Substrata
Archaeological Geophysical Surveyors

An archaeological gradiometer survey

Land at Liskey Hill
Perranporth, Cornwall

Ordnance Survey E/N: 176000,53700 (point)

Report: 140306

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6 March 2014

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Accompanying CD-ROM

1 Survey description and summary

Type of survey: twin-sensor fluxgate gradiometer
Date of survey: 18 and 20 February 2014
Area surveyed: 4.35 ha
Lead surveyor: Ross Dean BSc MSc MA MIfA

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

Location

Site:	Land Liskey Hill, Perranporth
Civil Parish:	Perranzabuloe
County:	Cornwall
Nearest Postcode:	TR6 0HF
NGR:	SW 760 537 (point)
Ordnance Survey E/N:	176000,53700 (point)
OASIS number:	substrata1-173601
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 Taylor Wimpey Exeter. It was prepared by Substrata as supporting information for a forthcoming planning application relating to a proposed residential development at the above site. The location of the site is shown in figure 4.

An Archaeological Assessment of the site and surrounding area was prepared by Exeter Archaeology during May 2010 (Manning, 2010).

The magnetic contrast across the survey areas was sufficient to be able to differentiate between anomalies representing possible archaeological features and background magnetic responses.

Forty-five magnetic anomaly groups were identified as pertaining to archaeological deposits or structures. The survey shows a local archaeological landscape dominated by changing field boundaries, field drainage and mining activities. No direct evidence of past settlement was recorded in the dataset although two sub-circular magnetic anomalies could possibly pertain to structures such as round houses or ring ditches. However, at least one of these may be associated with nineteenth century mining activities. Of the remaining anomaly groups, four may be related to former mining activities. A further ten groups coincide with former field boundaries mapped on historical maps from 1840 onwards. The remaining groups are most likely to reflect field boundaries, enclosure boundaries and field drainage of more than one phase of past land management.

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
The site lies at the south-eastern edge of Perranporth on farmland formerly associated with the settlement of Hendrawna which lies immediately to the east. The survey area was situated within three fields bordered by residential settlement except to the southeast where it adjoins farm fields. The land slopes to the northeast from approximately 55m to 25m O.D. (figure 4, appendix 1).

Land use at the time of the survey
Grass pasture.

Geology
The site is located on a solid geology of siltstones and mudstones of the Devonian Grampound Formation. These rocks comprise thinly interlaminated grey slaty mudstone and mid-grey siltstone, weathering yellowish green, with sporadic thin beds of sandstone and sparse lenticular limestone (British Geological Survey, undated). Felsite, a fine grained volcanic igneous rock, is present at the northern end of the site (Institute of Geological Sciences 1978 after Manning, 2010: 1)

The superficial geology is not recorded in the source used (British Geological Survey, undated).

5 Archaeological background

Exeter Archaeology produced an Archaeological Assessment of the site and surrounding area in May 2010 (Manning, 2010). The reader is referred to this document for a comprehensive analysis of the historical and archaeological background of the site. What follows is a short summary of the information presented in the Assessment relevant to the understanding of the gradiometer survey.

There is considerable evidence of prehistoric activity in the vicinity, including barrow cemeteries less than 1km distant to the north-east, east, south and west. The site lies within farmland that was associated with Hendrawna in the early 19th century, and probably since the medieval period. Hendrawna is surrounded by other farms recorded at similarly early dates.

The earliest large scale map of the area is the 1840 Perranzabuloe Tithe Map which shows up to nine fields (or parts of fields) within the survey area, an east-west access lane which is still extant and a substantial building of unknown function within the site but removed by 1880. In 1840 the land was divided between a number of tenants, and was under arable cultivation. A number of the field boundaries shown on the tithe map survive as substantial hedgebanks, and may be of early origin. The removal of a number of field boundaries across the site over time is discussed in section 6 below.

