Land North of St Georges Hospital, Morpeth

Gradiometer Survey Report

Client: Cushman and Wakefield

AB Heritage Project No:60630

Date:23/01/2019

Land North of St Georges Hospital, Morpeth

Gradiometer Survey Report

Client	**Cushman and Wakefield**
Project Number	**60630**
Prepared By	**Claire Stephens**
Illustrated By	**Claire Stephens**
Approved By	**Daniel Dodds**

Rev Number	Description	Undertaken	Approved	Date
1.0	FINAL	CS	DD	23/01/2019

Enquiries To:

AB Heritage Limited (Head Office)

Jarrow Business Centre, Rolling Mill Road

Jarrow, South Tyneside, NE32 3DT

Email: info@abheritage.co.uk

Tel: 03333 440 206

CONTENTS

FIGURES

APPENDICES

1. INTRODUCTION

1.1 Project Background

1.1.1 AB Heritage Limited (hereafter AB Heritage) was commissioned by Cushman and Wakefield, to undertake a Gradiometer Survey of Land North of St George's Hospital, Morpeth, Northumberland. AB Heritage elected to use their specialist contractor SUMO Geophysics to undertake the fieldwork,

1.1.2 The work forms part of a suite of work to be included with a planning application for a residential development on the site.

1.1.3 A Written Scheme of Investigation (WSI) was produced for the work (AB Heritage 2018), which was approved by Karen Derham, Assistant County Archaeologist for Northumberland County Council (NCC).

1.2 Site Location & Description

1.2.1 The site is located on the northern edge of Morpeth and bounded by farmland to the north and the hospital car park and grounds to the south.

1.2.1 The site is located at approximately 62.5m above Ordnance Datum (OD). The topography of the land is undulating. The site rises to a highest point of approximately 69m at the centre of the site. The land in the eastern part of the site declines sharply toward the woodland and How Burn and is approximately 57m above OD at the eastern boundary.

1.3 Geology & Soils

1.3.1 The underlying bedrock on the site is Pennine Lower Coal Measures Formation - Sandstone. Sedimentary Bedrock formed approximately 318 to 319 million years ago in the Carboniferous Period. Local environment previously dominated by swamps, estuaries and deltas.

1.3.2 The superficial geology at the site is Till, Devensian - Diamicton. Superficial Deposits formed up to 2 million years ago in the Quaternary Period. Local environment previously dominated by ice age conditions (BGS Geological Viewer, 2018).

1.3.3 Soilscape 18: Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils (CU 2019).

1.4 Archaeological Background

1.4.1 Previous work has been undertaken at the site in the form of an Archaeology Desk- Based Assessment (DBA) (AB Heritage 2017). The DBA noted that the site lies in an area of known archaeological activity. Excavations have taken place to the north of the site at Pegswood Moor Farm, and to the south of the new St Georges Hospital. The DBA therefore advised that the proposed development site has the potential for the survival of archaeological remains from the prehistoric period through to the medieval period.

2. METHODOLOGY

2.1 Introduction

2.1.1 Magnetometer survey was selected for the investigation of this site as this was deemed to be the most appropriate technique for the rapid assessment of a site in this geological setting. The survey was carried out using a Bartington Grad601-2 dual fluxgate gradiometer and was conducted in accordance with Historic England's guidelines (2008).

2.1.2 The survey was undertaken on the 9th and 10th of January 2019. Site conditions were generally good where the survey was possible. The temperature remained stable during the survey period with firm ground under foot.

2.2 Method

2.2.1 The survey grid nodes were established at 30m x 30m intervals using a Leica Viva RTK GNSS instrument. Positional corrections are provided for this system by SmartNet, which gives a precision of approximately 0.03m and therefore exceeds the Historic England minimum requirements for geophysical survey (2008).

2.2.2 The Bartington Grad601-2 gradiometer system has two sensor tubes set at a horizontal separation of 1m; this allows for two lines of data to be collected simultaneously. The upgraded system has an effective sensitivity of 0.03nT. Data were collected at 0.25m intervals along transects spaced 1m apart using the zigzag method. This survey strategy is in accordance with Historic England's minimum requirements for geophysical survey (2008).

