Substrata
Archaeological Geophysical Surveyors

An archaeological gradiometer survey

Land adjacent to Bottle Bridge Hill Chudleigh, Devon

Ordnance Survey (E/N): 287120,79950 (point)

Report: 140725

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25 July 2014

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Accompanying CD-ROM

1 Survey description and summary

Type of survey:	twin-sensor fluxgate gradiometer
Date of survey:	30 June 2014
Area surveyed:	1.5ha
Lead surveyor:	Ross Dean BSc MSc MA MIfA

Client
AC Archaeology Ltd, 4 Halthaies Workshops, Bradninch, Nr Exeter, Devon EX5 4QL

Location

Site:	Land adjacent to Bottle Bridge Hill
Parish & Town:	Chudleigh
District:	Teignbridge
County:	Devon
Nearest Postcode:	TQ13 0JY
NGR:	SX 871 799
Ordnance Survey E/N:	287120,79950 (point)
OASIS number:	substrat1-185679
Archive:	At the time of writing, the archive of this survey will be held by Substrata.

Summary
This report was commissioned by AC Archaeology Ltd on behalf of clients and has been prepared in support of a forthcoming planning application. The location of the proposed development area is shown in Figure 4.

The magnetic contrast across the area was sufficient to be able to differentiate between anomalies representing possible archaeological features and background magnetic responses. Fourteen magnetic anomaly groups were identified as pertaining to archaeological deposits or structures. Of these, three groups coincide with field boundaries mapped by the Ordnance Survey in 1888 and removed sometime before 1936. Two groups may represent highly heated in-situ deposits that can be associated with, for example, former hearths, kilns, furnaces or cremation burials. One of these groups may have an associated stony deposit. One group represents a possible curvilinear deposit of unknown archaeological provenance. A group of parallel linear deposits are likely to represent former ridge-and-furrow ploughing. The remaining anomaly groups are most likely to represent linear deposits associated with more than one phase of former field and/or enclosure boundaries and which are not recorded on any Ordnance Survey maps.

2 Survey aims and objectives

Survey aims
1. Define and characterise and detectable archaeological remains on the site.
2. Inform any future archaeological investigation of the area.

Survey Objectives
1. Complete a gradiometer survey across agreed parts of the survey area.
2. Identify any magnetic anomalies that may be related to archaeological deposits, structures or artefacts.
3. Within the limits of the techniques and dataset, archaeologically characterise any such anomalies or patterns of anomalies.
4. Accurately record the location of the identified anomalies.
5. Produce a report based on the survey that is sufficiently detailed to inform any subsequent development on the site about the location and possible archaeological character of the recorded anomalies.

3 Standards

The standards used to complete this survey are defined by the Institute for Archaeologists (2011). The codes of approved practice that were followed are those of the Institute for Archaeologists (2008 and 2009) and Archaeology Data Service/Digital Antiquity Guides (undated). The document text was written using the house style of the Institute for Archaeologists (Institute for Archaeologists, undated).

4 Site description

Landscape and land use

The survey area comprised one field shown in Figure 4. At the time of the survey the field was under grass pasture. The field boundaries were hedged and overgrown in parts.

Geology

The site is located on a solid geology of mudstone and sandstone of the Carboniferous Crackington Formation sandstones. These rocks comprise rhythmically bedded, dark blue-grey mudstones and subordinate predominantly grey sandstones and siltstones. The sandstone percentage varies from 20-75%, both vertically and geographically. Scattered ironstone nodules are present in the uppermost part of the Formation. The superficial geology is not recorded in the source used (British Geological Survey, undated).

5 Archaeological background

The Devon and Dartmoor Historic Environment Record (HER) was unavailable via the Heritage Gateway (English Heritage, undated 1) at the time the report was produced. A description of the heritage assets relevant to the application area will be produced elsewhere as part of this programme of work.

