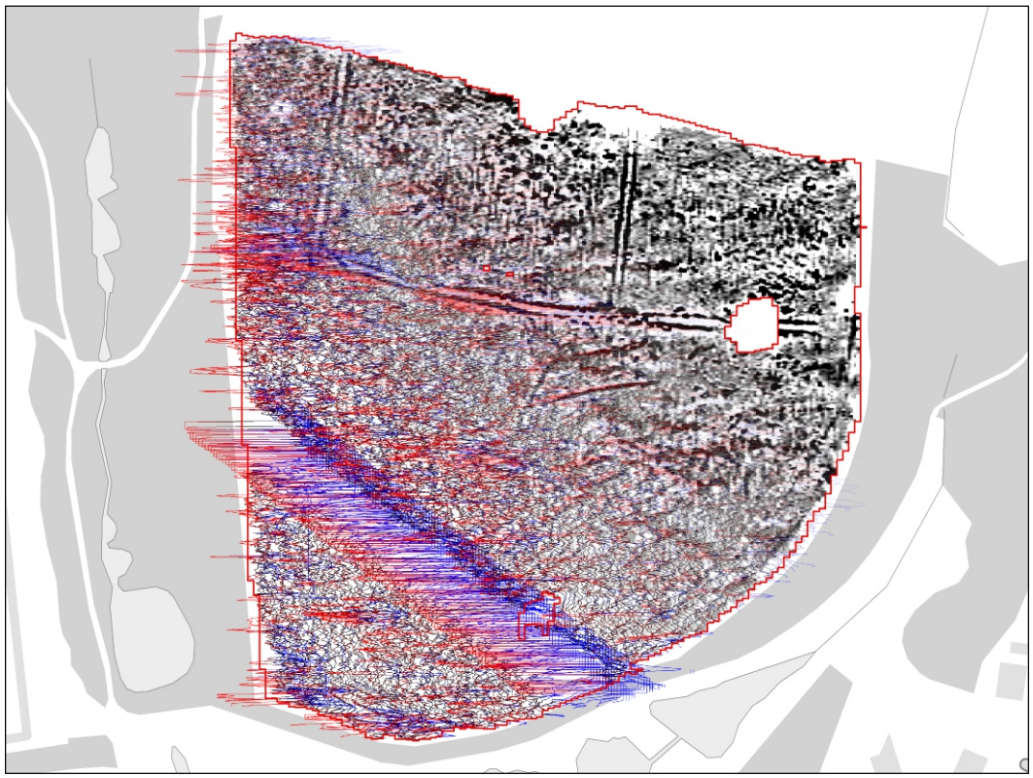
Land off Higher Hoopern Lane Exeter, Devon

Detailed Gradiometer Survey Report



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wessexarchaeology

Land off Higher Hoopern Lane, Exeter, Devon

Detailed Gradiometer Survey Report

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* I = Internal Draft; E = External Draft; F = Final

Land off Higher Hoopern Lane, Exeter, Devon

Detailed Gradiometer Survey Report

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Detailed Gradiometer Survey Report

Summary

A detailed gradiometer survey was conducted over land off Higher Hoopern Lane, Exeter, Devon (centred on NGR 292322, 94238). The project was commissioned by Terence O'Rourke Ltd. with the aim of establishing the presence, or otherwise, and nature of detectable archaeological features in support of a planning application for infrastructural development at the site.

The site comprises of one arable field located south of Higher Hoopern Lane, approximately 2.3 km southeast of Cowley and 2.2 km south of Stoke Woods, covering an area of 4.04 ha. The geophysical survey was undertaken on 10-11th of September 2016. The detailed gradiometer survey has demonstrated the presence of a number of anomalies of possible archaeological interest on the Site.

The anomalies identified as being of archaeological interest are primarily pit-like features. These features identified as such can be seen across the Site. It is difficult to be certain about their origins but an archaeological interpretation cannot be excluded, although it is possible that they may relate to natural features, such as tree throws, or agricultural activity.

A former field boundary can be seen traversing the northern end and appears to be double-ditched. The location of the feature appears to accurately coincide with the former field boundaries shown on the 1801 and 1876-1888 historical mapping of the area. It would appear that both the internal and external field boundaries have changed quite extensively over the last 200 years.

There are frequent agricultural drains and ploughing trends across the Site on a predominate alignment of northeast to south and north to south, respectively. These are likely to be medieval, post-medieval and modern in provenance as historical mapping indicates that the Site has been in use as agricultural fields from at least 1801 to the present day.

