A1 Birtley to Coal House

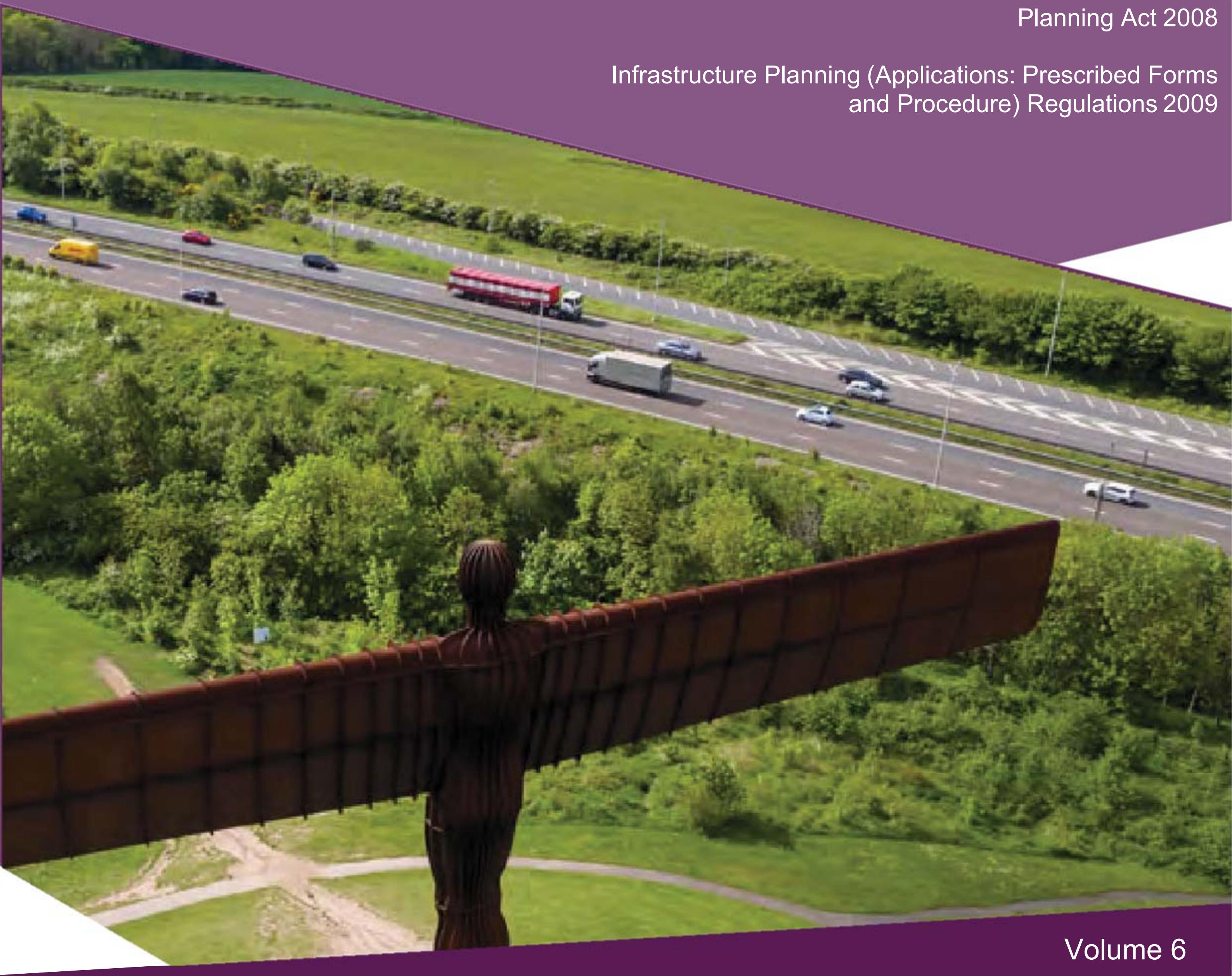
Scheme Number: TR010031

6.3 Environmental Statement – Appendix 6.2 Geophysical Survey Report

APFP Regulation 5(2)(a)

Planning Act 2008

Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009



Volume 6

August 2019

Infrastructure Planning

Planning Act 2008

The Infrastructure Planning (Applications: Prescribed Forms and Procedures) Regulations 2009

A1 Birtley to Coal House

Development Consent Order 20[xx]

Environmental Statement - Appendix

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Author:	A1 Birtley to Coal House Project Team, Highways England

