

# GEOPHYSICAL SURVEY REPORT

# sumo

Survey

**GEOPHYSICS FOR  
ARCHAEOLOGY &  
ENGINEERING**

## **Land at Cawston, Rugby, Warwickshire**

Client  
**Orion Heritage Ltd**

Survey Report  
**11186**

Date  
**May 2017**

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## GEOPHYSICAL SURVEY REPORT

Project name:  
**Land at Cawston, Rugby,  
Warwickshire**

SUMO Job reference:  
**11186**

Client:  
**Orion Heritage**

Survey date:  
**24-26 April 2017**

Report date:  
**23 May 2017**

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## DIGITAL CONTENT (Archive Data)

- Minimally Processed Greyscale Images and XY Trace Plots in DWG format
- DWG Viewer
- Digital Copies of Report Text and Figures (both PDF and native formats)

## 1 SUMMARY OF RESULTS

A detailed magnetometer survey was conducted over approximately 10 ha of arable land. No archaeological anomalies have been detected, though some linear anomalies of uncertain origin have been identified. Evidence of modern ploughing, land drains and an underground service are visible in the data, along with areas of natural magnetic variation.

## 2 INTRODUCTION

### 2.1 Background synopsis

**SUMO Services Ltd** were commissioned to undertake a geophysical survey of an area outlined for development. This survey forms part of an archaeological investigation being undertaken by **Orion Heritage Ltd**.

### 2.2 Site details

<b>NGR / Postcode</b>	SP 474 727 / CV22 7YJ
<b>Location</b>	The site is located to the south of Cawston Lane, Cawston, which lies on the south-western edge of Rugby, Warwickshire.
<b>HER/SMR</b>	Warwickshire
<b>District</b>	Rugby
<b>Parish</b>	Dunchurch CP
<b>Topography</b>	Mostly flat
<b>Current Land Use</b>	Arable
<b>Weather</b>	Overcast, dry
<b>Geology</b>	Solid: Charmouth Mudstone Formation - mudstone. Superficial: Bosworth Clay Member - clay and silt across Area 1, with Dunsmore Gravel - sand and gravel across Area 2 (BGS 2017).
<b>Soils</b>	Arrow Association (543), deep, permeable coarse loamy soils (SSEW 1983).
<b>Archaeology</b>	A search of Warwickshire HER (2017) within a 1km radius of the site identifies several medieval records. The medieval remains include the deserted medieval settlement at Cawston (MWA4144), comprising linear features, trackways and enclosures and the site of a possible medieval moat at Cawston House (MWA5539) approximately 200m north of Fox Covert. Further undated linear features of unknown date (MWA4140) are visible as cropmarks on aerial photographs approximately 100m east of Fox Covert.
<b>Survey Methods</b>	Magnetometer survey (fluxgate gradiometer)
<b>Study Area</b>	34.7ha - approximately 24.6ha could not be surveyed due to high crop and livestock, reducing the total area surveyed to c. 10ha.

### 2.3 Aims and Objectives

To locate and characterise any anomalies of possible archaeological interest within the study area.

### 3 METHODS, PROCESSING & PRESENTATION

#### 3.1 Standards & Guidance

This report and all fieldwork have been conducted in accordance with the latest guidance documents issued by Historic England (EH 2008) (then English Heritage), the Chartered Institute for Archaeologists (CIfA 2014) and the European Archaeological Council (EAC 2016).

#### 3.2 Survey methods

Detailed magnetic survey was chosen as an efficient and effective method of locating archaeological anomalies.

Technique	Instrument	Traverse Interval	Sample Interval
Magnetometer	Bartington Grad 601-2	1.0m	0.25m

More information regarding this technique is included in Appendix A.

#### 3.3 Data Processing

The following basic processing steps have been carried out on the data used in this report:

De-stripe; de-stagger; interpolate

#### 3.4 Presentation of results and interpretation

The presentation of the results for each site involves a grey-scale plot of processed data. Magnetic anomalies are identified, interpreted and plotted onto the 'Interpretation' drawings. The minimally processed data are provided as a greyscale image in the Archive Data Folder with an XY trace plot in CAD format. A CAD viewer is also provided.