Historical Landscape Characterisation

Modern enclosures adapting post-medieval fields: modern enclosures that have been created by adapting earlier fields of probable post-medieval date (Devon County Council, undated).

6 Results, discussion and conclusions

This survey was designed to record magnetic anomalies. The anomalies themselves cannot be regarded as actual archaeological features and the dimensions of the anomalies shown do not represent the dimensions of any associated archaeological features. The analysis presented below attempts to identify and characterise anomalies and anomaly groups that may pertain to archaeological deposits and structures.

The reader is referred to section 7.

6.1 Results

Figure 1 shows the interpretation of the survey. It includes the anomaly groups identified as pertaining to archaeological deposits along with their numbers. Table 1 is an extract from a detailed analysis of the survey data provided in the attribute tables of the GIS project on the accompanying CD-ROM.

Figure 1 along with table 1 comprises the analysis of the survey data.

Plots of the processed data are provided in figures 2 and 3 (appendix 1).

Site: An archaeological gradiometer survey
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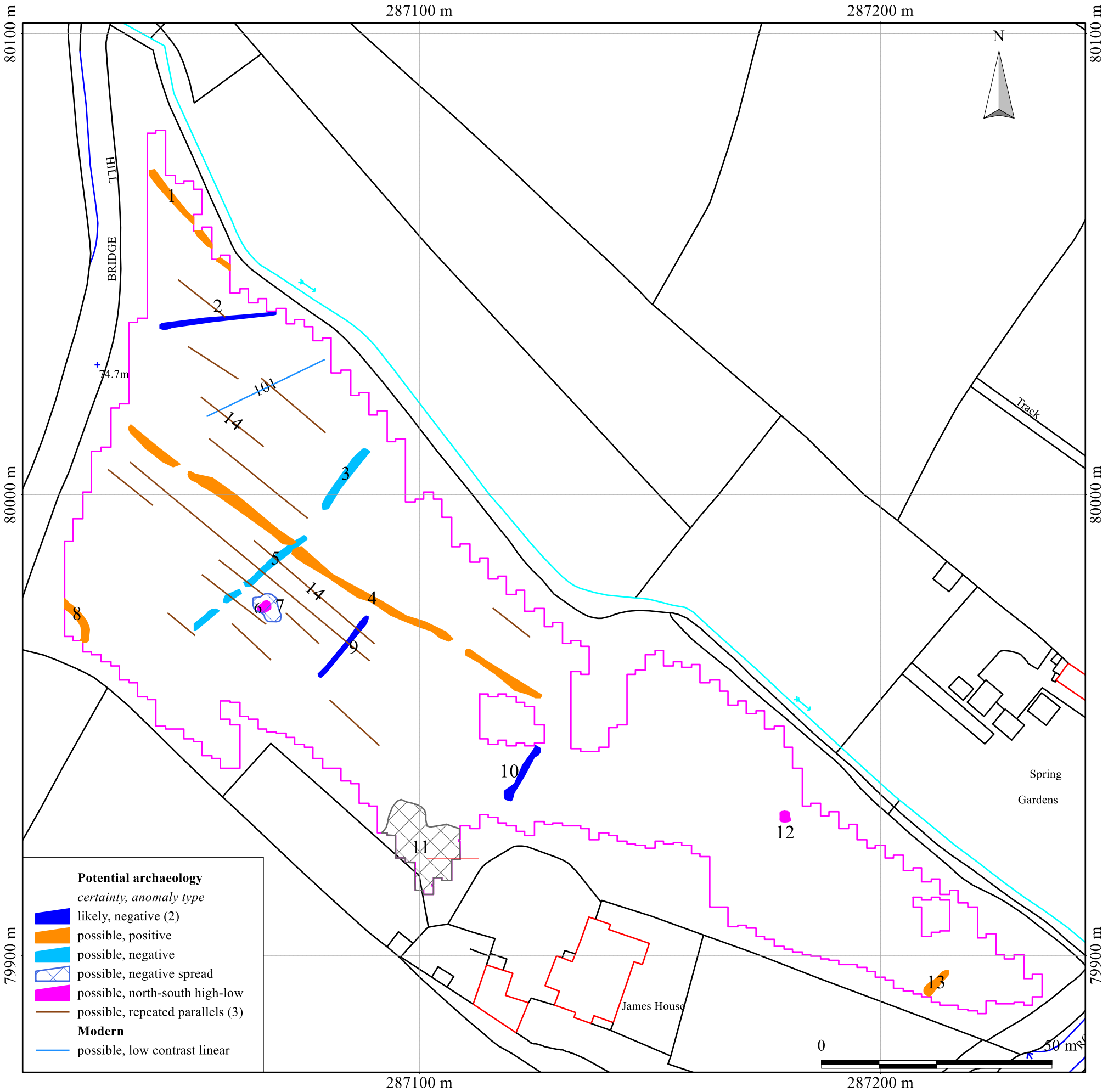
anomaly group	anomaly characterisation certainty & class	anomaly form	additional archaeological characterisation	comments	supporting evidence