Version	Date	Status of Version
Rev 0	14 August 2019	Application Issue

GEOPHYSICAL SURVEY REPORT

GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Gateshead A1

Client
WSP
For
Highways England

Survey Report
12655

Date
October 2018

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GEOPHYSICAL SURVEY REPORT

Project name:
Gateshead A1

SUMO Job reference:
12655

Client:
WSP
For:
Highways England

Survey date:
15 – 16 October 2018

Report date:
30 October 2018

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1 SUMMARY OF RESULTS

The geophysical survey at Gateshead, A1 detected no anomalies of archaeological interest. Linear responses may be ditches of unknown antiquity or they could be agricultural effects. A number of trends could be drains, minor boundaries or ploughing. Evidence of past ploughing was recorded in all survey areas.

2 INTRODUCTION

2.1 Background synopsis

SUMO Geophysics Ltd were commissioned to undertake a geophysical survey of an area outlined for a highway scheme. This survey forms part of an archaeological investigation being undertaken by **WSP** on behalf of **Highways England**.

2.2 Site details

NGR / Postcode	NZ 269 575 / NE9 7UB
Location	The site is located on the southern edge of Gateshead and 1km north of Birtley. It is bounded to the south by the A1 and to the north-west by the B1296.
HER/SMR	Tyne and Wear HER
District	Metropolitan Borough of Gateshead
Parish	Lamesley
Topography	Flat; slight gradients in Area 2.
Current Land Use	Pasture. Areas 5 – 7 comprised woodland and the south-east of Area 8 was a horse paddock. These areas were not surveyable. A large pylon surrounded by overgrown vegetation in Area 2/3 accounts for a small gap in the data.
Geology	Solid: High Main Post member **-** sandstone. Superficial: Till, Devensian – Diamicton (BGS 2018).
Soils	Rivington 2 (541g) Association well drained coarse loamy soils over rock. Some fine loamy soils with slowly permeable subsoils and slight seasonal waterlogging (SSEW 1983).
Archaeology	None known within the application area.
Survey Methods	Magnetometer survey (fluxgate gradiometer)
Study Area	6ha

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 Appendices A and B.

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 includes a ‘minimally processed data’ and a ‘processed data’ greyscale plot. Magnetic anomalies are identified, interpreted and plotted onto the ‘Interpretation’ drawings.

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 eight survey areas (Areas 1-8; Areas 2 and 3 comprise a single field) and specific anomalies have been given numerical labels [1] [2] *which appear in the text below, as well as on the Interpretation Figure.*

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 Linear anomalies [1] and [2] in Area 2 are parallel to the majority of the ploughing responses (see 4.3.1 below) and could represent contemporary boundaries, although none are shown on available mapping. Alternatively they could be magnetically enhanced material drawn out by the plough, and therefore they have been classified as *Uncertain Origin*.

4.2.2 A series of parallel trends in Area 2 are at right-angles to the main ploughing pattern, and could be due to field drains, minor boundaries, or they may themselves be caused by ploughing.

4.2.3 Several other magnetically weak trends were detected. They lack context and form no obvious patterns and are therefore likely to be natural, perhaps relating to pedological variations, or a result of agricultural activity

4.3 *Agricultural – Ploughing / Land Drains*

4.3.1 Numerous closely spaced, parallel linear anomalies in all of the survey areas are evidence of past ploughing.

4.4 *Ferrous / Magnetic Disturbance*

4.4.1 A group of four positive ferrous anomalies within a negative "halo" [3] in Area 2 / 3 is due to the remains of a former pylon base.

4.4.2 Ferrous responses close to boundaries are due to adjacent fences and gates. Smaller scale ferrous anomalies ("iron spikes") are present throughout the data and are characteristic of small pieces of ferrous debris (or brick / tile) in the topsoil; they 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 sandstone is poor. The results from this survey indicate the presence of ditch-like anomalies and ploughing responses as a consequence the technique is likely to have detected any archaeological features, if present.

6 CONCLUSION

6.1 No anomalies of archaeological interest were detected. A number of anomalies are of uncertain origin; linear responses may be former boundary ditches or ploughing effects and several trends could be drains. They may also be of agricultural or natural origin. Past ploughing is also in evidence.