When interpreting the results, several factors are taken into consideration, including the nature of archaeological features being investigated and the local conditions at the site (geology, pedology, topography etc.). Anomalies are categorised by their potential origin. Where responses can be related to other existing evidence, the anomalies will be given specific categories, such as: *Abbey Wall* or *Roman Road*. Where the interpretation is based largely on the geophysical data, levels of confidence are implied, for example: *Probable*, or *Possible Archaeology*. The former is used for a confident interpretation, based on anomaly definition and/or other corroborative data such as cropmarks. Poor anomaly definition, a lack of clear patterns to the responses and an absence of other supporting data reduces confidence, hence the classification *Possible*.

## 4 RESULTS

*The survey has been divided into two survey areas (Areas 1-2).*

### 4.1 **Probable/Possible Archaeology**

4.1.1 No magnetic responses have been recorded that could be interpreted as being of archaeological interest.

### 4.2 **Uncertain**

4.2.1 Two, weak, parallel linear anomalies have been detected running approximately northwest-southeast across Area 2, with one of the responses appearing to extend into Area 1. These may be related to the known medieval activity in the vicinity, however their interpretation as archaeological is tentative at best. It is more likely that they are of agricultural origin.

4.2.2 Two smaller, closely spaced parallel linear responses in the southwest of Area 2 are also of uncertain origin. Like the above (4.2.1), it is possible that these relate to the medieval settlement activity known in the area, however a natural or agricultural origin seems more likely.

### 4.3 **Agricultural – Ploughing, Land Drains**

4.3.1 Weakly magnetic, closely spaced, parallel linear anomalies are visible across Area 2. These are a result of modern ploughing.

4.3.2 Weak bipolar linear anomalies in Area 1 are indicative of modern land drains.

### 4.4 **Natural / Geological / Pedological / Topographic**

4.4.1 Large areas of enhanced magnetic response are visible across the site, though are mainly visible in Area 2. These responses are typical of natural variations found across superficial deposits of sand and gravel.

### 4.5 **Ferrous / Magnetic Disturbance**

4.5.1 A strong bipolar linear anomaly can be seen running along the northern edge of Area 2. The response is characteristic of an underground service, such as a pipe.

4.5.2 Ferrous responses close to boundaries are due to adjacent fences and gates. Smaller scale ferrous anomalies ("iron spikes") are present throughout the data and their form is best illustrated in the XY trace plots. These responses are characteristic of small pieces of ferrous debris (or brick / tile) in the topsoil and are commonly assigned a modern origin. Only the most prominent of these are highlighted on the interpretation diagram.

## 5 DATA APPRAISAL & CONFIDENCE ASSESSMENT

- 5.1 Historic England guidelines (EH 2008) Table 4 states that the average magnetic response on mudstone is variable, however previous surveys on Charmouth Mudstone tend to provide good results. Due to the presence of linear anomalies of uncertain origin, it is likely that the technique would have detected any further archaeological anomalies, should they be present.

## 6 CONCLUSION

- 6.1 The survey at Cawston has not identified any archaeological responses. A small number of linear anomalies of uncertain origin have been detected, though these are likely to be of agricultural origin as opposed to archaeological. The remaining features are natural or modern and include areas of natural magnetic variation, evidence of ploughing, land drains and an underground service.

## 7 REFERENCES

- BGS 2017 British Geological Survey, Geology of Britain viewer [Accessed 23/05/2017] *website:* (<http://www.bgs.ac.uk/opengeoscience/home.html?Accordion1=1#maps>)
- ClfA 2014 *Standard and Guidance for Archaeological Geophysical Survey*. Amended 2016. ClfA Guidance note. Chartered Institute for Archaeologists, Reading  
[http://www.archaeologists.net/sites/default/files/ClfAS%26GGeophysics\\_2.pdf](http://www.archaeologists.net/sites/default/files/ClfAS%26GGeophysics_2.pdf)
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## 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 (De-stagger)	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.
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## Interpretation Categories

In certain circumstances (usually when there is corroborative evidence from desk-based or excavation data) very specific interpretations can be assigned to magnetic anomalies (for example, *Roman Road, Wall, etc.*) and where appropriate, such interpretations will be applied. The list below outlines the generic categories commonly used in the interpretation of the results.