Additionally, this archaeological investigation has detected a large area of increased magnetic response, strong ferrous readings, areas of near surface geological variation and a modern service.

Land off Higher Hoopern Lane, Exeter, Devon

Detailed Gradiometer Survey Report

Acknowledgements

Wessex Archaeology would like to thank Terence O'Rourke Ltd. for commissioning the geophysical survey. The assistance of John Trehy is gratefully acknowledged in this regard.

The fieldwork was undertaken by Stewart Wareing and Sebastian Schuckelt. Jen Smith processed and interpreted the geophysical data, as well as wrote the report. The geophysical work was quality controlled by Gareth Davey and Lucy Learmonth. Illustrations were prepared by Richard Milwain. The project was managed on behalf of Wessex Archaeology by Lucy Learmonth.

Land off Higher Hoopern Lane, Exeter, Devon

Detailed Gradiometer Survey Report

1 INTRODUCTION

1.1 Project background

1.1.1 Wessex Archaeology was commissioned by Terence O'Rourke Ltd. to carry out a geophysical survey at land off Higher Hoopern Lane, Exeter, Devon (hereafter "the Site", centred on NGR 292322, 94238) (**Figure 1**). The survey forms part of an ongoing programme of archaeological works being undertaken in support of a planning application for infrastructural development at the Site.

1.1.2 This report presents a brief description of the methodology followed, the detailed survey results and the archaeological interpretation of the geophysical data.

1.2 The Site

1.2.1 The Site is located 2.3 km southeast of Cowley, 2.2 km south of Stoke Woods and 3.0 km northwest from the centre of Exeter, in the County of Devon.

1.2.2 The Site consists of an area of 4.04 ha of agricultural land, currently utilised for growing crops. The Site is bounded by a treeline and woodland to the west, north, east and south, with a public footpath or pavement to the south and west.

1.2.3 The Site has a steep incline sloping from approximately 115 m above ordnance datum (aOD) at the northern edge to approximately 70m aOD at the southern edge.

1.2.4 There are no overhead cables that traverse the Site.

1.2.5 The solid geology comprises of mudstone and sandstone of the Crackington Formation. There are no superficial geological deposits recorded at this location (BGS 2016).

1.2.6 The soils underlying the Site are likely to consist of typical brown earths of the 541j (Denbigh 1) association (SSEW SE Sheet 5, 1983). Soils derived from such geological parent material have been shown to produce magnetic contrasts acceptable for the detection of archaeological remains through magnetometer survey.

2 ARCHAEOLOGICAL BACKGROUND

2.1 Introduction

2.1.1 The following information is summarised from the Heritage Gateway website (www.heritagegateway.org.uk). A search was performed for all heritage assets within a 1 km radius of the Site in order to ascertain the archaeological potential of the Site.

2.1.2 There are no designated historical assets within the Site. However, there is 1 Scheduled Monument within the 1 km radius recorded 0.96 km to the southwest of the Site. The monument includes Danes Castle, a 12th century ringwork, situated within the city of Exeter on the shoulder of a ridge forming the north side of Longbrook valley which rises steeply on its south side to Rougemont Castle and the medieval city walls. The ringwork was revealed by archaeological excavations in 1993 on the removal of an overlying embankment which revetted a 19th century reservoir. The ringwork lies on ground sloping downwards from north to south. It consists of a steep sided circular ditch averaging 8m in width and 3.8m deep, with an external diameter of about 55m. It is thought that the ringwork was constructed in the 12th century during the reign of King Stephen (1135-54). From documentary evidence it is known that Stephen besieged the Earl of Devon, Baldwin de Redvers, in Rougemont Castle for some three months in 1136, and although there is no reference to the building of a castle, it would appear that the ringwork was constructed as a temporary campaign fortification at that time (NHLE 1011673).

2.1.3 There are no nationally Registered Parks and Gardens within the 1 km Study Area. However, the site is situated in the eastern extent of the 400 acre grounds of Reed Hall within the University of Exeter Landscaped Grounds. Pennsylvania Park Gardens also lie directly east of the Site just across Pennsylvania Road (HER MDV112395).

2.1.4 There are no World Heritage Sites or Historic Battlefields identified within the Study Area however 4 Grade II* and 38 Grade II listed buildings are recorded. There is also one conservation area to the east of the site within Pennsylvania.