The historic maps indicate that the area around the site, and the wider landscape, was dominated by post-medieval mining works (some of these may have been worked in earlier times), and a shaft has been identified within the site itself. It is possible that other remains of workings also exist below ground level. Historic maps show evidence of mining on the site. A

mining map of 1869 depicts four lodes running west-south-west to east-north-east through the site. A mine shaft was mapped on the one lode and Wheal Leisure is shown as the nearest mine to the development site. This shaft is shown as a mound on the eastern side of field 1 in figure 1.

Heritage assets

There are no designated heritage assets or non-designated heritage assets within the survey area.

Archaeological works adjacent to the survey area

There are no records for work within or immediately adjacent to the survey area.

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 (this section) shows the interpretation of the survey across all survey areas including 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.

Only those anomaly groups considered likely or possibly pertain to archaeological deposits or features are recorded in figure 1 and table 1.

Figure 1 and table 1 comprise the analysis of the survey data.

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

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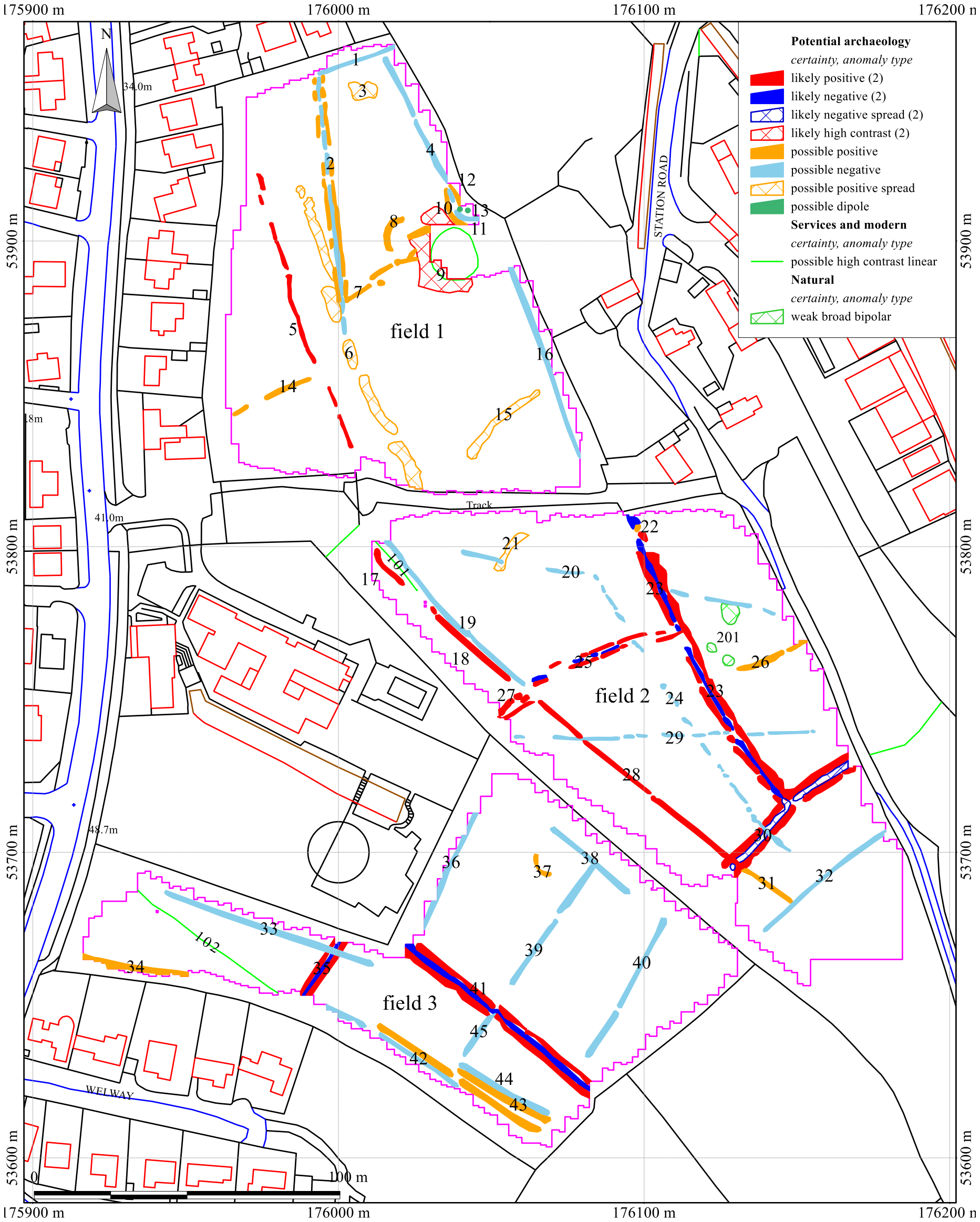
field number	anomaly group	associated anomalies	anomaly characterisation certainty & class	anomaly form	additional archaeological characterisation	comments	supporting evidence
1	1		possible negative			anomaly group may represent a leat, field drain, track or field boundary	
	2		possible pos/neg/pos	disrupted linear	field boundary	anomaly group may represent a former Cornish bank field boundary (stone-faced earth and rubble core with flanking ditches)	
	3		possible positive spread		mine shaft or natural deposits	anomaly group may represent natural deposits (possibly igneous rock) or a filled hollow, possibly a former mine shaft; no shaft has been mapped at this location.	
	4		possible negative			anomaly group may represent a leat, field drain, track or field boundary	
	5		likely positive	disrupted linear	field boundary	anomaly groups coincide with the location of a field boundary mapped on the tithe map and on subsequent OS maps to 1963	Perranzabuloe tithe map (1840) & Ordnance Survey maps between 1880 & 1963
	6		possible positive spread	disrupted broad linear			