<i>Archaeology / Probable Archaeology</i>	This term is used when the form, nature and pattern of the responses are clearly or very probably archaeological and /or if corroborative evidence is available. These anomalies, whilst considered anthropogenic, could be of any age.
<i>Possible Archaeology</i>	These anomalies exhibit either weak signal strength and / or poor definition, or form incomplete archaeological patterns, thereby reducing the level of confidence in the interpretation. Although the archaeological interpretation is favoured, they may be the result of variable soil depth, plough damage or even aliasing as a result of data collection orientation.
<i>Industrial / Burnt-Fired</i>	Strong magnetic anomalies that, due to their shape and form or the context in which they are found, suggest the presence of kilns, ovens, corn dryers, metal-working areas or hearths. It should be noted that in many instances modern ferrous material can produce similar magnetic anomalies.
<i>Former Field Boundary (probable &amp; possible)</i>	Anomalies that correspond to former boundaries indicated on historic mapping, or which are clearly a continuation of existing land divisions. Possible denotes less confidence where the anomaly may not be shown on historic mapping but nevertheless the anomaly displays all the characteristics of a field boundary.
<i>Ridge &amp; Furrow</i>	Parallel linear anomalies whose broad spacing suggests ridge and furrow cultivation. In some cases, the response may be the result of more recent agricultural activity.
<i>Agriculture (ploughing)</i>	Parallel linear anomalies or trends with a narrower spacing, sometimes aligned with existing boundaries, indicating more recent cultivation regimes.
<i>Land Drain</i>	Weakly magnetic linear anomalies, quite often appearing in series forming parallel and herringbone patterns. Smaller drains may lead and empty into larger diameter pipes, which in turn usually lead to local streams and ponds. These are indicative of clay fired land drains.
<i>Natural</i>	These responses form clear patterns in geographical zones where natural variations are known to produce significant magnetic distortions.
<i>Magnetic Disturbance</i>	Broad zones of strong dipolar anomalies, commonly found in places where modern ferrous or fired materials (e.g. brick rubble) are present. They are presumed to be modern.
<i>Service</i>	Magnetically strong anomalies, usually forming linear features are indicative of ferrous pipes/cables. Sometimes other materials (e.g. pvc) or the fill of the trench can cause weaker magnetic responses which can be identified from their uniform linearity.
<i>Ferrous</i>	This type of response is associated with ferrous material and may result from small items in the topsoil, larger buried objects such as pipes, or above ground features such as fence lines or pylons. Ferrous responses are usually regarded as modern. Individual burnt stones, fired bricks or igneous rocks can produce responses similar to ferrous material.
<i>Uncertain Origin</i>	Anomalies which stand out from the background magnetic variation, yet whose form and lack of patterning gives little clue as to their origin. Often the characteristics and distribution of the responses straddle the categories of <i>Possible Archaeology / Natural</i> or (in the case of linear responses) <i>Possible Archaeology / Agriculture</i> ; occasionally they are simply of an unusual form.

Where appropriate some anomalies will be further classified according to their form (positive or negative) and relative strength and coherence (trend: weak and poorly defined).

## 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 0.1 nanoTeslas (nT) in an overall field strength of 48,000 (nT), 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; 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 feature. The difference between the two sensors will relate to the strength of a magnetic field created by this 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 and disturbance from modern services.

75  
74  
73  
72  
71

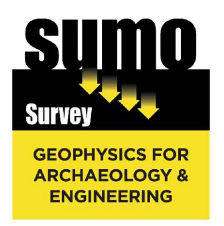


45                      46                      47                      48                      49



 Site Location

Reproduced from Ordnance Survey's 1:25 000 map of 1998 with the permission of the controller of Her Majesty's Stationery Office.  
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Licence No: AL 50125A