2.1.5 Previous archaeological works recorded within the Study Area have been undertaken over the years between 1993 and 2010 at three locations around the Site. These works include the excavation of Danes Castle (mentioned above) which discovered no evidence of any structures within the interior. It was concluded that the ringwork was abandoned before it was completed. There was no evidence of an associated bailey either from the excavation or from earliest maps. The ground surface beneath the ringwork contained evidence of earlier land use in the form of parallel ridge-and-furrow cultivation trenches, and a land boundary ditch on the same alignment. The cultivation soil contained medieval pottery of 11th/12th century date and Roman pottery.

2.1.6 Other archaeological works include two evaluations; one at a Jaguar showroom in 2000 and one at Matford Business Park in 2010. Both were carried out by Exeter Archaeology and the results of both being of little archaeological interest.

2.1.7 Local HER records show that there is recorded evidence of prehistoric, Romano-British, Saxon, medieval and post-medieval activity within the Study Area..

2.1.8 Prehistoric and Romano-British records in this area are predominately recorded find-spots of flint scatters, flint tools, pottery and the odd coin. However, there is a record of a possible prehistoric enclosure to the north of the Exeter University campus some 470 m northwest of the Site (HER MDV60435).

2.1.9 The only record or suggestion of Saxon occupation in the Study Area comes from the place name “Hoopern”. This is said to suggest the site of a watchtower in the Anglo-Saxon period (hooper) (HER MDV19015).

2.1.10 Medieval and post-medieval records are largely characterised by buildings associated with the rural landscape and of the early Exeter settlement, comprising of numerous houses and farmsteads dating from the 12th - 19th centuries. Other structures include the Grade II listed buildings which are of a military nature. Higher Barracks is approximately 760 m south of the Site and was established in the late 18th century during the French Revolution Wars of 1790-1802. The barracks was then enlarged in 1803 in response to the Napoleonic Wars of 1803-15 & remained in military use until 1997 (HER MDV42905). There is also the Hoopern Farm AA Battery (HER MDV71737) and the World War II Report and Control Centre (HER MDV78463).

2.1.11 Within the Site, a linear cropmark seen from aerial photography taken in 1989 has been recorded, but the date is unknown and has not been ascertained with further investigations (HER MDV60787).

2.1.12 Historic mapping indicates that the Site area has been in use as agricultural fields from at least the early 19th century to present with clear changes to the internal and external field boundaries having occurred predominately on the northern half of the Site since 1801.

3 METHODOLOGY

3.1 Introduction

3.1.1 The geophysical survey was undertaken by Wessex Archaeology's in-house geophysics team between the 10th and the 11th of September 2016. Field conditions at the time of the survey were good with dry conditions throughout the period of survey. An overall coverage of 4.0 ha was achieved, with reductions due to parts of the surrounding treeline making the survey area smaller and two islands of trees being present in the field. This work has been undertaken in line with correspondence and recommendations by Andy Pye, Exeter City Archaeologist who has been consulted on throughout the pre-application stage by Terence O'Rourke.

3.2 Aims and objectives

3.2.1 The aims of the survey comprise the following:

- to conduct a detailed survey covering as much of the specified area as possible, allowing for artificial obstructions;
- to clarify the presence/absence and extent of any buried archaeological remains within the site;
- to determine the general nature of the remains present.

3.3 Fieldwork methodology

3.3.1 Individual survey grid nodes were established at 30 m x 30 m intervals using a Leica Viva RTK GNSS instrument, which is precise to approximately 0.02 m and therefore exceeds Historic England recommendations (2008).

3.3.2 The detailed gradiometer survey was conducted using a Bartington Grad601-2 fluxgate gradiometer instrument, which has a vertical separation of 1 m between sensors. Data were collected at 0.25 m intervals along transects spaced 1 m apart with an effective sensitivity of 0.03 nT, in accordance with Historic England guidelines (English Heritage 2008). Data were collected in the zigzag method.

3.4 Data processing

3.4.1 Data from the survey was subject to minimal data correction processes. These comprise a zero mean traverse function (±5 nT thresholds) applied to correct for any variation between the two Bartington sensors used, and a de-step function to account for variations in traverse position due to varying ground cover and topography. These two steps were applied throughout the survey area, with no interpolation applied.

3.4.2 Further details of the geophysical and survey equipment, methods and processing are described in **Appendix 1**.

4 GEOPHYSICAL SURVEY RESULTS AND INTERPRETATION

4.1 Introduction

4.1.1 The detailed gradiometer survey has identified magnetic anomalies across the Site, along with a large area of increased magnetic response, superficial geology and a large amount of ferrous. Results are presented as a series of greyscale plots, XY plots and archaeological interpretations at a scale of 1:1250 (**Figures 2** to **4**). The data is displayed at -2 nT (white) to +3 nT (black) for the greyscale image and ±25 nT at 25 nT per cm for the XY trace plots.