1	possible, positive	disrupted linear			
2	likely, negative	linear	field boundary	anomaly group coincides with a former field boundary mapped by the Ordnance Survey between 1888 and 1906	Ordnance Survey maps between1888 (1:2500) and 1906 (1:10560)
3	possible, negative	disrupted linear			
4	possible, positive	disrupted linear			
5	possible, negative	disrupted linear			
6	possible, negative spread	irregular	stony deposit	anomaly group represents either a stony deposit or the magnetically negative 'shadow' anomaly or a high positive anomaly	
7	possible, north-south high-low		in-situ heating event	anomaly group may represent an in-situ heating event	
8	possible, positive	curvilinear			
9	likely, negative	linear	field boundary	anomaly group coincides with a former field boundary mapped by the Ordnance Survey between 1888 and 1890-1	Ordnance Survey maps between1888 (1:2500) and 1891 (1:10560)
10	likely, negative	linear	field boundary	anomaly group coincides with a former field boundary mapped by the Ordnance Survey between 1888 and 1906	Ordnance Survey maps between1888 (1:2500) and 1906 (1:10560)
11	possible, mixed spread	irregular	rubble deposit		
12	possible, north-south high-low		in-situ heating event	anomaly group may represent an in-situ heating event or a deposit of ferrous material	
13	possible, positive	linear			
14	possible, repeated parallels		ridge-and-furrow cultivation		
101	possible, low contrast linear		service trench or field drain		