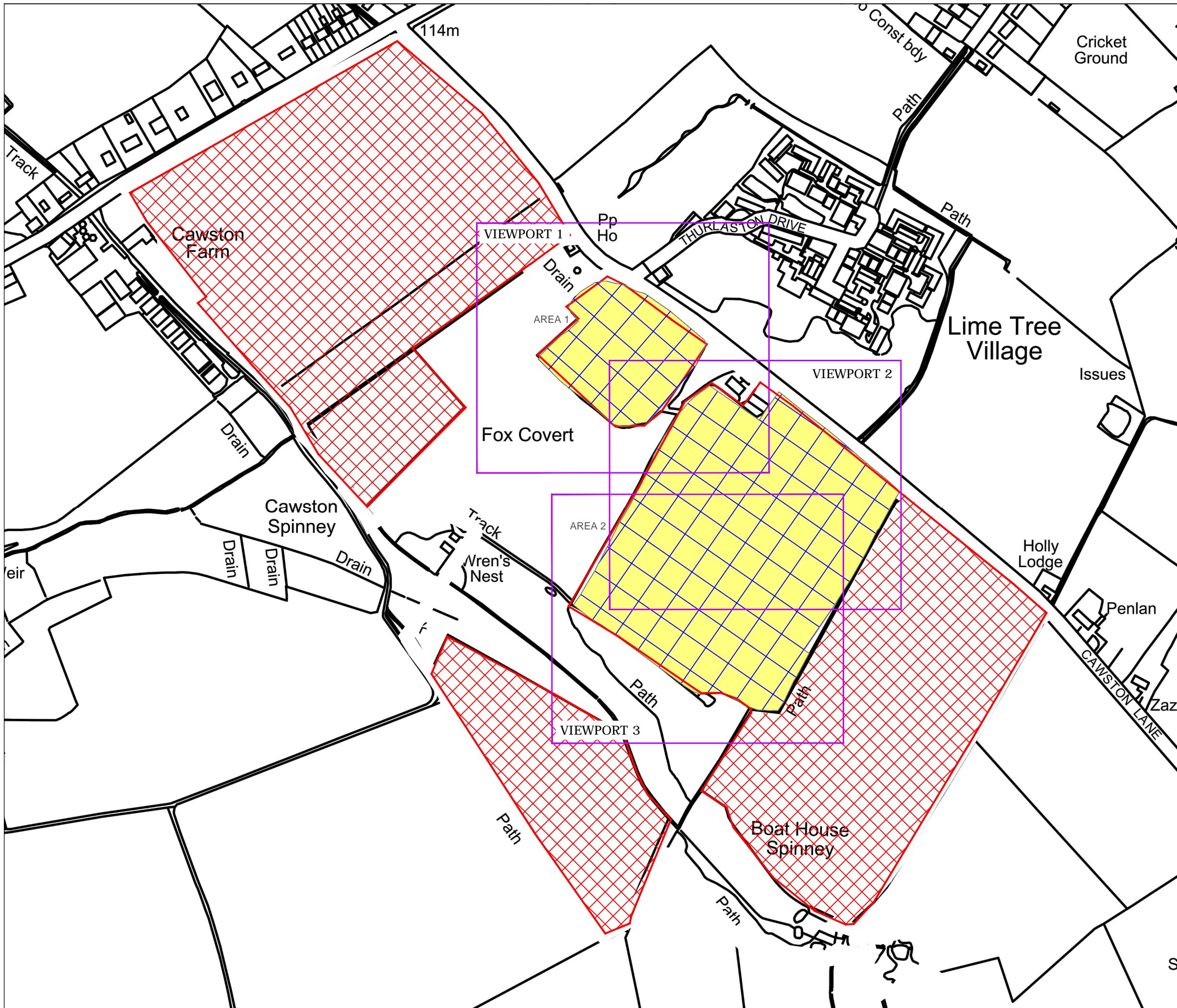
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Client: Orion Heritage Ltd

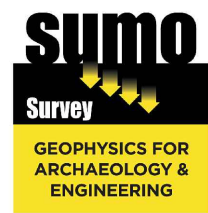
Project: 11186 - Land At Cawston, Rugby, Warwickshire