2.2.3 The survey data were subject to minimal correction processes using Geoplot. The processing functions used include:

- Group Zero Median Traverse (GZMT): This was applied to remove minor variations between the two Bartington sensors. This method of processing prevents the removal of archaeological features that run in-line with the traverse direction. Thresholds of ±5nT were applied.
- Zero Median Traverse (ZMedT): This was applied to all grids to remove minute variations between the two Bartington sensors left behind by GZMT. Thresholds of ±1nT were applied.
- Zero Mean Traverse (ZMT): This was applied to grids dominated by ferrous responses where GZMT failed to remove sensor variations. Thresholds of ±5nT were applied.
- Deslope: This was used on selected grids to correct minor grid edge discontinuities introduced by earlier processing steps.
- Destagger: This corrects small errors in traverse position introduced by varying topography and ground cover.

2.2.4 Further details of the survey equipment, fieldwork procedures and methods of processing are described in **Appendix 1**.

3. RESULTS & INTERPRETATION

3.1 Introduction

3.1.1 Ground conditions severely limited the area available for survey. In addition to several young tree plantations, a combination of tall weeds, dense tangled undergrowth, steep slopes and uneven ground rendered many parts of the site unsuitable for safe data collection.

3.2 Probable / Possible Archaeology

3.2.1 No magnetic responses have been recorded that could be interpreted as being of probable or possible archaeological interest.

3.3 Uncertain

3.3.1 In the areas less affected by magnetic disturbance (see below), a few isolated small discrete anomalies and linear trends have been identified. They do not form any obvious patterns that would suggest a specific origin. Although the wider regional context means that an archaeological origin cannot be dismissed entirely; on balance it seems more likely that they relate to the modern disturbance at the site.

3.4 Magnetic Disturbance / Ferrous

3.4.1 Ferrous and strongly magnetic responses predominate across the entire dataset. This magnetic disturbance reflects spreads of strongly magnetic material (iron, brick, cinders etc) deposited across the site, probably as a result of deliberate dumping. Utilising different plotting levels, several core areas (where the disturbance is most severe) have been identified. The main one of these coincides with the central mound. To the south of this, one small core zone displays a rectilinear pattern which might indicate deliberate infill of a former structure, though this interpretation is tentative.

3.4.2 The levels of disturbance are such that they will have masked any underlying weaker responses, regardless of origin.

3.4.3 A few discrete ferrous anomalies have been highlighted. These relate to modern surface and buried features, including several borehole caps.

4. DATA APPRAISAL AND CONFIDENCE ASSESSMENT

4.1.1 Substantial late prehistoric / RB archaeological features would be expected to produce readily identifiable magnetic responses over the prevailing geology. In this instance however, the widespread magnetic disturbance will have masked any weaker anomalies, regardless of origin; this, together with the limited area available for safe data collection, has severely impacted a full assessment of the site's archaeological potential.

5. CONCLUSIONS

5.1.1 The whole of the area surveyed is dominated by magnetic disturbance, of presumed modern origin associated with the stockpiling of material from the St Georges Hospital site. The most severe area of disturbance coincides with a central topographic mound and is thought to reflect a deliberate dump of material. In the areas less affected by the noise, no anomalies of obvious archaeological interest have been identified. A few isolated discrete responses and trends are highlighted but their origin cannot be determined.

6. REFERENCES

ABH 2017 Land North of St George's Hospital, Morpeth: Desk Based Assessment

ABH 2018 Land North of St Georges Hospital, Morpeth: WSI for Archaeological Work

BGS 2019 British Geological Survey, Geology of Britain viewer [accessed 22/01/2019] *website*: (http://www.bgs.ac.uk/opengeoscience/home.html?Accordion1=1#maps)

CIfA 2014 *Standard and Guidance for Archaeological Geophysical Survey.* Amended 2016. CIfA Guidance note. Chartered Institute for Archaeologists, Reading http://www.archaeologists.net/sites/default/files/CIfAS%26GGeophysics_2.pdf

CU 2019 The Soils Guide. Available: www.landis.org.uk. Cranfield University, UK. [accessed 22/01/2019] *website: http://mapapps2.bgs.ac.uk/ukso/home.html*

EAC 2016 *EAC Guidelines for the Use of Geophysics in Archaeology,* European Archaeological Council, Guidelines 2.

