

# Geophysical Survey Report

## Land off Ingham Road/Yarmouth Road, Stalham, Norfolk

for

Archaeological Solutions Ltd

February 2012

Job ref. J3056

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**Document Title:**        **Geophysical Survey Report**  
**Land off Ingahm Road/Yarmouth Road, Stalham, Norfolk**

**Client:**                    **Archaeological Solutions Ltd**

**Stratascan Job No:**    **J3056**

**Survey Date:**            **February 2012**

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**National Grid Ref:**    **TG 377 252**

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## 1 SUMMARY OF RESULTS

A detailed gradiometry survey was conducted over approximately 9.06 hectares of arable farmland off Ingham Road/Yarmouth Road, Stalham, Norfolk. The survey has identified a number of anomalies of archaeological interest. These include a set of anomalies to the south which are characteristic of a Romano-British settlement, a set of anomalies in the eastern corner of site which may be of prehistoric origin in line with the cropmark identification in this area, and definitely one but possibly two former field systems.

## 2 INTRODUCTION

### 2.1 Background synopsis

Stratascan were commissioned to undertake a geophysical survey of an area outlined for development. This survey forms part of an archaeological investigation being undertaken by Archaeological Solutions Ltd.

### 2.2 Site location

The site is located near Stalham at land east of Ingham Road, and north of Yarmouth Road, Norfolk at OS ref. TG 377 252.

### 2.3 Description of site



*View south across site*

The survey area is approximately 9.06 hectares of arable farmland at Ingham Road/Yarmouth Road, Norfolk. The land is mainly flat, bordered by Ingham Road along the

western boundary behind a thin row of trees, and Yarmouth Road running along the southern boundary behind Church Farm. The northern and eastern boundaries are comprised of arable fields.

#### 2.4 Geology and soils

The underlying geology is Crag Group – sand and gravel. (British Geological Survey website). The drift geology across the majority of site is Happisburgh Glacigenic Formation – Diamicton. An area to the west of site is formed of Happisburgh Glacigenic Formation – Sand and Gravel (British Geological Survey website).

The overlying soils are known as Wick 2 which are typical brown earths. These consist of deep well drained coarse loamy soils that are often stoneless. Some soils with slowly permeable subsoils and slight seasonal waterlogging occur locally. (Soil Survey of England and Wales, Sheet 4 Eastern England).

#### 2.5 Site history and archaeological potential

The following information has been provided by the client in the ‘Brief for Archaeological Evaluation by Geophysical Survey at Church Farm, Stalham, Norfolk’:

*The proposed development site is located in an area of largely unknown archaeological potential. The development area contains cropmarks, possibly representing an incomplete prehistoric enclosure. In addition prehistoric flints have been recovered from many of the surrounding fields. The potential for surviving prehistoric deposits is therefore high.*

*The site is also located within a wider landscape of Iron Age and Roman field systems, and Roman activity in the Stalham area is confirmed by the find of a Roman cremation within the town.*

*Although outside the medieval settlement area, medieval pottery has been found in the adjacent field and it is possible that some activity may exist within the development area.*

#### 2.6 Survey objectives

The objective of the survey was to locate any features of possible archaeological significance in order that they may be assessed prior to development.

#### 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 3 days from 20<sup>th</sup> February 2012. Weather conditions during the survey were dry and overcast.

#### 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 Trimble RTK GPS.

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. A SmartNet RTK GPS uses Ordnance Survey's network of over 100 fixed base stations to give an accuracy of around 0.01m.

#### 3.3 Survey equipment and gradiometer configuration

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 using an appropriate instrument.

The mapping of the anomaly in a systematic manner will allow an estimate of the type of material present beneath the surface. Strong magnetic anomalies will be generated by buried iron-based objects or by kilns or hearths. More subtle anomalies such as pits and ditches can be seen if they contain more humic material which is normally rich in magnetic iron oxides when compared with the subsoil.

To illustrate this point, the cutting and subsequent silting or backfilling of a ditch may result in a larger volume of weakly magnetic material being accumulated in the trench compared to the undisturbed subsoil. A weak magnetic anomaly should therefore appear in plan along the line of the ditch.