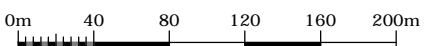
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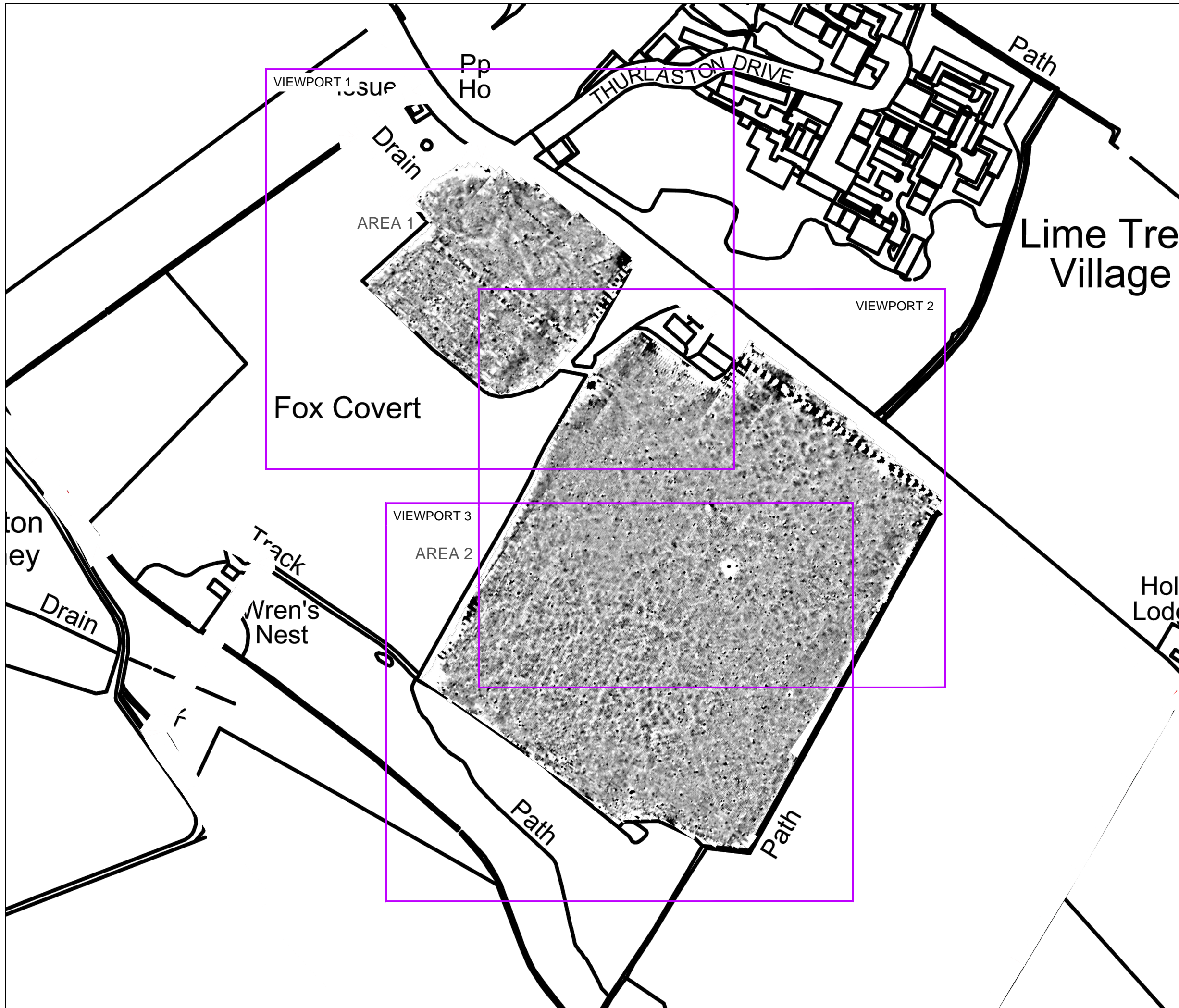
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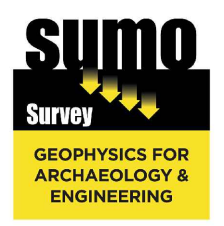
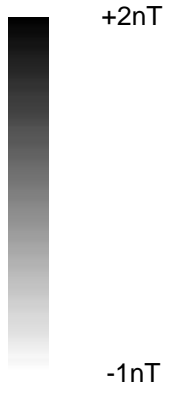
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Client:	Orion Heritage Ltd
Project:	11186 - Land At Cawston, Rugby, Warwickshire
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Plotting parameters



Title: Magnetometer Data - Greyscale Plot - Overview

Client: Orion Heritage Ltd

Project: 11186 - Land At Cawston, Rugby, Warwickshire

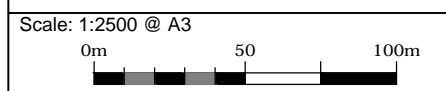


Fig No: 03

Issue

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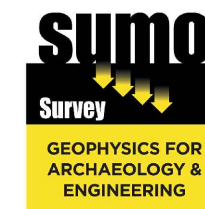
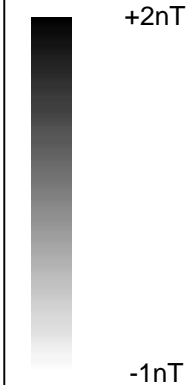
Drain

