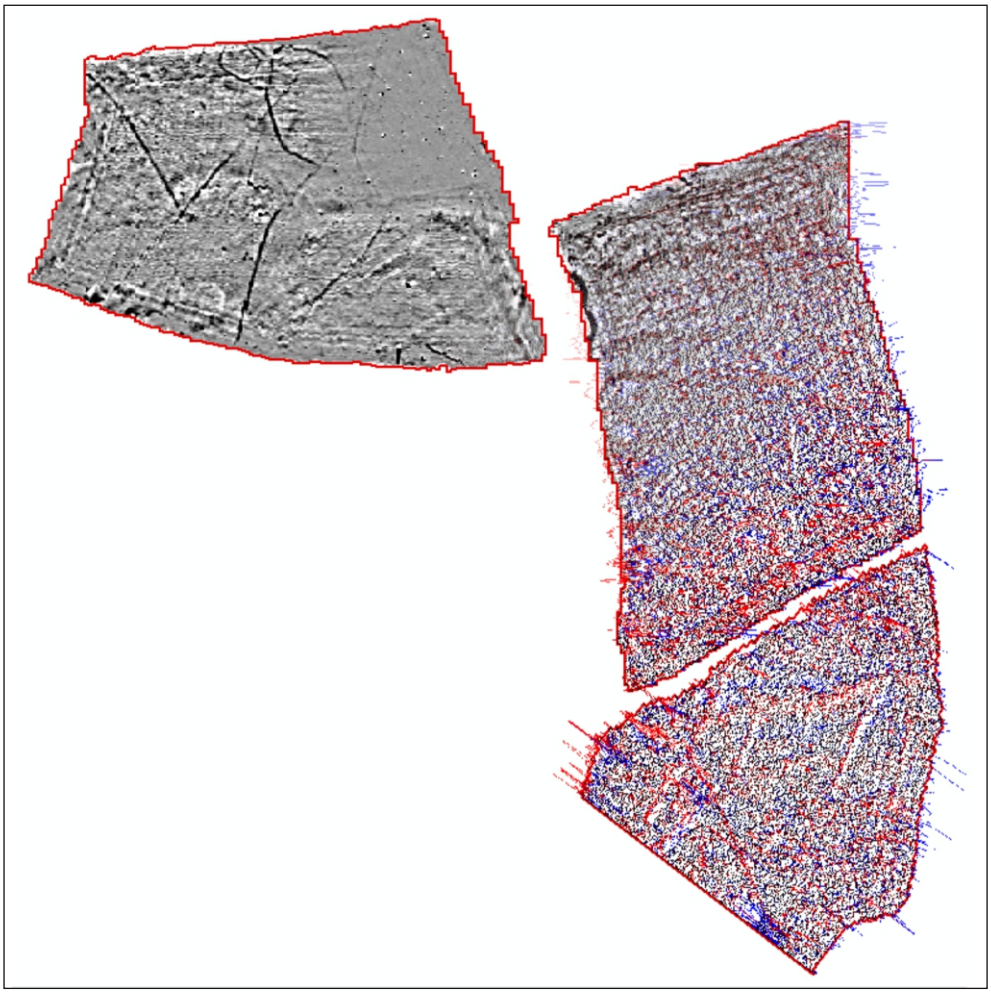
making sense of heritage

Land at Freathy, Antony Estate Torpoint, Cornwall

Detailed Gradiometer Survey Report



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August 2014

geoservices

Land at Freathy, Antony Estate
Torpoint, Cornwall

Detailed Gradiometer Survey Report

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

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Detailed Gradiometer Survey Report

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Summary

A detailed gradiometer survey was conducted over land at Freathy, near Torpoint in Cornwall . The project was commissioned by British Solar Renewables Ltd. with the aim of establishing the presence, or otherwise, and nature of detectable archaeological features on the site ahead of the proposed development of a solar farm.

The site comprises three arable fields on land south of the B3247, approximately 0.75km NNE of Freathy and 4km southwest of Torpoint, Cornwall centred on NGR 240150, 052725. The Site spans a stream valley that is aligned roughly north-south; the stream is unnamed and flows into Whitsand Bay a short distance to the southwest. Thistles and vegetation covered some parts of the site at the time of surveying. The gradiometer survey covered 10.1ha and has demonstrated the presence of anomalies of likely, probable and possible archaeological interest within the survey area along with areas of superficial geology and several former field boundaries.

The geophysical data has revealed a number of different field systems and enclosures with at least two distinct phases of activity visible in the dataset. Several pit-like anomalies have been detected that may relate to the use of these former field systems. One of the former field boundaries is notable in that the magnetic values within the field are very quiet compared to the rest of the site; this may indicate some form of extraction or addition of soil has taken place in this area. Most of the enclosures detected appear to define field boundaries rather than settlement enclosures although the possible presence of a settlement cannot be ruled out entirely.

The survey was undertaken between 28th July and 1st August 2014.

Land at Freathy, Antony Estate Torpoint, Cornwall

Detailed Gradiometer Survey Report

Acknowledgements

The detailed gradiometer survey was commissioned by British Solar Renewables Limited. The assistance of Emily Ditchfield is gratefully acknowledged in this regard.

The fieldwork was undertaken by Ross Lefort, Laura Andrews, Ben Urmston and Alistair Salisbury. Alistair Salisbury processed the geophysical data which was interpreted by Genevieve Shaw. This report was written by Genevieve Shaw and Ross Lefort. The geophysical work was quality controlled by Ross Lefort. Illustrations were prepared by Ross Lefort and Karen Nichols. The project was managed on behalf of Wessex Archaeology by Steve Beach.