4.1.2 The interpretation of the datasets highlights the presence of possible archaeological anomalies, ferrous/burnt or fired objects, and magnetic trends (**Figure 4**). Full definitions of the interpretation terms used in this report are provided in Appendix 2.

4.1.3 Numerous ferrous anomalies are visible throughout the dataset. These are presumed to be modern in provenance and are not referred to, unless considered relevant to the archaeological interpretation.

4.1.4 It should be noted that small, weakly magnetised features may produce responses that are below the detection threshold of magnetometers. It may therefore be the case that more archaeological features may be present than have been identified through geophysical survey.

4.1.5 Gradiometer survey may not detect all services present on Site. This report and accompanying illustrations should not be used as the sole source for service locations and appropriate equipment (e.g. CAT and Genny) should be used to confirm the location of buried services before any trenches are opened on Site.

4.2 Gradiometer survey results and interpretation

4.2.1 There are numerous clusters of small strong positive anomalies that can be seen at **4000**, **4001**, **4002**, **4003** and **4004** with readings ranging from +1 nT to +4.5 nT. These anomalies have been interpreted as possible archaeology as they may represent clusters of pit- or ditch-like features. Their form and size suggest that they may be of some archaeological interest although it is possible that they relate to natural features, such as tree throws, or agricultural activity as there appears to be no clear pattern of distribution.

4.2.2 Traversing the northern end of the field, a strong curvilinear anomaly **4005** that is aligned east to west can be seen. This anomaly has two junctions that turn 90° and extend northwards to the survey extents. Each section of the anomaly appears to be comprised of two smaller parallel curvilinear anomalies to form the larger feature. Their size, form and shape suggest that they are ditch-like features and likely to represent former field boundaries.

4.2.3 Numerous linear and other curvilinear trends can be seen throughout the dataset. Some of the linear trends are stronger than the others with readings between +1 - +10 nT. These stronger linear anomalies can be seen near **4002**, **4003** and **4004** on a predominant alignment of northeast to southwest. Their form, size and shape suggest these are more than likely agricultural field drains. The weaker trends are more likely to be the result of ploughing, or other agricultural activity, and these extend predominately north to south.

4.2.4 The entire Site is dominated by an increased magnetic response as well as strong ferrous responses and those of superficial geological responses. The overall increase in the magnetic response over the Site might be connected to the extensive agricultural practises

and change that has occurred on the Site over time but it is not possible to determine this from the dataset alone.

4.2.5 There is at least one modern service at **4006** running through the south-western corner of the Site that appears to be ferrous pipe. This service is oriented northwest–southeast and extends past the survey extents in both directions.

5 DISCUSSION

5.1.1 The detailed gradiometer survey has been successful in detecting anomalies of possible archaeological interest within the survey area. In addition to these, anomalies interpreted as former field boundaries, ploughing trends, field drains, a large area of increased magnetic response, superficial geology and a modern service have also been identified.

5.1.2 The anomalies of archaeological interest are primarily pit-like features. These features identified as such can be seen across the Site with clusters at **4000**, **4001**, **4002**, **4003** and **4004**. It is difficult to be certain about their origins but an archaeological interpretation cannot be excluded entirely, resulting in their classification as being of possible interest. No clear coherent spatial patterns are apparent within their distribution, however, it is possible that they are natural or agricultural in origin.

5.1.3 The curvilinear features at **4005** that can be seen traversing the northern end of the field are more than likely double-ditched former field boundaries. The locations of these curvilinear features appear to accurately coincide with the former field boundaries shown on the 1801 and 1876-1888 historical mapping of the area. As mentioned previously, both the internal and external field boundaries have changed quite extensively over the last 200 years.

5.1.4 Frequent agricultural drains and ploughing trends are visible across the Site on a predominate alignment of northeast to south and north to south, respectively. These are likely to be medieval, post-medieval and modern in provenance as historical mapping indicates that the Site has been in use as agricultural fields from at least 1801 to the present day.

5.1.5 A linear cropmark seen from aerial photography taken in 1989 was reported to the local HER (HER MDV60787). Unfortunately, we have been unable to acquire a copy of the 1989 photograph to make a direct comparison with the geophysical data so it is unknown whether or not this linear cropmark coincides with any of the linear features seen in the dataset. LiDAR data (data.gov.uk, 2016) of the survey area also shows no archaeological features on the Site. This linear cropmark will need to be verified in order to ascertain its origins.