AREA 1

Fox Covert



Plotting parameters



Title: Magnetometer Data - Greyscale Plot - Viewport 1

Client: Orion Heritage Ltd

Project: 11186 - Land At Cawston, Rugby, Warwickshire

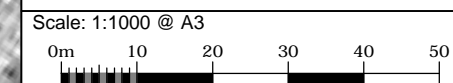
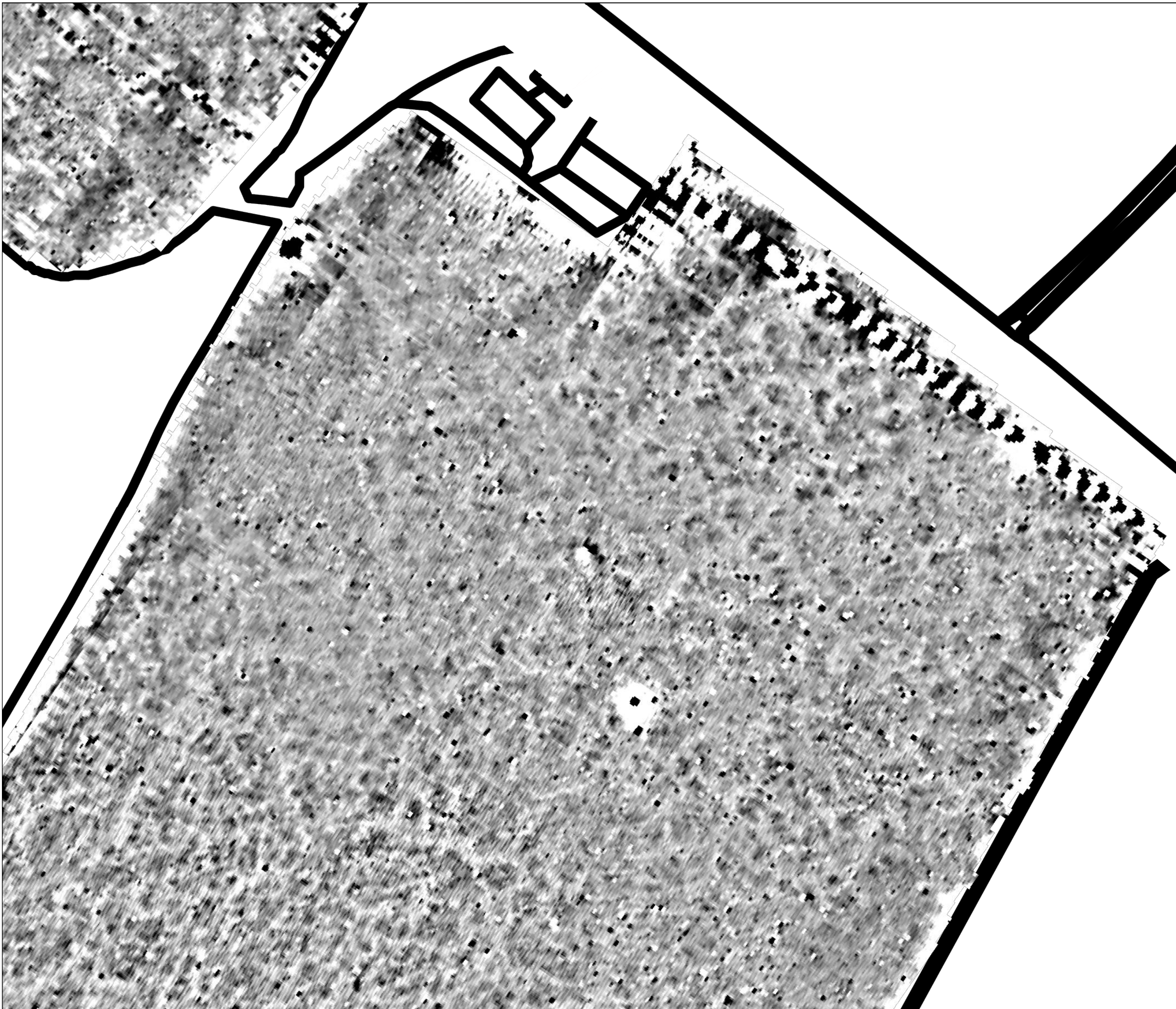
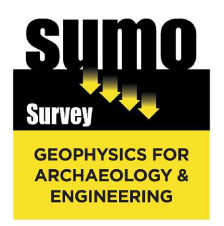
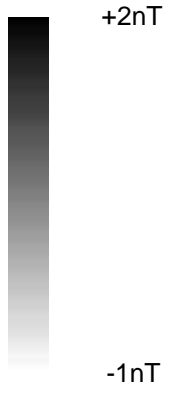