The magnetic survey was carried out using a dual sensor Grad601-2 Magnetic Gradiometer manufactured by Bartington Instruments Ltd. The instrument consists of two fluxgates 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 gradiometer has a 1m separation between the sensing elements so enhancing the response to weak 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 Grad 601-2 has a typical depth of penetration of 0.5m to 1.0m, though strongly magnetic objects may be visible at greater depths. The collection of data at 0.25m centres provides an optimum methodology for the task 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 downloaded into a portable computer whilst on site. At the end of each site survey, 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. 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. 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. *Destripe* (Removes striping effects caused by zero-point discrepancies between different sensors and walking directions)

2. *Destagger* (Removes zigzag effects caused by inconsistent walking speeds on sloping, uneven or overgrown terrain)

### 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 a greyscale plot (Figures 3 & 4) and a colour plot showing extreme magnetic values (Figures 5 & 6), together with a greyscale plot of the processed data (Figures 7-9). Magnetic anomalies have been identified and plotted onto the 'Abstraction and Interpretation of Anomalies' drawing for the site (Figures 10-12).

## 4 RESULTS

The following list of numbered anomalies refers to numerical labels on the interpretation plots (Figures 10-12).

### *Probable Archaeology*

- 1-5** Strong positive and negative linear cut features forming neat, rectangular enclosures. This is characteristic of a former Romano-British settlement.
- 6-7** Areas of moderate strength magnetic variation which are likely to be of thermoremanent origin. Anomaly **6** seems to form a fairly regular rectangular area of responses surrounding the cut features **1**, **2**, **4** and **5** suggesting an area of brick and/or tile debris associated with former occupation.
- 8-13** A number of positive linear cut features, indicative of former field boundaries, appear across site.

### *Possible Archaeology*

- 14-24A** A number of positive linear features appear across the site. Several of these (**16-21**) appear to be in a similar alignment to each other, but in a different alignment to Anomalies **8-13**, indicating a possible second field system. Anomalies **14** and **15** are both weak positive features appearing in 'cross' formations. These may represent corners of a former field system.
- 25-32** An area of positive linear and curvilinear anomalies appear in the eastern corner of the survey area, directly north west of cropmark 38518 identified in the Archaeological Brief. Anomaly **25** is a partial circular feature which may indicate the presence of a ring ditch. Similarly, Anomaly **32** appears to be a series of partial circular features in a linear arrangement. Anomalies **26** and **27** appear to form a sickle-shaped anomaly which seems to be of a similar size and shape to the cropmark, indicated just south west. The cropmark has been identified as being of



a possible prehistoric date (see Section 2.5 of this report), suggesting that anomalies **25-32** could be of similar origin.

**33-35** Positive and negative linear features running in a north east-south west direction along the western boundary of the survey area. These anomalies have been identified as being of possible archaeology, but could also be evidence of modern agricultural activity.

**36** A number of magnetic 'spikes' (strong focussed values with associated antipolar response) indicate ferrous metal objects. Although most of these are likely to be modern debris, some may be of archaeological interest. Particular attention may be paid to those found in association with other potentially archaeological anomalies.

#### *Other Anomalies*

**37** 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.

**38** Areas of scattered magnetic debris appear along the western boundary, and just north of Anomaly 7. This area close to the probable thermoremanent feature may represent a ploughing out of archaeological remains, hence scattering them further from their site of origin.

**39** An area of weak amorphous magnetic variation just north of centre is likely to be of natural (i.e. geological or pedological) origin.

## **5 CONCLUSION**

The detailed gradiometry survey carried out at land off of Ingham Road and Yarmouth Road, Stalham, has identified a number of anomalies of probable archaeological origin. The most obvious being a set of anomalies (**1-7**) along the southern boundary of site set on a neat, rectangular alignment which is indicative of a Romano-British settlement. A set of positive linear cut features (**8-13**) which appear across the site on their own alignment indicate a former field system. There also appears to be a set of anomalies (**16-21**) which are aligned on a different orientation, which may suggest the presence of a second field system on this site. Some of the anomalies appearing in the eastern corner of site seem to share the characteristics of the cropmark (38518) identified as being of prehistoric date. This suggests Anomalies **26-32** could be of similar origin.

## 6 REFERENCES

British Geological Survey, n.d., *website*:  
(<http://www.bgs.ac.uk/opengeoscience/home.html?Accordion1=1#maps>) Geology of Britain viewer.

Soil Survey of England and Wales, 1983. *Soils of England and Wales, Sheet 4 Eastern England*.

Kelly Powell, Norfolk Historic Environment Service, 2011. *Brief for Archaeological Evaluation by Geophysical Survey at Church Farm, Stalham, Norfolk*.