EH 2008 *Geophysical Survey in Archaeological Field Evaluation.* English Heritage, Swindon https://content.historicengland.org.uk/images-books/publications/geophysical-survey-in-archaeological-field-evaluation/geophysics-guidelines.pdf/

OASIS DATA COLLECTION FORM: England

Printable version

OASIS ID: abherita1-360574

Project details

Project name	Land North of St Georges Hospital, Morpeth Gradiometer Survey Report
Short description of the project	A Gradiometer Survey of Land North of St George's Hospital, Morpeth, Northumberland.
Project dates	Start: 09-01-2019 End: 23-01-2019
Previous/future work	No / Yes
Any associated project reference codes	STG19 - Sitecode
Type of project	Field evaluation
Site status	None
Current Land use	Grassland Heathland 2 - Undisturbed Grassland
Monument type	0 None
Significant Finds	0 None
Methods & techniques	"Geophysical Survey"
Development type	Housing estate
Prompt	Planning Application
Position in the planning process	Pre-application
Solid geology (other)	Pennine Lower Coal Measures Formation - Sandstone. Sedimentary Bedrock formed approximately 318 to 319 million years ago in the Carboniferous Period.
Drift geology (other)	Till
Techniques	Magnetometry

Project location

Country	England
Site location	NORTHUMBERLAND CASTLE MORPETH MORPETH Land to the north of St George’s Hospital, Morpeth, Northumberland
Postcode	NE61 2NU
Study area	5.1 Hectares
Site coordinates	NZ 20220 87381 55.180257616045 -1.682450731384 55 10 48 N 001 40 56 W Point
Height OD / Depth	Min: 57m Max: 62.5m

Project creators

Name of Organisation	AB Heritage Limited

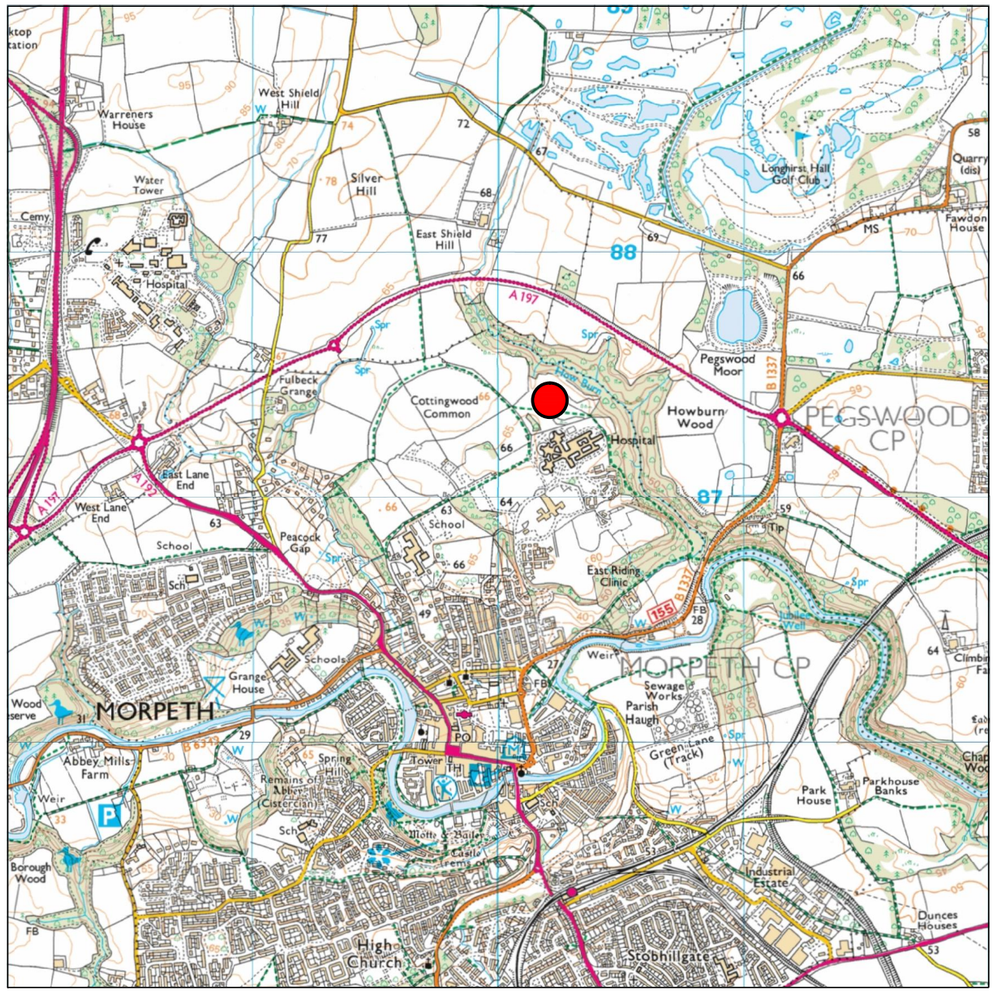
Project brief originator	Local Planning Authority (with/without advice from County/District Archaeologist)
Project design originator	AB Heritage Limited
Project director/manager	AB Heritage Limited
Project supervisor	Sumo GSB
Type of sponsor/funding body	Developer