Fig No: 04



Plotting parameters



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- Viewport 2

Client: Orion Heritage Ltd

Project: 11186 - Land At Cawston, Rugby,  
Warwickshire

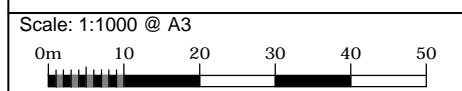
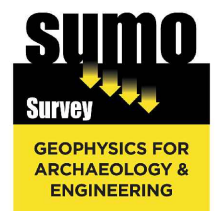
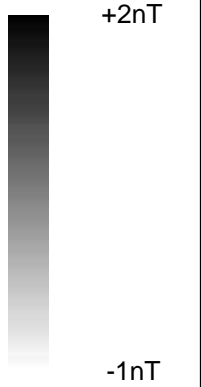


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AREA 2



Plotting parameters



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Client: Orion Heritage Ltd

Project: 11186 - Land At Cawston, Rugby, Warwickshire

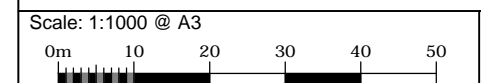
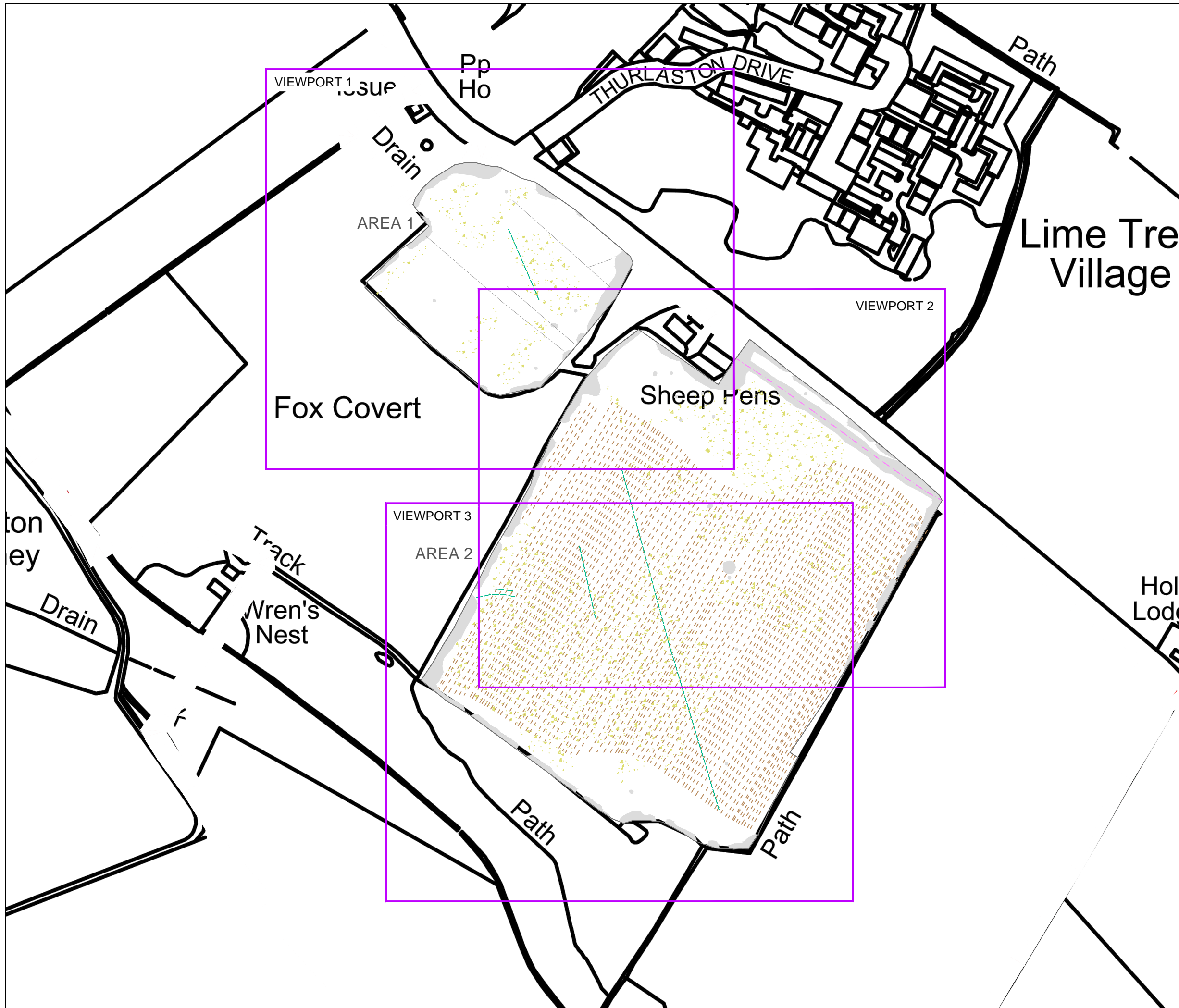