## 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 *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.

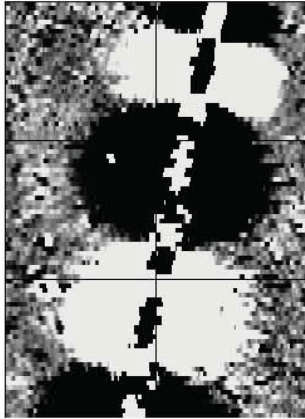
Magnetic survey is carried out using a fluxgate gradiometer which is a passive instrument consisting of two sensors mounted vertically either 0.5 or 1m apart. The instrument is carried about 30cm above the ground surface and the top sensor measures the Earth's magnetic field whilst the lower sensor measures 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.



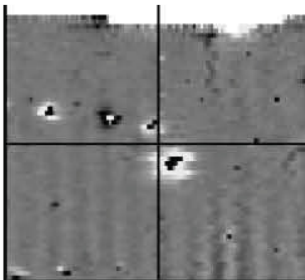
## APPENDIX B – Glossary of magnetic anomalies

### Bipolar



A bipolar anomaly is one that is composed of both a positive response and a negative response. It can be made up of any number of positive responses and negative responses. For example a pipeline consisting of alternating positive and negative anomalies is said to be bipolar. See also dipolar which has only one area of each polarity. The interpretation of the anomaly will depend on the magnitude of the magnetic field strength. A weak response may be caused by a clay field drain while a strong response will probably be caused by a metallic service.

### Dipolar

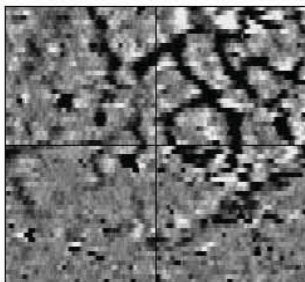


This consists of a single positive anomaly with an associated negative response. There should be no separation between the two polarities of response. These responses will be created by a single feature. The interpretation of the anomaly will depend on the magnitude of the magnetic measurements. A very strong anomaly is likely to be caused by a ferrous object.

### Positive anomaly with associated negative response

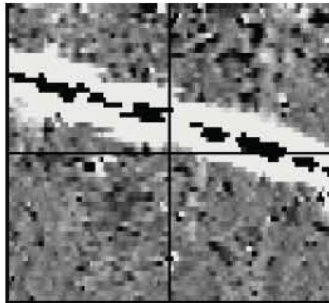
See bipolar and dipolar.

### Positive linear



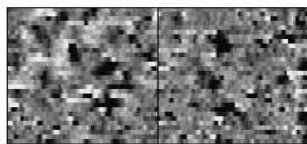
A linear response which is entirely positive in polarity. These are usually related to in-filled cut features where the fill material is magnetically enhanced compared to the surrounding matrix. They can be caused by ditches of an archaeological origin, but also former field boundaries, ploughing activity and some may even have a natural origin.

### Positive linear anomaly with associated negative response



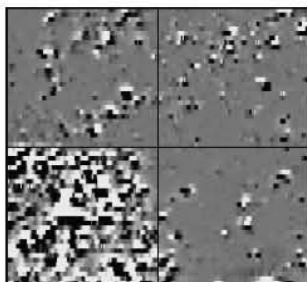
A positive linear anomaly which has a negative anomaly located adjacently. This will be caused by a single feature. In the example shown this is likely to be a single length of wire/cable probably relating to a modern service. Magnetically weaker responses may relate to earthwork style features and field boundaries.

### Positive point/area



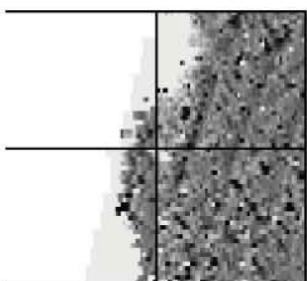
These are generally spatially small responses, perhaps covering just 3 or 4 reading nodes. They are entirely positive in polarity. Similar to positive linear anomalies they are generally caused by in-filled cut features. These include pits of an archaeological origin, possible tree bowls or other naturally occurring depressions in the ground.

### Magnetic debris



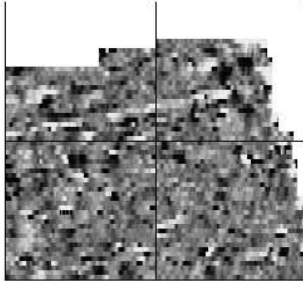
Magnetic debris consists of numerous dipolar responses spread over an area. If the amplitude of response is low ( $\pm 3\text{nT}$ ) then the origin is likely to represent general ground disturbance with no clear cause, it may be related to something as simple as an area of dug or mixed earth. A stronger anomaly ( $\pm 250\text{nT}$ ) is more indicative of a spread of ferrous debris. Moderately strong anomalies may be the result of a spread of thermoremanent material such as bricks or ash.