	7		possible positive	linear		anomaly groups are adjacent to a former mine shaft mapped in 1869; archaeological relationship with the shaft is unknown	Map of Chiverton Mining District, Perranzabuloe, Cornwall by E H Brenton (1869 & Ordnance Survey maps 1880 onwards
	8		possible positive	curvilinear		anomaly group is adjacent to a former mine shaft; archaeological relationship with the shaft is unknown	
	9		likely high contrast		horse whim (?)	anomaly groups surround the location of a former mine shaft mine mapped in 1869	Map of Chiverton Mining District, Perranzabuloe, Cornwall by E H Brenton (1869 & Ordnance Survey maps 1880 onwards
	10		possible positive	curvilinear			
	11		possible negative	curvilinear			
	12		possible positive	linear			
	13		possible dipole		ferrous deposit	anomaly group mapped because of influence on surrounding anomalies needs to be illustrated - may represent relatively modern deposits	
	14		possible positive	disrupted linear			
	15		possible positive spread	broad curvilinear		anomaly group may represent archaeological deposits but could be natural deposits or bedrock	
	16		possible negative	linear		anomaly group may represent a leat, field drain, track or field boundary	
2	17		likely positive	disrupted linear	field boundary	anomaly group coincides with the location of a field boundary mapped on the tithe map and on subsequent OS maps to 1963	Perranzabuloe tithe map (1840) & Ordnance Survey maps between 1880 & 1963
	18		likely positive	disrupted linear	field boundary	anomaly group coincides with the location of a field boundary mapped on the tithe map and on subsequent OS maps to 1963	Perranzabuloe tithe map (1840) & Ordnance Survey maps between 1880 & 1963
	19		possible negative	linear		anomaly groups may represent a leat, field drain or field boundary	
	20		possible negative	disrupted linear		anomaly groups may represent field boundary or possibly a leat	
	21		possible positive spread	broad linear			
	22		possible positive	pit			
	23		likely neg/pos/neg	disrupted linear	field boundary	anomaly group coincides with the location of a field boundary mapped on the tithe map and on subsequent OS maps to 1963	Perranzabuloe tithe map (1840) & Ordnance Survey maps between 1880 & 1963
	24		possible negative	disrupted linear		anomaly groups may represent field boundary or possibly a leat	
	25		likely pos/neg/pos	disrupted linear	field boundary	anomaly group coincides with the location of a field boundary or track mapped on the tithe map but not on subsequent OS maps	Perranzabuloe tithe map (1840)
	26		possible positive	disrupted linear			