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Path

Path

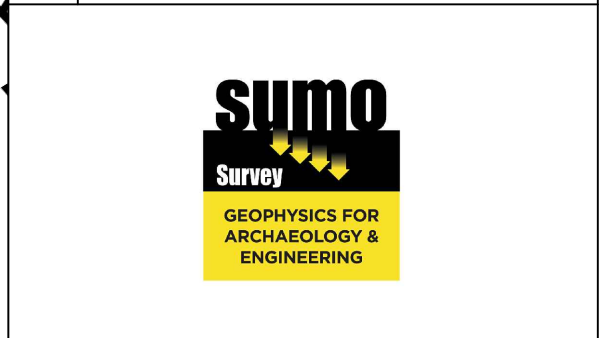




N

Lime Tree Village

KEY	
	Uncertain (trend)
	Agriculture (e.g. ploughing)
	Land drain
	Natural (e.g. geological or pedological)
	Service
	Ferrous



Title: Magnetometer Data - Interpretation - Overview

Client: Orion Heritage Ltd

Project: 11186 - Land At Cawston, Rugby, Warwickshire

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Fig No: 07

Issue

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Drain







AREA 1

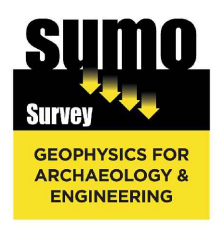
Fox Covert

Sheep P



KEY

	Uncertain (trend)
	Agriculture (e.g. ploughing)
	Land drain
	Natural (e.g. geological or pedological)
	Service
	Ferrous



Title: Magnetometer Data - Interpretation - Viewport 1

Client: Orion Heritage Ltd







Project: 11186 - Land At Cawston, Rugby, Warwickshire

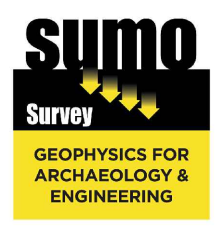
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# Sheep Pens



## KEY

	Uncertain (trend)
	Agriculture (e.g. ploughing)
	Land drain
	Natural (e.g. geological or pedological)
	Service
	Ferrous



Title: Magnetometer Data - Interpretation  
- Viewport 2

Client: Orion Heritage Ltd

Project: 11186 - Land At Cawston, Rugby,  
Warwickshire

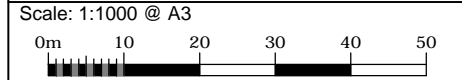








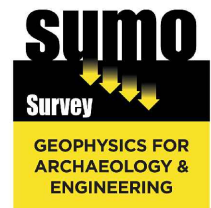
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AREA 2



KEY

	Uncertain (trend)
	Agriculture (e.g. ploughing)
	Land drain
	Natural (e.g. geological or pedological)
	Service
	Ferrous



Title: Magnetometer Data - Interpretation  
- Viewport 3

Client: Orion Heritage Ltd

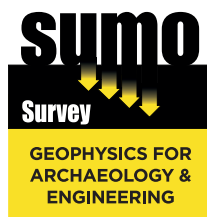
Project: 11186 - Land At Cawston, Rugby,  
Warwickshire

Scale: 1:1000 @ A3  
0m 10 20 30 40 50

Fig No: 10

Path

Path



- Archaeological
- Geophysical
- Laser Scanning
- Measured Building
- Topographic
- Utility Mapping

SUMO Services Ltd, incorporated under the laws of England and Wales,  
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