Table 1: data analysis



British Grid
centre X: 287129.17 m, centre Y: 79988.48 m

Scale: 1:900 @ A3. Spatial Units: Meter. Do not scale off this drawing

Notes:
1. All interpretations are provisional and represent potential archaeological deposits.
2. Anomalies designated "likely archaeology" have supporting evidence e.g. historical maps and or visible earthworks.
3. Representative; not all instances are mapped.
4. Anomalies likely to represent geological or other natural deposits are not mapped unless relevant to potential archaeological events or deposits.

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Figure 1: survey interpretation

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6.2 Discussion

Refer to Figure 1 (this section) and Figures 2 and 3 (Appendix 1). Not all anomalies or anomaly groups identified in the survey dataset are necessarily discussed below. All identified anomaly groups are recorded in the GIS project on the accompanying CD-ROM. Those anomaly groups possibly representing archaeological deposits are included in the data analysis (Table 1).

General points
There are distinct, parallel, closely spaced, northwest to southeast trending linear patterns in the magnetic response across the south-eastern part of the survey area. These patterns reflect recent ploughing and crop sowing.

Anomalies though to relate to natural features were not mapped. Recent man-made objects such as manholes, water management equipment or drains have not been mapped except where they comprise significant magnetic responses across the dataset.

Data collection along the field edges was restricted as shown in Figures 2 and 3 due to the width of the hedges making up the field boundaries and to the presence of magnetic materials and objects in and adjacent to the field boundaries. Strong magnetic responses mapped close to the field boundaries are likely to relate to these items except where indicated otherwise in Figure 1.

Data collection within the field was restricted by the presence of trees as shown in Figures 2 and 3.

Data relating to historical maps and other records
Anomaly groups **2 and 10** coincide with field boundaries mapped by the Ordnance Survey between 1888 and 1906 and removed sometime before 1936.

Anomaly group **9** coincides with a field boundary mapped by the Ordnance Survey between 1888 and 1890-91 and removed sometime before 1905.

Data with no previous provenance
Groups **1, 4 and 13** are magnetically positive anomaly patterns that may relate to linear deposits such as filled ditches and, as such, are most likely to relate to former field or enclosure boundaries of unknown date and removed before the production of the 1888 Ordnance Survey map.

Groups **3 and 14** are magnetically negative anomaly patterns that may relate to stony linear deposits and, as such, are most likely to relate to former field or enclosure boundaries of unknown date and removed before the production of the 1888 Ordnance Survey map.

Group **6** has a pattern that is often associated with highly heated in-situ deposits such as those left by cremations, hearths, kilns and furnaces. Group **7** represents a possible stony deposit surrounding group 6 or the magnetically negative 'shadow' anomaly associated with group 6. That latter has no archaeological significance but if the former proves to be the case then the features represented by anomalies 6 and 7 may be associated in an archaeological context.

Group **12** is similar to group 6 and may also represent a highly heated in-situ deposit that may result from cremations, hearths, kilns and furnaces. In this case the anomaly pattern is less clear and could alternatively be the result of a fortuitously orientated ferrous object.

Group **8** represents a curvilinear deposit of unknown provenance.

Group 11 represents a deposit of rubble of unknown date.

Group **14** comprises a set of parallel linear anomalies across the western side of the survey area. They are most likely to represent former ridge-and-furrow ploughing.

6.3 Conclusions

The magnetic contrast across the area was sufficient to be able to differentiate between anomalies representing possible archaeological features and background magnetic responses. Fourteen magnetic anomaly groups were identified as pertaining to archaeological deposits or structures. Of these, three groups coincide with field boundaries mapped by the Ordnance Survey in 1888 and removed sometime before 1936. Two groups may represent highly heated in-situ deposits that can be associated with, for example, former hearths, kilns, furnaces or cremation burials. One of these groups may have an associated stony deposit. One group represents a possible curvilinear deposit of unknown archaeological provenance. A group of parallel linear deposits are likely to represent former ridge-and-furrow ploughing. The remaining anomaly groups are most likely to represent linear deposits associated with more than one phase of former field and/or enclosure boundaries and which are not recorded on any Ordnance Survey maps.

7 Disclaimer and copyright

The description and discussion of the results presented in this report are the authors, based on his interpretation of the survey data. Every effort has been made to provide accurate descriptions and interpretations of the geophysical data set. The nature of archaeological geophysical surveying is such that interpretations based on geophysical data, while informative, can only be provisional. Geophysical surveys are a cost-effective early step in the multi-phase process that is archaeology. The evaluation programme of which this survey is part may also be informed by other archaeological assessment work and analysis. It must be presumed that more archaeological features will be evaluated than those specified in this report.

8 Acknowledgements

Substrata would like to thank John Valentin of AC Archaeology Ltd for commissioning us to complete this survey.

9 Bibliography

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Appendix 1 Supporting plots

General Guidance

The anomalies represented in the survey plots provided in this appendix are magnetic anomalies. The apparent size of such anomalies and anomaly patterns are unlikely to correspond exactly with the dimensions of any associated archaeological features.