	27		likely positive	disrupted linear	field boundary	anomaly group coincides with the location of a field boundary mapped on the tithe map and on subsequent OS maps to 1963	Perranzabuloe tithe map (1840) & Ordnance Survey maps between 1880 & 1963
	28	31	likely positive	disrupted linear	field boundary	anomaly group coincides with the location of a field boundary or track mapped on the tithe map but not on subsequent OS maps	Perranzabuloe tithe map (1840)
	29		possible negative	disrupted linear		anomaly groups may represent field boundary or possibly a leat	
	30		likely pos/neg spread/pos	disrupted curvilinear	track	anomaly groups represent an edged track (ditch or bank) coinciding with a field boundary mapped on the tithe map & 1st edition OS map: the southern half is mapped on OS maps up to 1963	Perranzabuloe tithe map (1840) & Ordnance Survey maps between 1880 & 1963
	31	28	possible positive	linear		anomaly group likely to be an extension of group b or relate to relatively recent ploughing disturbance	
	32		possible negative	linear		anomaly groups may represent a field drain or field boundary	
	101		possible high contrast linear		ferrous cable, pipe or drain		
	201		weak broad bipolar		spring		
3	33		possible negative	linear		anomaly group may represent a field drain or field boundary	
	34		possible positive	curvilinear			
	35		likely pos/neg/pos	linear	field boundary: Cornish bank	anomaly group coincides with the location of a field boundary mapped on the tithe map but not on later maps	Perranzabuloe tithe map (1840)
	36		possible negative	linear		anomaly group may represent a field drain or field boundary	
	37		possible positive	curvilinear			
	38		possible negative	linear		anomaly group may represent a field drain or field boundary	
	39		possible negative	disrupted linear		anomaly group may represent a field drain or field boundary	
	40		possible negative	disrupted linear		anomaly group may represent a field drain or field boundary	
	41		likely pos/neg/pos	disrupted linear	field boundary: Cornish bank	anomaly group coincides with the location of a field boundary mapped on the tithe map and on subsequent OS maps to 1963 but not on OS maps published between1880 and 1883	Perranzabuloe tithe map (1840) & Ordnance Survey maps between 1880 & 1975
	42		possible pos & neg	linear			
	43	44	possible positive	linear			
	44	43	possible negative	linear		anomaly group may be a 'shadow anomaly' of group 43 or may represent an archaeological deposit	
	45		possible negative	linear		anomaly group may represent a field drain or field boundary	
	102		possible high contrast linear		ferrous cable, pipe or drain		

