GEOPHYSICAL SURVEY REPORT

STRATASCAN™

SUMO Survey Services
SUMO Group Member

Project name:

Western Springs Road, Rugeley, Staffordshire

Client:

AECOM

Job ref:

J9763

April 2016

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Project name: **Western Springs Road, Rugeley, Staffordshire** Client: **AECOM**	Job ref: **J9763**
Survey date: **31st March - 1st April 2016**	Report date: **April 2016**
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Version number and issue date:	Amendments:
V1 19/04/2016	

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1 SUMMARY OF RESULTS

A detailed gradiometry survey was carried out over approximately 10 hectares of grassland to trace a culvert detected to the north and assumed to continue in to this site. Anomalies have been identified in the north east corner of the site which are likely to be the culvert continuing for approximately 80m. After this point the signal is lost. It is unclear why the signal is lost but the most likely possibility is that the culvert runs close to a field boundary and the anomaly is concealed by strong magnetic disturbance caused by metal within the fence. A number of other land drains and a former sluice channel have been detected. Further linear anomalies and discrete responses are of uncertain origin, and are possibly associated with the landscaped park of Hagley Hall. The remaining features are natural or modern and include underground services, scattered magnetic debris, ferrous objects related to former sports pitches, and evidence of modern ploughing.

2 INTRODUCTION

2.1 Background synopsis

Stratascan were commissioned to undertake a geophysical survey of an area in order to establish the location of a culvert, identified through a previous geophysical survey immediately to the north. This survey forms part of an investigation being undertaken by AECOM.

2.2 Site Details

NGR / Postcode	SK 037 176 / WS15 2JG
Location	The site is located in Rugeley, Staffordshire and is bound by Rising Brook to the west, a leisure centre to the east and grassland to the north and south.
HER/SMR	Staffordshire
District	Cannock Chase
Parish	Rugeley CP
Topography	Mostly flat
Current Land Use	Grassland and playing field
Weather Conditions	Dry, clear
Soils	The overlying soils are known as Wick 1, which are typical brown earths. These consist of well drained, coarse loamy and sandy soils (Soil Survey of England and Wales, Sheet 3 Midland and Western England).
Geology	The underlying geology comprises sandstone and conglomerate of Kidderminster Formation. Superficial deposits of River Terrace Deposits,

	3 – sand and gravel, are recorded across the site (British Geological Survey website).
Site Background	A previous geophysical survey (Stratascan, 2015) and subsequent targeted trenching identified a culvert in the adjacent field to the north The culvert is aligned north east – south west and is presumed to extend into this site. CCTV surveys have also been carried out within the culvert which found it to be collapsed in places limiting the run accessible for the CCTV. The objective of this survey is to locate and trace the culvert (and any other culverts and land drains that may be present) as it extends southwards.
Survey Methods	Detailed magnetic survey (gradiometry)
Study Area	c. 10ha

2.3 Aims and objectives

To locate a culvert, detected through geophysical survey to the north of the site.

3 METHODS, PROCESSING & PRESENTATION

3.1 Standards & Guidance

Stratascan Ltd are a Registered Organisation with the CIfA and are committed to upholding its policies and standards.

3.2 Survey methods

A previous gradiometer survey, carried immediately north of the site, is the only geophysical survey technique whereby a culvert has been detected, therefore detailed magnetic survey was used as an efficient and effective method of locating further land drains and culverts.

More information regarding this technique is included in Appendix A.

3.3 Processing

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

1. *Destripe*
2. *Destagger*

3.4 Presentation of results

The presentation of the data for each site involves a plot of the minimally processed data as a greyscale plot and a colour plot showing extreme magnetic values. Magnetic anomalies have been identified and plotted onto the 'Interpretation of Anomalies' drawing.

4 RESULTS

The detailed magnetic gradiometer survey conducted at Rugeley has identified a number of anomalies that are likely to be related to culverts and land drains. The following list of numbered anomalies refers to numerical labels on the interpretation plots.

1 Positive linear anomalies in the north of the site. These are likely to be related to land drains or culverts, with Anomaly 1a appearing to form a continuation of the culvert identified to the north.

2 A positive linear anomaly running roughly east-west across the south of the site. This is related to a sluice channel, visible on available OS mapping from 1884 to 1955.

3 A series of positive linear anomalies across the site. These are possibly related to land drains or culverts and may be associated with the landscaped park of Hagley Hall.

4 Closely spaced, parallel linear anomalies across the south of the site. These re related to modern agricultural activity, such as ploughing.

5 Two strong, bipolar linear anomalies in the west and north-east of the site. These are related to underground services, such as pipes or cables.

6 Discrete areas of magnetic enhancement across the site. These are of uncertain origin, though are likely to be modern or related to drainage.

7 Positive linear anomalies in the north and south of the site. These are indicative of former cut features, though their origin is unknown. They are likely to be modern in origin, or related to the landscaping of Hagley Park.

8 A number of magnetic spikes across the north of the site. These are likely to be ferrous objects related to former sports pitches, visible on aerial photographs.

9 Areas of scattered magnetic debris in the north, north-east and south of the site. These are likely to be modern in origin.

10 Areas of weak amorphous magnetic variation in the south and north of the site. These are likely to be natural, i.e. geological, in origin.