5.1.6 The increased magnetic response over the Site is more difficult to define. Such areas normally represent areas of former burning or contain debris, like ceramic materials, that have no definite form or shape. However, it appears that the entire area has been affected. It is possible that the overall increase in the magnetic response over the Site may be connected to the extensive agricultural practises and change that has occurred on the Site over time, i.e. destruction of field boundaries, formation of new field extents, introduction of agricultural drains and a modern service. These events would explain the high levels of strong ferrous readings on the Site. It is also possible that the underlying geology is contributing to the increased magnetic response which is why we can interpret some superficial geological features. Unfortunately, it is not possible to determine this from the dataset alone so the cause remains unknown.

5.1.7 It should be noted that it is not clear from the geophysical data whether the service identified **4006** is in active use or not. Also gradiometer data will not be able to locate and identify all services present on site. This report and accompanying illustrations should not be used as the sole source for service locations and appropriate equipment (e.g. CAT and Genny) should be used to confirm the location of buried services before any trenches are opened on site.

5.2 Recommendations

5.2.1 Following the results of the geophysical survey, it is considered that further archaeological investigations may be required by the Local Planning Authority. If this is advised by the County Archaeologist, these works could take the form of archaeological trial trenching in the first instance. If this is the case, it is recommended that any anomalies identified as possible archaeology are ground-truthed.

5.2.2 Additionally, further data should be collected via trial trenching from the areas identified as superficial archaeology / potential spreads to ensure that these responses are not masking weaker and potentially archaeological responses. Trenches should also be planned to investigate areas where no anomalies of potential archaeological interest have been identified within the Site.

6 REFERENCES

6.1 Bibliography

English Heritage 2008 *Geophysical Survey in Archaeological Field Evaluation. Research and Professional Service Guideline No 1.* Swindon (2nd Edition)

6.2 Cartographic and documentary sources

1801 Exeter 5, 3”

1876-1888 Devonshire LXXX.NW, Ordnance Survey 6”

Ordnance Survey 1983 *Soil Survey of England and Wales Sheet 5, Soils of Midland and Western England.* Southampton.

6.3 Online resources

British Geological Survey Geology of Britain Viewer (accessed September 2016)
http://mapapps.bgs.ac.uk/geologyofbritain/home.html

Environment Agency Free UK LiDAR Data Viewer (accessed September 2016)
http://environment.data.gov.uk/ds/survey/index.jsp#/survey?grid=SX99

Heritage Gateway (accessed September 2016)
http://www.heritagegateway.org.uk/Gateway

Old Maps Online Viewer (accessed September 2016)
http://www.old-maps.co.uk

7 APPENDICES

7.1 Appendix 1: Survey Equipment and Data Processing

Survey methods and equipment

The magnetic data for this project will be acquired using a non-magnetic cart fitted with 4x Bartington Grad-01-1000L magnetic gradiometers. The instrument has four sensor assemblies fixed horizontally 1 m apart allowing four traverses to be recorded simultaneously. Each sensor contains two fluxgate magnetometers arranged vertically with a 1m separation, and measures the difference between the vertical components of the total magnetic field within each sensor array. This arrangement of magnetometers suppresses any diurnal or low frequency effects.

The gradiometers have an effective resolution of 0.03 nT over a ±100 nT range, and measurements from each sensor are logged at a rate of 6 hz (intervals of sub 0.25 m). All of the data are stored on a Leica Viva CS35 tablet controller using the data acquisition program MLGrad 601. This also collects readings streamed by a Leica GS14 GNSS receiver, which is fixed to the cart at a measured distance from the sensors.

The use of the non-magnetic cart has several advantages over the use of the Bartington Grad 601-2 fluxgate gradiometer instrument. Perhaps chief amongst these is that it has a higher sample rate resulting in higher resolution dataset. The addition of the GPS receiver also negates the need to establish a survey grid prior to the survey and therefore increases efficiency. Mounting the instrument on the cart also reduces the occurrence of operator error caused by inconsistent walking speeds and variation in traverse position due to varying ground cover and topography.