A rough rule for interpreting magnetic anomalies is that the width of an anomaly at half its maximum reading is equal to the width of the buried feature, or its depth if this is greater (Clark, 2000: 83). Caution must be applied when using this rule as it depends on the anomalies being clearly identifiable and distinct from adjacent anomalies. In northern latitudes the position of the maximum of a magnetic anomaly will be displaced slightly to the south of any associated physical feature.

British Grid
centre X: 287129.17 m, centre Y: 79988.48 m

Scale: 1:900 @ A3. Spatial Units: Meter. Do not scale off this drawing

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Figure 2: shade plot of processed data

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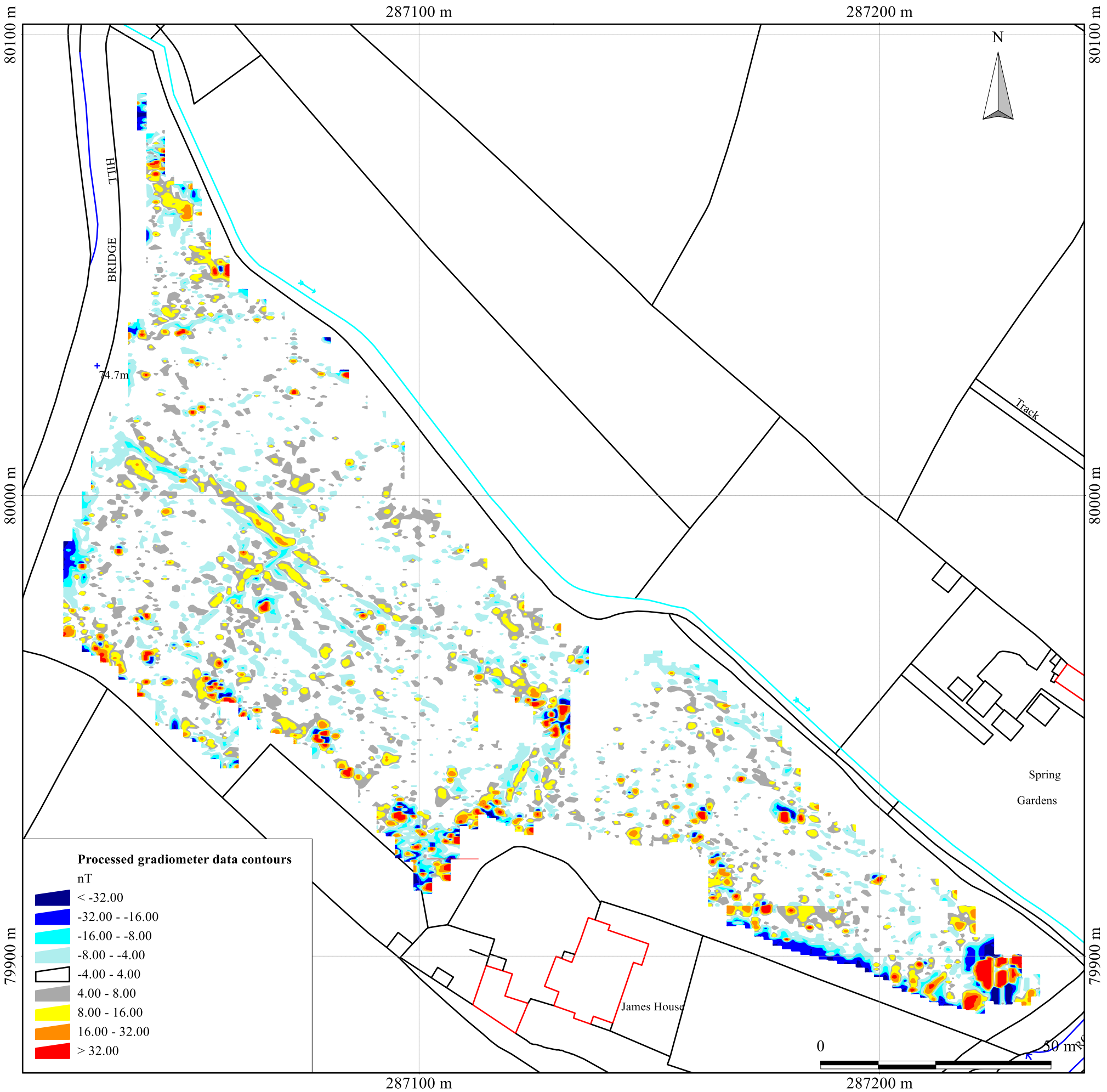