7 REFERENCES

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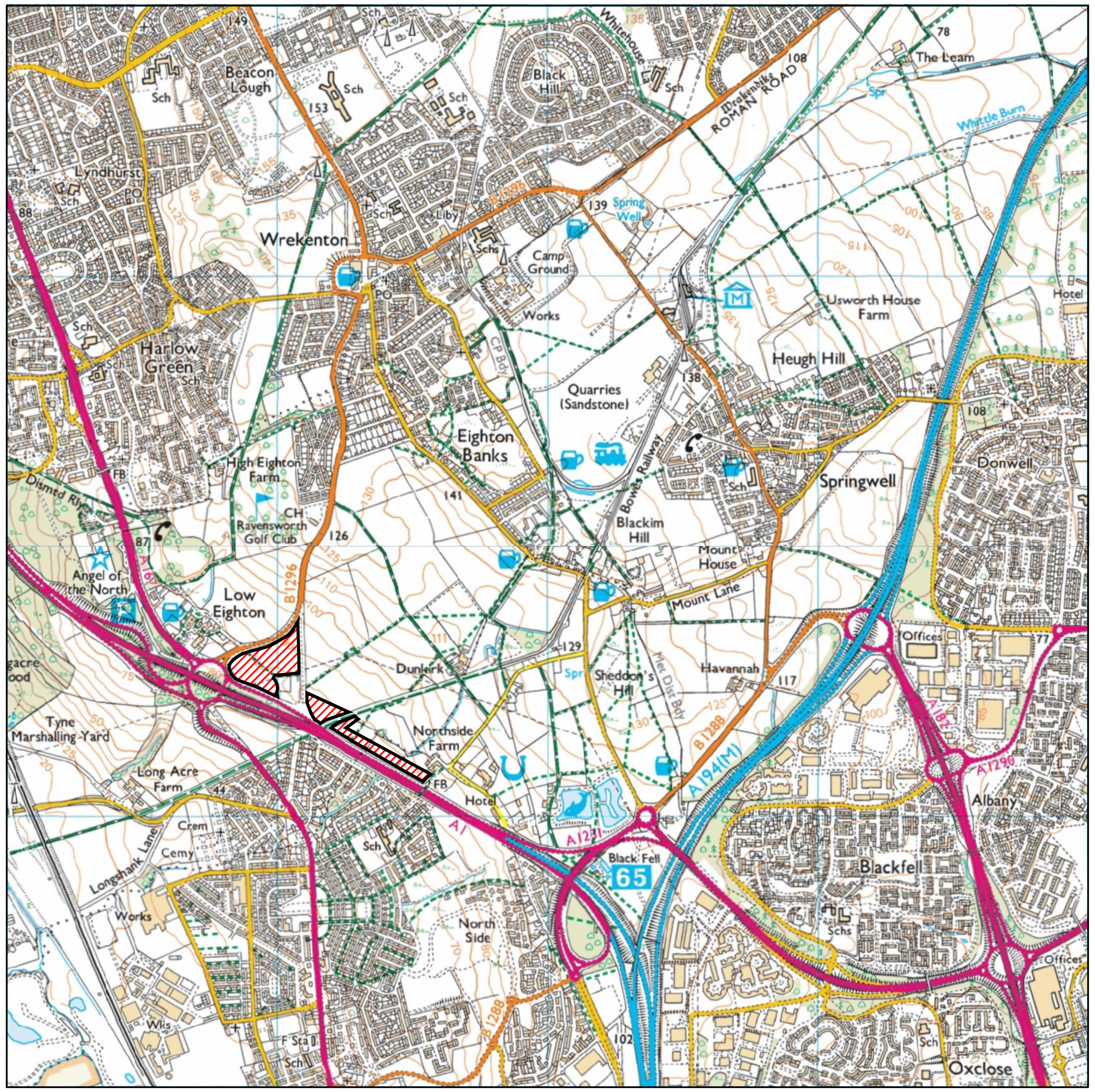

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Site Location

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SUMO Survey
GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