Table 1: data analysis



British Grid
centre X: 176049.58 m, centre Y: 53778.56 m

Scale: 1:1300 @ 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 deposit

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Figure: draft shade plot

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6.2 Discussion

Refer to figures 1 (this section), 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 data analysis table 1.

The field numbers are shown in figure 1.

General points
Data collection along the field edges was restricted as shown in figures 2 and 3 due to the presence of magnetic materials in and adjacent to the field boundaries.

There is are background linear trends in each of the three fields. These trends, shown as parallel linear patterns in figures 2 and 3, are likely to reflect near-surface deposits affected by relatively recent ploughing.

Data relating to historical maps and other records
Anomaly group **5** in field 1, groups **17, 18, 23, 25, 27** and **28** in field 2, and groups **35** and **41** in field 3 are mapped as field boundaries on the 1840 Perranzabuloe Tithe Map and later Ordnance Survey maps as described in table 1.

Group **30** in field 2, while mapped as a field boundary on the tithe map, has an anomaly pattern typical of a track with boundaries to each side that are likely to be ditches, earthen banks or a combination of both.

Group **9** represents deposits surrounding a former mine shaft first mapped in 1896 and mapped as a mound on modern Ordnance Survey maps.

Data with no previous provenance
Group **3** in field 1 may represent a large filled hollow which, speculatively, could be associated with past mining activities although it may reflect near-surface igneous rocks.

Group **8,** field 1, is a partial subcircular anomaly that may be associated with the adjacent mineshaft and, speculatively, could be a former horse whim used as part of the mechanism for raising and lowering items and people in mine shafts (S. Hughes AC Archaeology 2014, *pers. comm*. February), although other archaeological origins are also possible. Group **37** is of similar pattern to group 8 but with no known adjacent mine-related artifacts or deposits. This leave open the possibility that groups 8 and/or 37 pertain to other archaeological deposits such as those related to ring ditches or round houses.

Groups **10, 11 and 12** (field 1) are close to the former mine shaft and may be associated with it.

Group **6** (field 1) has a broad, linear anomaly pattern that may reflect a ploughed out former cultivation terrace, field boundary or former routeway. Groups **15** (field 1) and **23** (field 2) have similar patterns and may reflect former field boundaries or routeways.

A number of magnetically negative linear groups across all fields have similar characteristics: groups **1, 4 and 16** in field 1 along with groups **33, 36 and 38** in field 3 may represent field drains, leats or, less likely, tracks. Group **32** in field 2 along with groups **39, 40 and 45** in field 3 may represent field drains or, less likely, former field boundaries.

All the other anomalies identified as pertaining to archaeological deposits or structures are linear anomalies which typically represent former enclosure and field boundaries. Some of these are not on the orientation of the current field system. It is likely that they represent more than one phase of past land management.

6.3 Conclusions

The magnetic contrast across the survey areas was sufficient to be able to differentiate between anomalies representing possible archaeological features and background magnetic responses.

Forty-five magnetic anomaly groups were identified as pertaining to archaeological deposits or structures. The survey shows a local archaeological landscape dominated by changing field boundaries, field drainage and mining activities. No direct evidence of past settlement was recorded in the dataset although two sub-circular magnetic anomalies could possibly pertain to structures such as round houses or ring ditches. However, at least one of these may be associated with nineteenth century mining activities. Of the remaining anomaly groups, four may be related to former mining activities. A further ten groups coincide with former field boundaries mapped on historical maps from 1840 onwards. The remaining groups are most likely to reflect field boundaries, enclosure boundaries and field drainage of more than one phase of past land management.

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 Dr Paula Lutescu-Jones 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: 176049.58 m, centre Y: 53778.56 m