British Grid
centre X: 287129.17 m, centre Y: 79988.48 m

Scale: 1:900 @ A3. Spatial Units: Meter. Do not scale off this drawing

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Figure 3: contour plot of processed data

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Fulfords Land and Planning
LOCATION PLAN

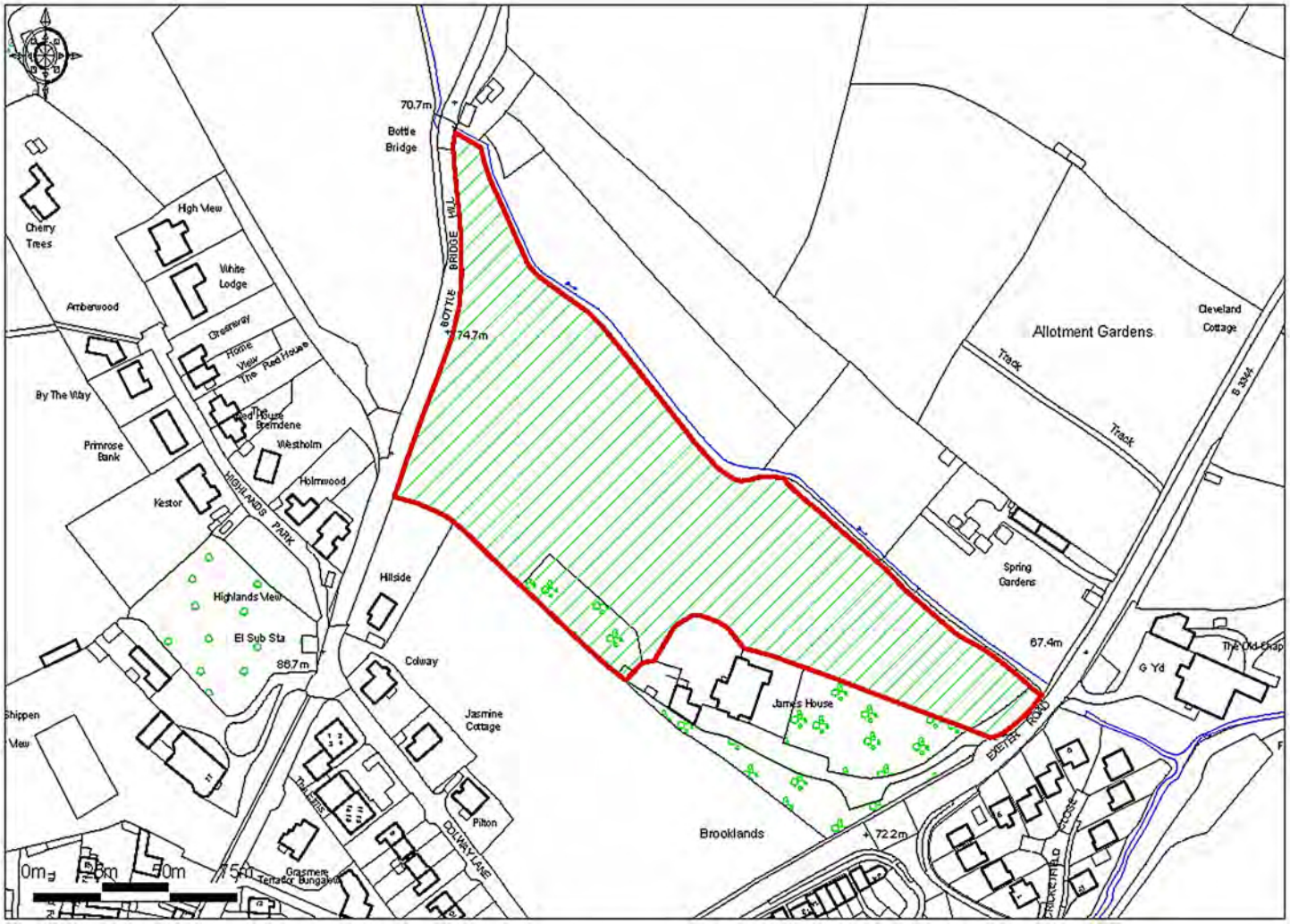

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Figure 4: location of site

Appendix 2 Methodology Summary

<table>
<tr><th colspan="2">Table 2: methodology summary, field 1 (refer to Heard 2006for field 2)</th></tr>
<tr><td colspan="2">Documents
Survey methodology statement: Dean (2014)</td></tr>
<tr><td colspan="2">Methodology
1. The work was undertaken in accordance with the survey methodology statement. The geophysical (gradiometer) survey was undertaken with reference to standard guidance provided by the Institute for Archaeologists (2011) and Archaeology Data Service/Digital Antiquity Guides (undated).
2. The survey grid location information and grid plan was recorded as part of the project in a suitable GIS system.
3. Data processing was undertaken using appropriate software, with all anomalies being digitised and geo-referenced. The final report included a graphical and textual account of the techniques undertaken, the data obtained and an archaeological interpretation of that data and conclusions about any likely archaeology.</td></tr>
<tr><td colspan="2">Grid
Method of Fixing: DGPS set-out using pre-planned survey grids and Ordnance Survey coordinates.
Composition: 30m by 30m grids