Wessex Archaeology undertakes two types of magnetic surveys: scanning and detail. When not using the handheld Bartington 601-2 dual magnetic gradiometer, both types depend upon the establishment of an accurate 20 m or 30 m site grid, which is achieved using a Leica Viva RTK GNSS instrument and then extended using tapes. The Leica Viva system receives corrections from a network of reference stations operated by the Ordnance Survey and Leica Geosystems, allowing positions to be determined with a precision of 0.02 m in real-time and therefore exceed the level of accuracy recommended by Historic England (English Heritage 2008) for geophysical surveys.

Scanning surveys consist of recording data at 0.25 m intervals along transects spaced 10m apart, acquiring a minimum of 80 data points per transect. Due to the relatively coarse transect interval, scanning surveys should only be expected to detect extended regions of archaeological anomalies, when there is a greater likelihood of distinguishing such responses from the background magnetic field.

The detailed surveys consist of 20 m x 20 m or 30 m x 30 m grids, and data are collected at 0.25 m intervals along traverses spaced 1m apart. These strategies give 1600 or 3600 measurements per 20 m or 30 m grid respectively, and are the recommended methodologies for archaeological surveys of this type (EH, 2008).

Data may be collected with a higher sample density where complex archaeological anomalies are encountered, to aid the detection and characterisation of small and ephemeral features. Data may be collected at up to 0.125 m intervals along traverses spaced up to 0.25 m apart, resulting in a maximum of 28800 readings per 30 m grid, exceeding that recommended by Historic England (English Heritage 2008) for characterisation surveys.

Post-Processing

The magnetic data collected during the detail survey are downloaded from the Bartington system for processing and analysis using both commercial and in-house software. This software allows for both the data and the images to be processed in order to enhance the results for analysis; however, it should be noted that minimal data processing is conducted so as not to distort the anomalies.

As the scanning data are not as closely distributed as with detailed survey, they are georeferenced using the GPS information and interpolated to highlight similar anomalies in adjacent transects. Directional trends may be removed before interpolation to produce more easily understood images.

Typical data and image processing steps for the non-magnetic cart fitted system may include:

- Smooth – Applying a smooth function removes any small scale spiking or 'fuzziness', generally caused by internal system noise. This effectively 'destripes' the data and reduces the appearance of dominant anomalous readings.
- Spline interpolation – Gridding the data with splines allows the application of minimum and maximum data values and reduces oscillations for potential fields such as gravity or magnetic.

Typical data and image processing steps for the dual magnetic gradiometer system may include:

- Destripe – Applying a zero mean traverse in order to remove differences caused by
- directional effects inherent in the magnetometer;
- Destagger – Shifting each traverse longitudinally by a number of readings. This corrects for operator errors and is used to enhance linear features;
- Despike – Filtering isolated data points that exceed the mean by a specified amount to reduce the appearance of dominant anomalous readings (generally only used for earth resistance data)

Typical displays of the data used during processing and analysis:

- XY Plot – Presents the data as a trace or graph line for each traverse. Each traverse is displaced down the image to produce a stacked profile effect. This type of image is useful as it shows the full range of individual anomalies.
- Greyscale – Presents the data in plan view using a greyscale to indicate the relative strength of the signal at each measurement point. These plots can be produced in colour to highlight certain features but generally greyscale plots are used during analysis of the data.

7.2 Appendix 2: Geophysical Interpretation

The interpretation methodology used by Wessex Archaeology separates the anomalies into four main categories: archaeological, modern, agricultural and uncertain origin/geological.

The archaeological category is used for features when the form, nature and pattern of the anomaly are indicative of archaeological material. Further sources of information such as aerial photographs may also have been incorporated in providing the final interpretation. This category is further sub-divided into three groups, implying a decreasing level of confidence:

- Archaeology – used when there is a clear geophysical response and anthropogenic pattern.
- Possible archaeology – used for features which give a response but which form no discernible pattern or trend.

The modern category is used for anomalies that are presumed to be relatively modern in date:

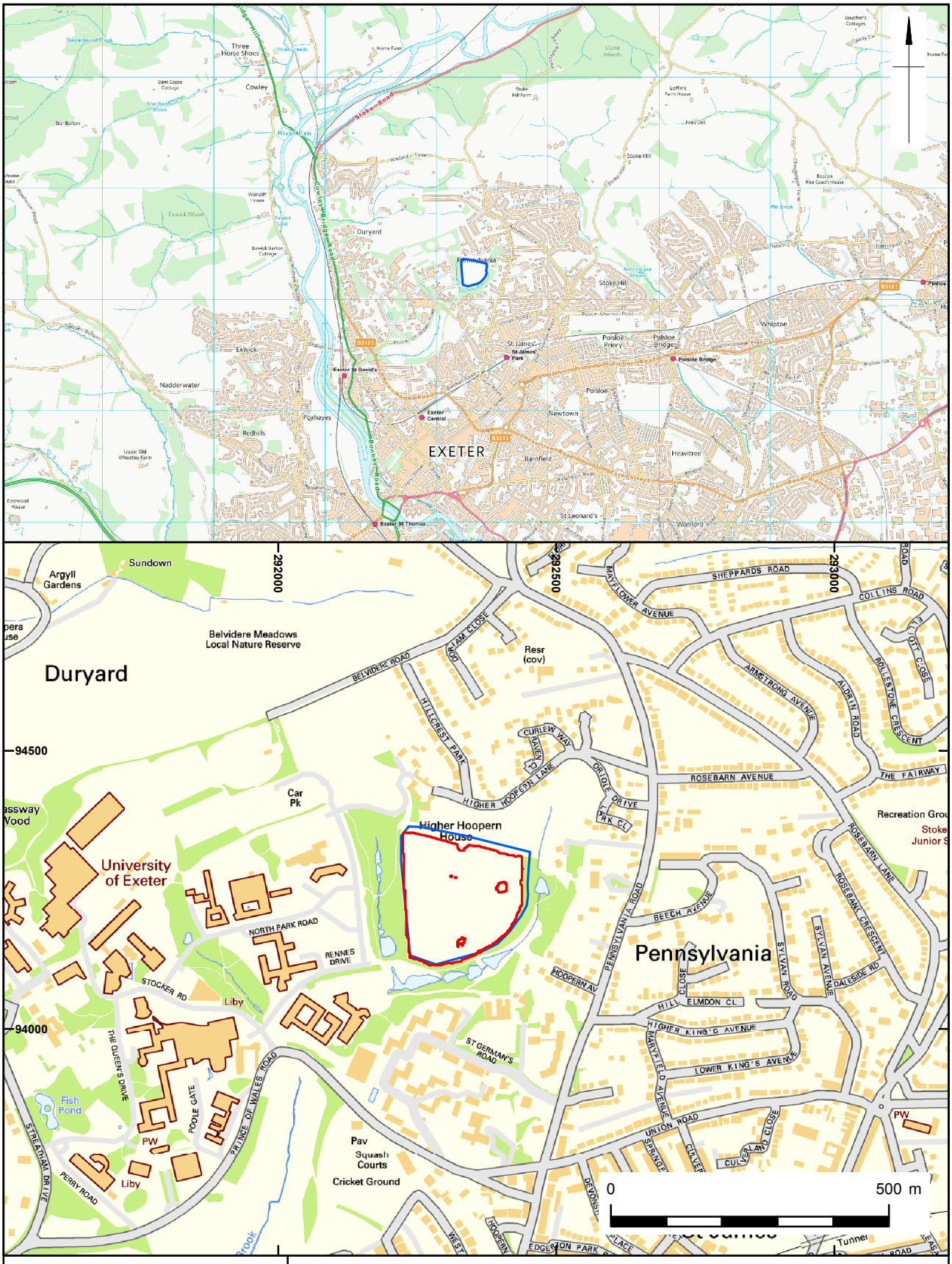
- Ferrous – used for responses caused by ferrous material. These anomalies are likely to be of modern origin.
- Modern service – used for responses considered relating to cables and pipes; most are composed of ferrous/ceramic material although services made from non-magnetic material can sometimes be observed.

The agricultural category is used for the following:

- Former field boundaries – used for ditch sections that correspond to the position of boundaries marked on earlier mapping.
- Ridge and furrow – used for broad and diffuse linear anomalies that are considered to indicate areas of former ridge and furrow.
- Ploughing – used for well-defined narrow linear responses, usually aligned parallel to existing field boundaries.
- Drainage – used to define the course of ceramic field drains that are visible in the data as a series of repeating bipolar (black and white) responses.

The uncertain origin/geological category is used for features when the form, nature and pattern of the anomaly are not sufficient to warrant a classification as an archaeological feature. This category is further sub-divided into:

- Increased magnetic response – used for areas dominated by indistinct anomalies which may have some archaeological potential.
- Trend – used for low amplitude or indistinct linear anomalies.
- Superficial geology – used for diffuse edged spreads considered to relate to shallow geological deposits. They can be distinguished as areas of positive, negative or broad bipolar (positive and negative) anomalies.