### Magnetic disturbance



Magnetic disturbance is high amplitude and can be composed of either a bipolar anomaly, or a single polarity response. It is essentially associated with magnetic interference from modern ferrous structures such as fencing, vehicles or buildings, and as a result is commonly found around the perimeter of a site near to boundary fences.

### Negative linear

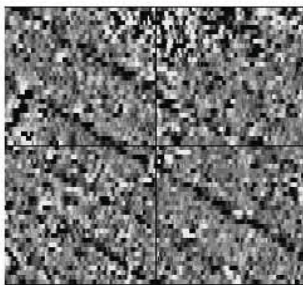


A linear response which is entirely negative in polarity. These are generally caused by earthen banks where material with a lower magnetic magnitude relative the background top soil is built up. See also ploughing activity.

### Negative point/area

Opposite to positive point anomalies these responses may be caused by raised areas or earthen banks. These could be of an archaeological origin or may have a natural origin.

### Ploughing activity



Ploughing activity can often be visualised by a series of parallel linear anomalies. These can be of either positive polarity or negative polarity depending on site specifics. It can be difficult to distinguish between ancient ploughing and more modern ploughing, clues such as the separation of each linear, straightness, strength of response and cross cutting relationships can be used to aid this, although none of these can be guaranteed to differentiate between different phases of activity.

### Polarity

Term used to describe the measurement of the magnetic response. An anomaly can have a positive polarity (values above 0nT) and/or a negative polarity (values below 0nT).

### Strength of response

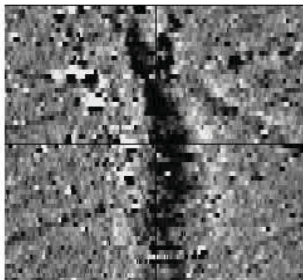
The amplitude of a magnetic response is an important factor in assigning an interpretation to a particular anomaly. For example a positive anomaly covering a 10m<sup>2</sup> area may have values up to around 3000nT, in which case it is likely to be caused by modern magnetic interference. However, the same size and shaped anomaly but with values up to only 4nT may have a natural origin. Colour plots are used to show the amplitude of response.



### **Thermoremanent response**





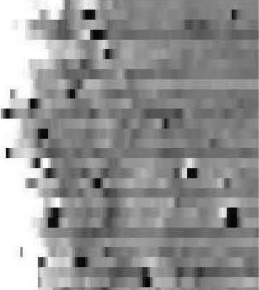

A feature which has been subject to heat may result in it acquiring a magnetic field. This can be anything up to approximately +/-100 nT in value. These features include clay fired drains, brick, bonfires, kilns, hearths and even pottery. If the heat application has occurred in situ (e.g. a kiln) then the response is likely to be bipolar compared to if the heated objects have been disturbed and moved relative to each other, in which case they are more likely to take an irregular form and may display a debris style response (e.g. ash).

### **Weak background variations**



Weakly magnetic wide scale variations within the data can sometimes be seen within sites. These usually have no specific structure but can often appear curvy and sinuous in form. They are likely to be the result of natural features, such as soil creep, dried up (or seasonal) streams. They can also be caused by changes in the underlying geology or soil type which may contain unpredictable distributions of magnetic minerals, and are usually apparent in several locations across a site.

### APPENDIX C – Gradiometer Data Recollection

<p>Grid 001 +/- 5nT Surveyed AM 20/2/2012 30m x 30m 1m x 0.25m Data collected by Alex Portch Using Stratascan Bartington Grad 601 No 4</p>			<p>Grid 001 +/- 5nT Surveyed PM 20/2/2012 30m x 30m 1m x 0.25m Data collected by Alex Portch Using Stratascan Bartington Grad 601 No 4</p>
<p>Grid 036 +/- 5nT Surveyed AM 21/2/2012 30m x 30m 1m x 0.25m Data collected by Sean Parker Using Stratascan Bartington Grad 601 No 2</p>			<p>Grid 036 +/- 5nT Surveyed PM 21/2/2012 30m x 30m 1m x 0.25m Data collected by Sean Parker Using Stratascan Bartington Grad 601 No 2</p>
<p>Grid 061 +/- 5nT Surveyed AM 22/2/2012 30m x 30m 1m x 0.25m Data collected by Sean Parker Using Stratascan Bartington Grad 601 No 2</p>			<p>Grid 061 +/- 5nT Surveyed PM 22/2/2012 30m x 30m 1m x 0.25m Data collected by Sean Parker Using Stratascan Bartington Grad 601 No 2</p>