Recording: Geo-referenced and recorded using digital map tiles.
DGPS used: Spectra Precision PM5V2 GPS with external antenna and survey pole and DigiTerra Explorer 7 as the survey control program.</td></tr>
<tr><td>Equipment
Instrument: Bartington Instruments grad601-2
Firmware: version 6.1</td><td>Data Capture
Sample Interval: 0.25-metres
Traverse Interval: 1 metre
Traverse Method: zigzag
Traverse Orientation: GN</td></tr>
<tr><td colspan="2">Data Processing, Analysis and Presentation Software
IntelliCAD Technology Consortium IntelliCAD 7.2
DW Consulting TerraSurveyor3
Manifold System 8 GIS
Microsoft Corp. Office Excel 2013
Microsoft Corp. Office Publisher 2013
Adobe Systems Inc Adobe Acrobat 9 Pro Extended</td></tr>
</table>

Appendix 3 Data processing

Table 3: gradiometer survey - processed data metadata
SITE Instrument Type: Bartington Grad 610 Units: nT Direction of 1st Traverse: 0 deg Collection Method: ZigZag Sensors: 2 @ 1.00 m spacing. Dummy Value: 32702 PROGRAM Name: TerraSurveyor Version: 3.0.22.1
Stats Max: 66.57 Min: -72.51 Std Dev: 7.79 Mean: -0.09 Median: 0.00 Processes: 6 1 Base Layer 2 Clip at 1.00 SD 3 Clip at 2.00 SD 4 De Stagger: Grids: All Mode: Both By: -3 intervals 5 DeStripe Median Sensors: cd11.xgd cd19.xgd cd20.xgd cd23.xgd cd26.xgd cd1.xgd cd10.xgd cd12.xgd cd17+cd18.xgd cd21.xgd cd22.xgd cd2.xgd cd9.xgd cd13.xgd cd16.xgd cd3.xgd cd8.xgd cd14.xgd cd4.xgd cd7.xgd cd15.xgd cd5.xgd cd6.xgd 6 DeStripe Median Traverse: Grids: cd24.xgd cd25.xgd cd27.xgd Note: importing the data into the GIS results in an x=y interpolation in the x plane.