Scale: 1:1300 @ 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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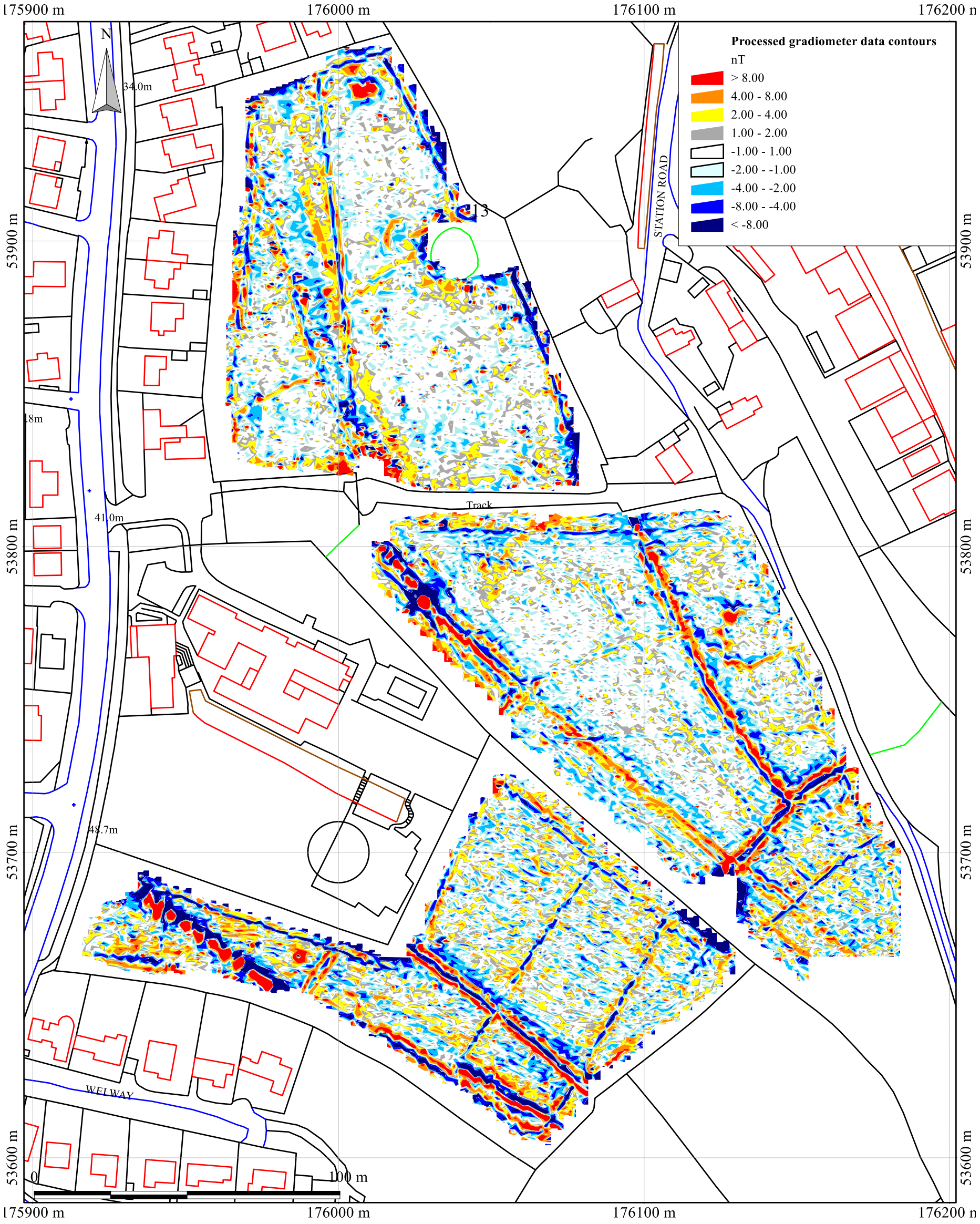

