation of results and interpretation

The presentation of the data for each site involves a print-out of the raw data both as greyscale (Figures 4, 10 and 14) and trace plots (Figures 5, 6, 11, 12, 15 and 16), together with greyscale plots of the processed data (Figures 7, 13 and 17). Magnetic anomalies have been identified and plotted onto the 'Abstraction and Interpretation of Anomalies' drawings for the site (Figures 8, 18 and 19). An additional plot (Figure 20) allows a comparison between geophysical anomalies and cropmarks observed on aerial photography.

4 RESULTS

The geophysical survey has located a large number of anomalies having an archaeological origin. These mainly consist of linear responses and discrete anomalies within the northern section of survey Area 2. Other anomalies within the survey areas are likely to be associated with modern ferrous objects within the topsoil and land boundaries or have been caused by modern agricultural activity. Anomalies are discussed in greater detail below and reference should be made to the appropriate plots.

Area 1 (Figures 4 – 8 and 19)

No characteristically archaeological anomalies were located in Area 1. Areas of magnetic debris may be associated with dumped thermoremnant material such as brick and tile, alternatively these may be areas where modern burning has taken place.

Areas of magnetic disturbance are likely to have been caused by ferrous material used in adjacent land boundaries. Linear magnetic disturbance crossing the survey area from north west to south east is likely to relate to an underground service such as a ferrous pipeline or possibly a cable.

Strong discrete positive anomalies with negative returns have been caused by ferrous objects within the topsoil and are not likely to be archaeologically significant.

Area 2 (Figures 9 - 19)

A very complex series of anomalies has been located in the northern half of Area 2. The anomaly group consists of mainly positive linear and curvilinear responses with a small number of discrete positive anomalies. The colour coding of anomalies has attempted to separate those responses where confidence is high for an archaeological cut feature (red) from less certain anomalies also relating to cut features (orange). The latter group are linear features that are of low magnitude and separate from the main cluster.

The strong magnetic response to features within the main group of anomalies would suggest that the fill of these cut features incorporates a significant amount of settlement derived material. This could be further defined as soils containing material associated with burning and biological decay.

Linear and curvilinear elements within the main anomaly group appear to form a series of enclosures, land boundaries and track ways. There would appear to be a complex relationship between the linear elements forming the group suggesting multiple phasing and possibly a long period of occupation.

The irregular layout incorporating curvilinear elements tends to suggest a prehistoric origin for anomalies although this ‘native’ settlement style may continue in use well into the Romano-British period. The findings of the magnetic survey are consistent with the results of air photo analysis carried out across the site as can be seen on the comparison plot, Figure 20.

Discrete positive anomalies within the main group are likely to represent cut features such as large pits or fragmented response to other linear features. A single low magnitude negative linear anomaly was abstracted from the northern end of the group which is likely to be related to a former embankment of soil having low magnetic properties. The discontinuity in positive linear anomalies adjacent to the negative linear response possibly supports the existence of a former embankment or some other disturbance that has introduced soils of lower magnetic enhancement.

Positive linear anomalies away from the main group have an uncertain origin and have been given a different colour code to those associated with the main group. It is likely that these anomalies represent features associated with drainage or agricultural activity although an archaeological origin should not be dismissed. Two positive parallel linear anomalies at the southern end of the survey area are likely to represent agricultural marks.

Areas of magnetic debris close to the northern end of the survey area may relate to dumped thermoremnant material, such as brick and tile, or areas of burning. Although these areas are adjacent to anomalies of archaeological origin, it is uncertain as to whether there is any association. Similar areas of debris further north within survey Area 1 may be related.

Areas of magnetic disturbance close to the field boundaries have been caused by modern ferrous objects. Strong discrete positive anomalies with negative returns have been caused by ferrous objects within the topsoil. Linear areas of magnetic disturbance are likely to have been caused by pipelines or cables.

5 CONCLUSION

The magnetic survey has located a complex series of anomalies that, from pattern characterisation, are likely to have been caused by ditches defining and surrounding a prehistoric or early Romano-British farmstead. The relatively high magnitude response and good definition of features within the main anomaly group would also be consistent with prolonged settlement activity. This type of enhancement is often seen close to settlement sites due to the incorporation of soils altered by biological activity and burning into the fill of cut features. This effect often diminishes away from the focus of a settlement and this in part may be responsible for the lower magnitude of response towards the periphery of the main cluster of anomalies.

There are a number of other factors that should be considered when assessing the extent of the site. In addition to the variable enhancement of soils as mentioned above, subsequent agricultural activity and soil depth may be important factors. The lack of linear features within Area 1 and the abrupt end of features that clearly must extend beyond the northern limit of Area 2, indicates possible disturbance or removal of features within Area 1.

Due to the complex layout of anomalies caused by different phases of construction probably over a long period, abstraction and interpretation has been problematic. It has not been possible to indicate the relationships between contemporary elements of the site from the geophysics, this could only be effectively achieved through intrusive works.

APPENDIX A – Basic principles of magnetic survey

Detailed magnetic survey can be used to effectively define areas of past human activity by mapping spatial variation and contrast in the magnetic properties of soil, subsoil and bedrock.

Weakly magnetic iron minerals are always present within the soil and areas of enhancement relate to increases in *magnetic susceptibility* and permanently magnetised *thermoremnant* material.

Magnetic susceptibility relates to the induced magnetism of a material when in the presence of a magnetic field. This magnetism can be considered as effectively permanent as it exists within the Earth's magnetic field. Magnetic susceptibility can become enhanced due to burning and complex biological or fermentation processes.

Thermoremnance is a permanent magnetism acquired by iron minerals that, after heating to a specific temperature known as the Curie Point, are effectively demagnetised followed by re-magnetisation by the Earth's magnetic field on cooling. Thermoremnant archaeological features can include hearths and kilns and material such as brick and tile may be magnetised through the same process.

Silting and deliberate infilling of ditches and pits with magnetically enhanced soil creates a relative contrast against the much lower levels of magnetism within the subsoil into which the feature is cut. Systematic mapping of magnetic anomalies will produce linear and discrete areas of enhancement allowing assessment and characterisation of subsurface features. Material such as subsoil and non-magnetic bedrock used to create former earthworks and walls may be mapped as areas of lower enhancement compared to surrounding soils.

Magnetic survey is carried out using a fluxgate gradiometer which is a passive instrument consisting of two sensors mounted vertically either 0.5 or 1m apart. The instrument is carried about 30cm above the ground surface and the top sensor measures the Earth's magnetic field whilst the lower sensor measures the same field but is also more affected by any localised buried field. The difference between the two sensors will relate to the strength of a magnetic field created by a buried feature, if no field is present the difference will be close to zero as the magnetic field measured by both sensors will be the same.

Factors affecting the magnetic survey may include soil type, local geology, previous human activity, disturbance from modern services etc.