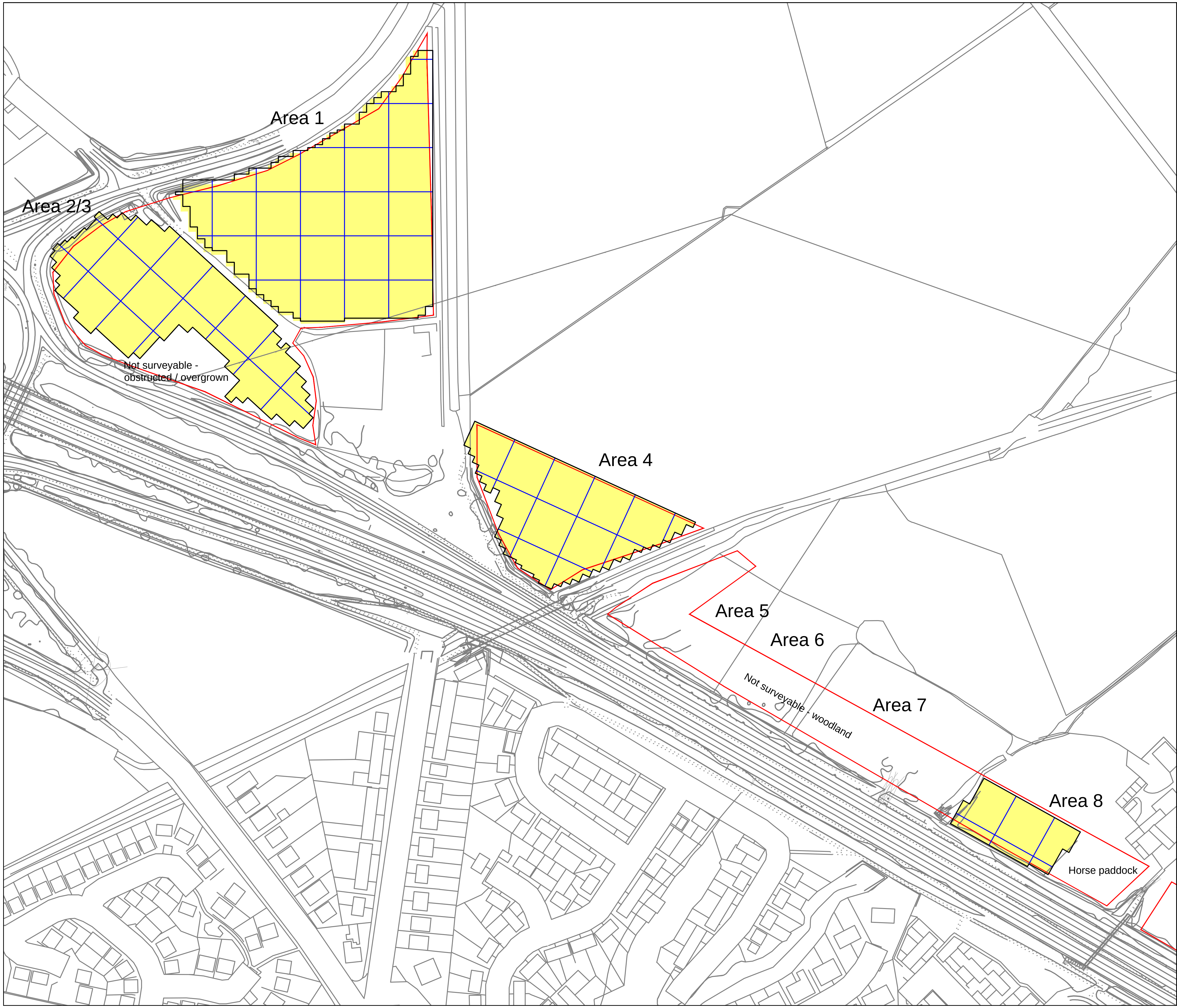
Title:
Site Location Diagram

Client:
WSP

Project:
12655 Gateshead A1

Scale:
0 metres 1250
1:25000 @ A3

Fig No:
01



Magnetometer Survey Area showing 30m grids

SUMO Survey
GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title: Location of Survey Areas