11 Areas of magnetic disturbance are the result of substantial nearby ferrous metal objects such as fences and underground services. These effects can mask weaker archaeological anomalies, but on this site have not affected a significant proportion of the area.

12 A number of magnetic ‘spikes’ (strong focussed values with associated antipolar response) indicate ferrous metal objects. These are likely to be modern rubbish.

5 DATA APPRAISAL & CONFIDENCE ASSESSMENT

Sandstone geologies, combined with superficial deposits of sand and gravel, can provide variable results for gradiometer survey. In this instance, a high contrast is visible between land drains and a former sluice channel and the background magnetic response. Given that a number of anomalies have been detected, it can be determined that the survey has been effective.

6 CONCLUSION

The survey at Rugeley has identified the likely continuation of theknown culvert for approximately 30m in the north east corner of the site. It is traced until the anomaly is cut by a crossing utility. A further linear feature emerges to the south which may be the culvert running an additional 50m, after this point the anomaly is lost and is not traced further. There are several possible reasons for this:

1. The field boundary is causing magnetic disturbance along its length extending approximately 10-15m out, it is possible that the culvert anomaly is being swamped and lost in this strong disturbance suggesting that it may run close to the current field boundary.
2. The full extent of the culvert has been traced.
3. The culvert may have been damaged during the installation of the crossing utility and was removed leaving no remnant geophysical signature to trace.
4. It is possible, although unlikely, that the culvert changes direction at the field boundary and is observed as the land drains detected in the smaller field north of the artificial pitches.
5. The culvert may increase in depth and is beyond the detection range of the magnetometers.

While it is unclear why the signal is lost it seems that the most likely reason is that it runs close to the field boundary and is being lost in the magnetic noise.

Other features located include a sluice channel and a series of linear anomalies possibly associated with additional drainage, though their exact origin is uncertain. Discrete positive anomalies and two smaller linear anomalies are indicative of former cut features and are likely to be modern in origin, or related to the drainage system visible across the site. The remaining features are natural or modern in origin and include underground services, areas of scattered magnetic debris, magnetic disturbance from nearby ferrous metal objects, such as fencing and magnetic spikes, some of which are related to features of former sports pitches.

7 REFERENCES

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Stratascan Ltd, 2015. *Geophysical Survey Report – Land off Western Spring Road, Rugeley, Staffordshire (J7900)*

Appendix A - Technical Information: Magnetometer Survey Method

Grid Positioning

For hand held gradiometers the location of the survey grids has been plotted together with the referencing information. Grids were set out using a Trimble R8 Real Time Kinematic (RTK) VRS Now GNSS GPS system.

An RTK GPS (Real-time Kinematic Global Positioning System) can locate a point on the ground to a far greater accuracy than a standard GPS unit. A standard GPS suffers from errors created by satellite orbit errors, clock errors and atmospheric interference, resulting in an accuracy of 5m-10m. An RTK system uses a single base station receiver and a number of mobile units. The base station re-broadcasts the phase of the carrier it measured, and the mobile units compare their own phase measurements with those they received from the base station. This results in an accuracy of around 0.01m.

Technique	Instrument	Traverse Interval	Sample Interval
Magnetometer	Bartington Grad 601-2	1m	0.25m

Instrumentation: Bartington *Grad*601-2

Bartington instruments operate in a gradiometer configuration which comprises fluxgate sensors mounted vertically, set 1.0m apart. The fluxgate gradiometer suppresses any diurnal or regional effects. The instruments are carried, or cart mounted, with the bottom sensor approximately 0.1-0.3m from the ground surface. At each survey station, the difference in the magnetic field between the two fluxgates is measured in nanoTesla (nT). The sensitivity of the instrument can be adjusted; for most archaeological surveys the most sensitive range (0.1nT) is used. Generally, features up to 1m deep may be detected by this method, though strongly magnetic objects may be visible at greater depths. The Bartington instrument can collect two lines of data per traverse with gradiometer units mounted laterally with a separation of 1.0m.

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 site survey, data is transferred to the office for processing and presentation.

Data Processing

Zero Mean Traverse	This process sets the background mean of each traverse within each grid to zero. The operation removes striping effects and edge discontinuities over the whole of the data set.
Step Correction (Destagger)	When gradiometer data are collected in 'zig-zag' fashion, stepping errors can sometimes arise. These occur because of a slight difference in the speed of walking on the forward and reverse traverses. The result is a staggered effect in the data, which is particularly noticeable on linear anomalies. This process corrects these errors.

Display

Greyscale/ Colourscale Plot	This format divides a given range of readings into a set number of classes. Each class is represented by a specific shade of grey, the intensity increasing with value. All values above the given range are allocated the same shade (maximum intensity); similarly all values below the given range are represented by the minimum intensity shade. Similar plots can be produced in colour, either using a wide range of colours or by selecting two or three colours to represent positive and negative values. The assigned range (plotting levels) can be adjusted to emphasise different anomalies in the data-set.

Appendix B - Technical Information: Magnetic Theory

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. Although the changes in the magnetic field resulting from differing features in the soil are usually weak, changes as small as 0.2 nanoTeslas (nT) in an overall field strength of 48,000nT, can be accurately detected.

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

Thermoremanence 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. Thermoremanent 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 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.

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