Appendix 4 Geophysical surveying techniques

1 Introduction

Substrata offers magnetometer and earth resistance surveying. We also provide other archaeology-specific geophysical surveys such as ground penetrating radar and resistivity. The particular method or combination of methods used depends on local soil conditions and the survey requirements. These methods are capable of delivering fast and accurate assessments of the archaeology of both large and small sites.

Further details can be found on our website at www.substrata.co.uk.

2 Magnetometer surveying

Standard magnetometer surveys are the workhorse of archaeological surveying when speed and cost-effectiveness are important. Identifiable archaeological features include areas of occupation, hearths, kilns, furnaces, ditches, pits, post-holes, ridge-and-furrow, timber structures, wall footings, roads, tracks and similar buried features.

Magnetometer surveying is used to detect and map small changes in the earth's magnetic field caused by concentrations of ferrous-based minerals within the soil and subsoil, and by materials buried beneath the surface. While most of these changes are too small to affect a compass needle, they can be detected and mapped by sensitive field equipment. During surveys the different magnetic properties of top-soils, sub-soils, rock formations and archaeological features are recorded as variations against a background value. Subsequently magnetic anomalies resulting from potential archaeology can be identified and interpreted.

Bartington grad601-2 gradiometers

A gradiometer is a type of magnetometer and is sensitive to relatively small changes in the earth's magnetic field. Our primary surveying instruments are Bartington Grad601-2 (dual sensor) fluxgate gradiometers with automatic data loggers. They are specifically designed for field use by archaeologists. The Bartington gradiometers provide proven technology in archaeological magnetic surveying and offer fast, accurate set-up and survey rates. They are sensitive to depths of between 0 and 1.5m below ground level, with optimum sensitivity at depths of 1m or less.

Multiple sensor arrays

A technique relatively new to commercial archaeological surveying but well understood in academic circles involves the use of multiple magnetometer sensors towed behind a quad bike or similar vehicle. With multiple sensors and the use of on-board GPS units, it is possible to achieve faster survey rates at competitive commercial rates when compared to the use of multiple instruments and the techniques discussed above provided the ground is suitable for the vehicle and array. Substrata is pleased to announce that we now offer this service on suitable larger sites

3 Earth resistance surveying

Earth resistance surveying is an excellent tool for detecting buried archaeology. Its relatively slow rate of survey compared to magnetometer surveys means that it usually employed in commercial surveys when a detailed understanding of buried building remains is required. This technique measures changes in the electrical resistance of the ground being surveyed. In practice, the recording of differences in the electrical resistance of near-surface deposits and structures allows the detection and interpretation of masonry and brick foundations, paving and floors, drains and other cavities, large pits, building platforms, robber trenches, ditches, graves and similar buried features.

Resistance to electrical current flow in the ground depends on the moisture content and structure of the soil and other materials buried beneath the surface. For example, the higher the moisture content of a soil, the less resistant it is to electrical current flow. A ditch completely buried beneath the present ground surface is likely to have an infill soil different to that surrounding the ditch in terms of compactness and composition. As a result, the soil filling the buried ditch will retain moisture in a different way to the surrounding soil which means it will

have an electrical resistance at variance with the surrounding environment. By passing a small current through the ground it is possible to detect, record, plot and interpret such changes in electrical resistance.

For earth resistance surveying Substrata uses the Geoscan Research RM15 series multi-probe resistance meters and purpose-built automatic data-loggers. The Geoscan MPX15 multiplexer is an integral part to the instrument configuration and facilitates multi-probe arrays which speed up survey area coverage rates and, if required, facilitate simultaneous multiple-depth data collection.