Project archives

Physical Archive Exists?	No
Digital Archive Exists?	No
Digital Media available	"Geophysics"
Paper Archive Exists?	No

Entered by	Kim McDonald (info@abheritage.co.uk)
Entered on	24 July 2019

OASIS:



N

Site Location

sumo Survey
GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

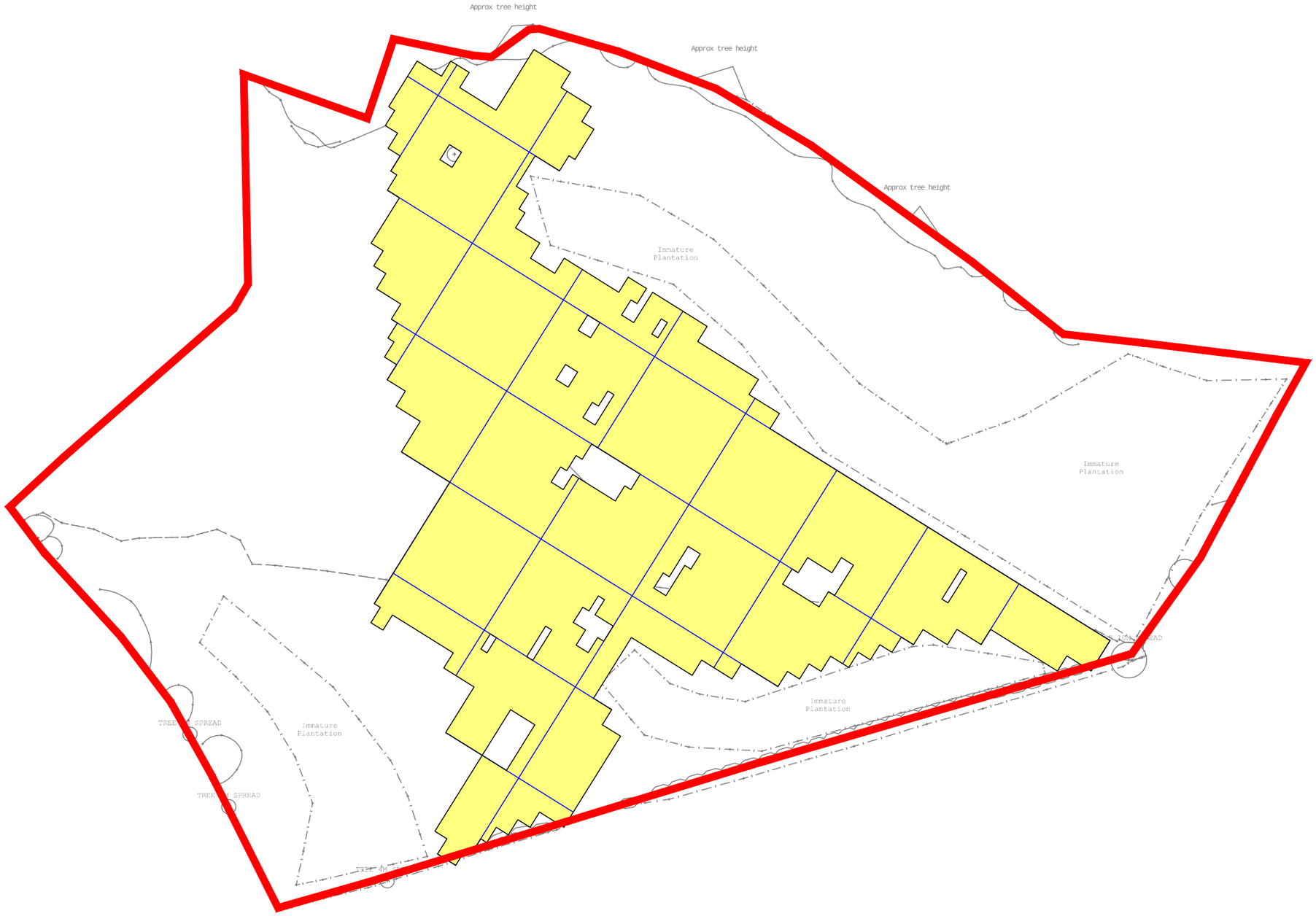
Title:
Site Location Diagram

Client:
AB Heritage

Project:
14194 Land North of St. George's Hospital, Morpeth, Northumberland

Scale:
0 metres 1250
1:25000 @ A3

Fig No:
01



N

Magnetometer Survey Area showing 30m grids

sumo Survey
GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title:
Location of Survey Area