Site Boundary

Detailed Survey Extents

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Site Location and Detailed Survey Extents

Figure 1

292100
292200
292300
292400
292500
94300
94200
94100
RENNES DRIVE
NORTH PARK ROAD
HOOPERN AVENUE
+3nT
-2nT
0
50 m

Detailed Survey Extents

Coordinate system:
OSGB36(02)

Date:	16/09/16	Revision Number:	0
Scale:	1:1250 at A3	Illustrator:	RAM
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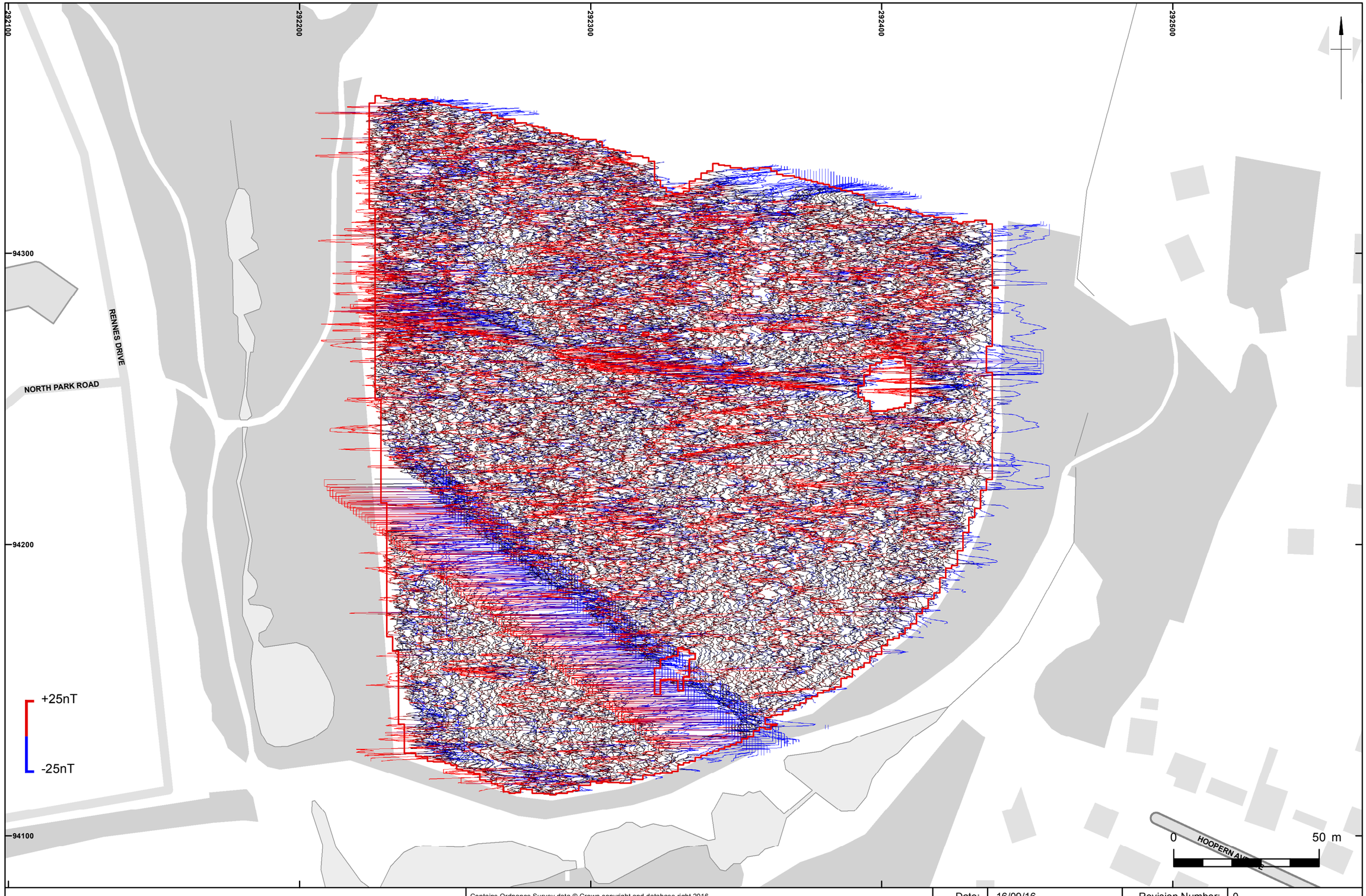
Greyscale plot

Figure 2



Detailed Survey Extents

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XY Trace plot

Figure 3

Coordinate system:
OSGB36(02)

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Archaeological Interpretation

Figure 4

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