Client: WSP

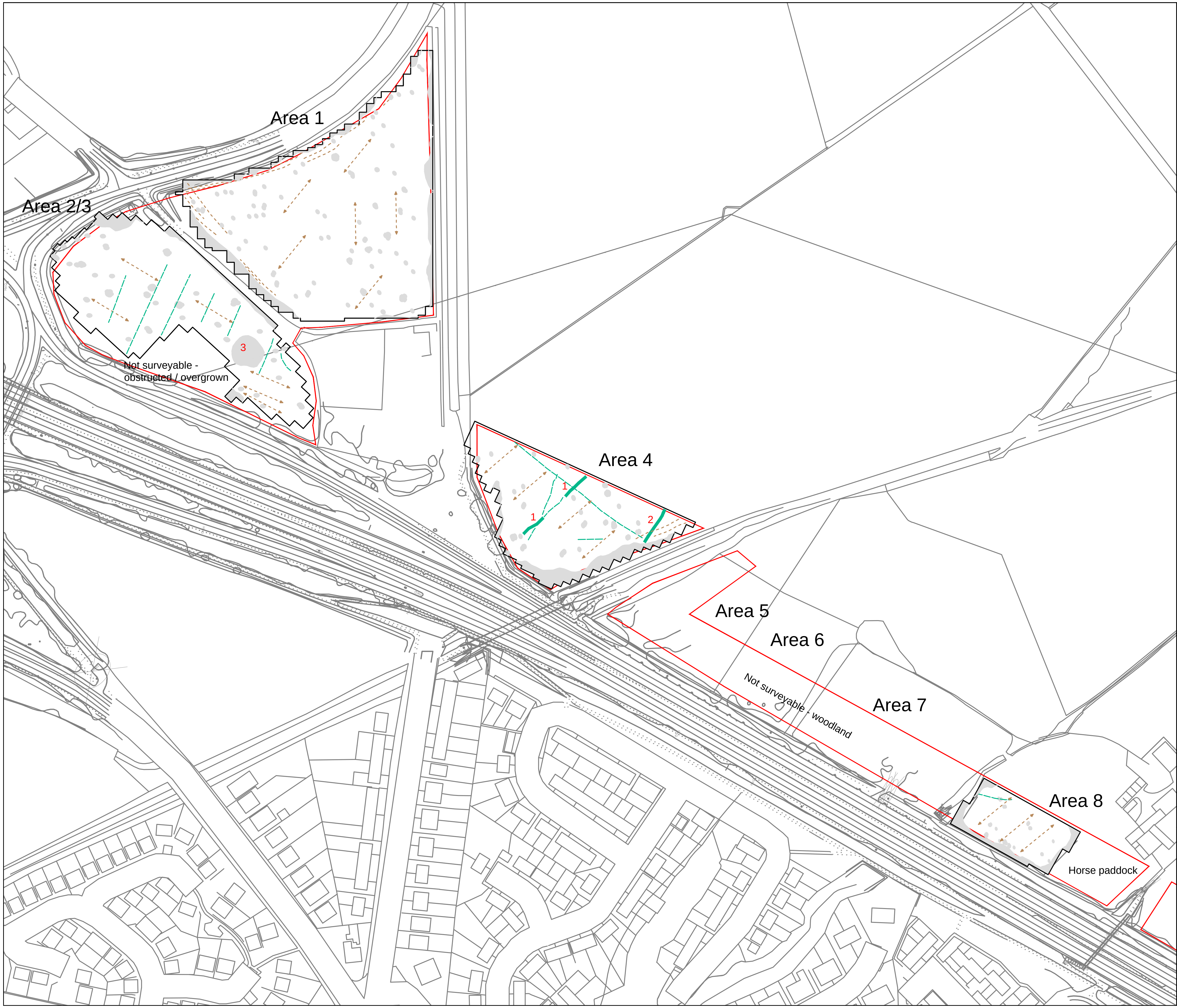
Project: 12655 Gateshead A1

Scale: 0 metres 125
1:2500 @ A3

Fig No: 02

sumo Survey
GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title:	Magnetometer Survey Greyscale Plots
Client:	WSP
Project:	12655 Gateshead A1
Scale: 0 metres 125 1:2500 @ A3	Fig No: 03



KEY

	Uncertain Origin (discrete / trend)
	Ploughing
	Ferrous

Title: Magnetometer Survey Interpretation

Client: WSP

Project: 12655 Gateshead A1

Scale: 0 metres 125

1:2500 @ A3

Fig No: 04

GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title: Minimally Processed Data - Greyscale Plots

Client: WSP

Project: 12655 Gateshead A1

Scale: 0 metres 125

1:2500 @ A3

Fig No: 05

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.

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.

Archaeology / Probable Archaeology	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.
Possible Archaeology	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.
Industrial / Burnt-Fired	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.
Former Field Boundary (probable & possible)	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.
Ridge & Furrow	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.
Agriculture (ploughing)	Parallel linear anomalies or trends with a narrower spacing, sometimes aligned with existing boundaries, indicating more recent cultivation regimes.
Land Drain	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.
Natural	These responses form clear patterns in geographical zones where natural variations are known to produce significant magnetic distortions.
Magnetic Disturbance	Broad zones of strong dipolar anomalies, commonly found in places where modern ferrous or fired materials (e.g. brick rubble) are present.
Service	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.
Ferrous	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.
Uncertain Origin	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 *Possible Archaeology* / *Natural* or (in the case of linear responses) *Possible Archaeology / Agriculture*; 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.

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

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