Client:
AB Heritage

Project:
14194 Land North of St. George's Hospital, Morpeth, Northumberland

Scale:
0 metres 62.5
1:1250 @ A3

Fig No:
02

N

3
nT
-2

sumo Survey
GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

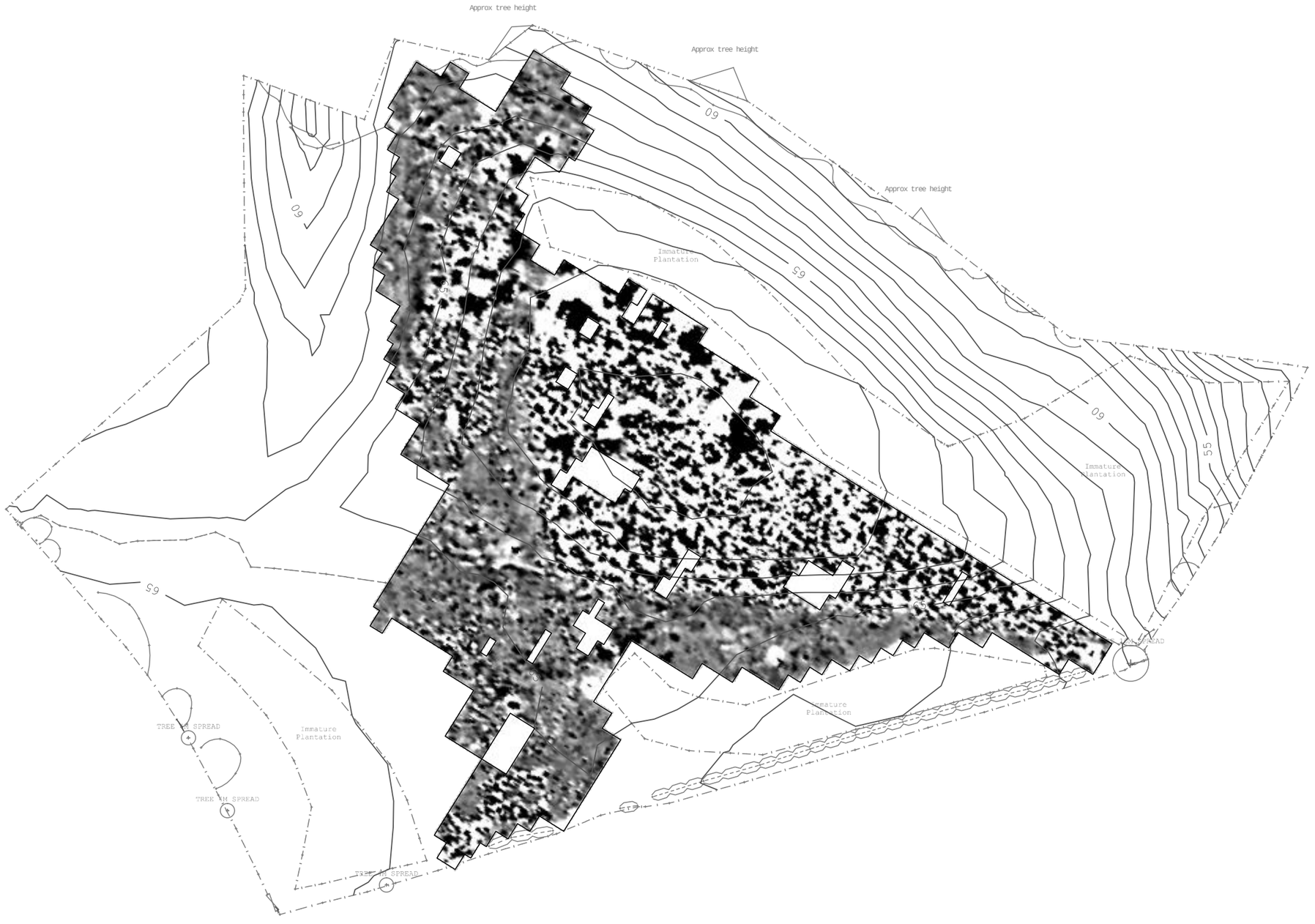
Title:
Magnetometer Survey
Greyscale Plot at -2 to 3 nT

Client:
AB Heritage

Project:
14194 Land North of St. George's Hospital, Morpeth, Northumberland

Scale:
0 metres 62.5
1:1250 @ A3

Fig No:
03



N

8
nT
-8

sumo Survey
GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title:
Magnetometer Survey
Greyscale Plot at -8 to 8 nT

Client:
AB Heritage

Project:
14194 Land North of St. George's Hospital, Morpeth, Northumberland

Scale:
0 metres 62.5
1:1250 @ A3

Fig No:
04

N

20
nT
-20

sumo Survey
GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title:
Magnetometer Survey
Greyscale Plot at -20 to 20 nT

Client:
AB Heritage

Project:
14194 Land North of St. George's Hospital, Morpeth, Northumberland

Scale:
0 metres 62.5
1:1250 @ A3

Fig No:
05

N

KEY

	Uncertain Origin (discrete anomaly / trend)
	Magnetic Disturbance (core area / general)
	Ferrous (discrete anomaly)

sumo Survey
GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title:
Magnetometer Survey
Interpretation

Client:
AB Heritage

Project:
14194 Land North of St. George's Hospital, Morpeth, Northumberland

Scale:
0 metres 62.5
1:1250 @ A3

Fig No:
06

N

5
nT
-5

sumo Survey
GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title:
Magnetometer Survey [Minimally Processed Data] Greyscale Plot

Client:
AB Heritage

Project:
14194 Land North of St. George's Hospital, Morpeth, Northumberland

Scale:
0 metres 62.5
1:1250 @ A3

Fig No:
07

Appendix A - Technical Information: Magnetometer Survey Method, Processing and Presentation

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 (ClfA 2014) and the European Archaeological Council (EAC 2016).

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.

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.

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.

AB HERITAGE
ARCHAEOLOGICAL CONSULTANCY

AB Heritage Limited (Head Office)
Jarrow Business Centre, Rolling Mill Road, Jarrow, South Tyneside, NE32 3DT
Tel: 03333 440 206
e-mail: info@abheritage.co.uk