British Grid
centre X: 176049.58 m, centre Y: 53778.56 m

Scale: 1:1300 @ 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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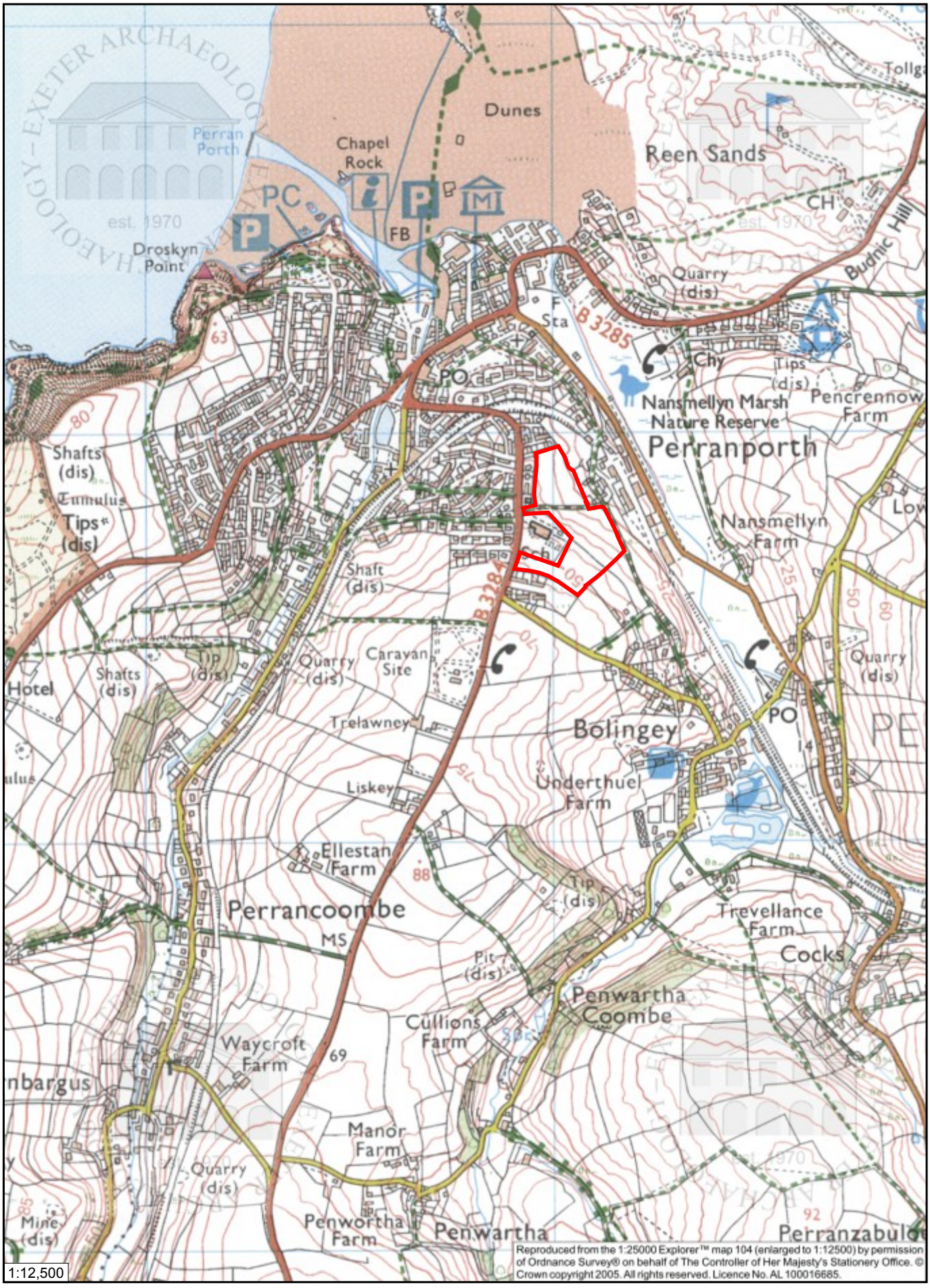

Figure 4: Location of proposed development site after Exeter Archaeology report 10/25, May 2010

Appendix 2 Methodology Summary

<table>
<tr><th colspan="2">Table 2: methodology summary</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
DW Consulting TerraSurveyor3
Manifold System 8
Microsoft Corp. Office Publisher 2013.</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: 270.68 Min: -269.91 Std Dev: 9.56 Mean: 0.09 Median: 0.00 Processes: 8 1 Base Layer 2 De Stagger: Grids: All Mode: Both By: -2 intervals 3 De Stagger: Grids: lhb4.xgd Mode: Both By: -1 intervals 4 De Stagger: Grids: lhc1.xgd lhc2.xgd lhc3.xgd lhc4.xgd lhc5.xgd Mode: Both By: -1 intervals 5 De Stagger: Grids: lhc10.xgd lhc9.xgd lhc8.xgd lhc7.xgd lhc6.xgd Mode: Both By: -1 intervals 6 De Stagger: Grids: lhb19.xgd Mode: Both By: -3 intervals 7 DeStripe Median Sensors: All 8 Clip at 4.00 SD Note: exporting the processed data from TerraSurveyor into Manifold GIS for analysis imposes an 'x matches y' interpolation on the data which is reflected in the processed data figures.

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.