Land at Freathy, Antony Estate Torpoint, Cornwall

Detailed Gradiometer Survey Report

1 INTRODUCTION

1.1 Project background

1.1.1 Wessex Archaeology was commissioned by British Solar Renewables Limited to carry out a geophysical survey on land south of the B3247, near Freathy, Cornwall (**Figure 1**), hereafter "the Site" (centred on NGR 240150, 052725). The survey forms part of an ongoing programme of archaeological works being undertaken in advance of the proposed development of a solar farm. The total size of the area initially proposed for geophysical survey was 10.1ha.

1.1.2 A Written Scheme of Investigation (WSI) was prepared by Wessex Archaeology that set out the aim of the survey and the methodology (Wessex Archaeology 2014). The aim of the geophysical survey was to establish the presence/absence, extent and character of detectable archaeological remains within the survey area.

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

1.2 Site Location and Topography

1.2.1 The Site is made up of three arable fields located approximately 0.75km NNE of Freathy and 4km southwest of Torpoint. The survey extents are defined by existing boundaries for the most part with the southern extent defined by the limits of the proposed solar farm.

1.2.2 The Site spans a stream valley that is aligned roughly north-south; the stream is unnamed and flows into Whitsand Bay a short distance to the southwest. The land rises from a height of 80m above Ordnance Datum (aOD) at the central region of the valley to over 100m aOD at the western edge and 105m aOD at the eastern edge of the Site.

1.3 Soils and Geology

1.3.1 The bedrock geology under the northern half of the Site is recorded as Whitsand Bay formation slate, siltstone and sandstone that date to the Devonian period with Lower Long Sands and sandstone member sandstone, siltstone and mudstone recorded across the southern half of the Site. Extrusive igneous deposits of Kingsand rhyolitic formation rhyolite are recorded a short distance to the east and south of the Site. No superficial deposits are recorded under the Site but shallow alluvial deposits may exist in the base of the valley (BGS).

1.3.2 The soils underlying most of the Site are likely to be brown rankers of the 313b (Powys) association with the southern edge of the Site recorded as typical brown earths of the 541j (Denbigh 1) association (SSEW 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.

1.4 Archaeological Background

1.4.1 An archaeological assessment was carried out by Archaedia in 2012 that revealed mainly medieval and modern features within the six fields that were initially considered for this proposed development (Archaedia 2012). The results of this assessment will be discussed in relation to the geophysical survey where relevant.

2 METHODOLOGY

2.1 Introduction

2.1.1 The detailed magnetometer survey was conducted using a Bartington Grad 601-2 dual fluxgate gradiometer system. The survey was conducted in accordance with English Heritage guidelines (English Heritage 2008).

2.1.2 The geophysical survey was undertaken by Wessex Archaeology's in-house geophysics team between 28th July and 1st August 2014. Field conditions at the time of the survey were variable with dense vegetation in places resulting from the fields being left fallow for a year. A total of 9.16ha of the proposed 10.1ha survey area was covered by the gradiometer survey; the area was reduced in size by the width of the field boundaries and the stream.

2.2 Method

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

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

2.2.3 Data from the survey was subject to minimal data correction processes. These comprise a zero mean traverse function (±5nT 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 to all survey areas, with no interpolation applied.

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

3 GEOPHYSICAL SURVEY RESULTS AND INTERPRETATION

3.1 Introduction

3.1.1 The gradiometer survey has been successful in identifying a few anomalies of probable and possible archaeological interest across the Site, along with a single modern service. Results are presented as a series of greyscale and XY plots, with corresponding archaeological interpretations, at a scale of 1:2000 (**Figures 2** to **4**). The data are displayed at -4nT (white) to +6nT (black) for the greyscale image and ±50nT at 50nT per cm for the XY trace plots.

3.1.2 The interpretation of the datasets highlights the presence of potential 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**.

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

3.2 Gradiometer Survey Results and Interpretation

3.2.1 The greatest concentration of archaeological features lies in the northwest field. These features mostly comprise a series of linear and slightly curved ditches such as those at **4000** to **4003**. These ditches seem to form a field system although it appears that more than one phase of activity may be represented in the data as the linear ditch at **4001** cuts or is cut by a curved enclosure at **4004**. The alignment of many of these ditches is not in keeping with the modern scheme of landscape division so they may prove to be archaeological. The magnetic values of these ditches varies from over +6nT at their strongest to around +1.5nT at their weakest points. These ditches have been interpreted as either archaeology or probable archaeology depending on the strength of their magnetic response.

3.2.2 There are two enclosures along the northern edge of this field at **4004** and **4005**; the former is the largest with a sub-oval shape measuring roughly 55m x 40m and the latter is sub-rectangular measuring roughly 18m x 13m. These two enclosures are separated by a short distance but may be linked by fragmentary ditches visible in the data. The interior of these enclosures is identical to the exterior in terms of having no greater concentration of pit-like anomalies. It is unclear whether these enclosures define small fields or are part of a settlement complex extending outside of the survey area. The ditches have magnetic values ranging from +6nT to +1.5nT and have been interpreted as either archaeology or possible archaeology depending on these values.

3.2.3 There are numerous weak and fragmentary ditch-like anomalies across other parts of this field at **4006** to **4009**; these ditches may link up to form parts of the field systems discussed above. The magnetic values range from over +5nT to less than +1nT and have been interpreted as either possible or probable archaeology according to the patterns they form and the magnetic values they possess.

3.2.4 There is a former field boundary at **4010** and **4012** that is marked on the 1840 Antony tithe map. This field boundary is notable as it appears to define an area of very quiet magnetic values. The magnetic background across the majority of the Site is very noisy which is a common response expected from slate geology in Cornwall but this enclosed area is very quiet by comparison. It is possible this is due to geological variation but its close association with a field boundary suggests this is likely due to anthropogenic activity. This may be in the form of quarrying and backfilling or may be the deliberate filling of an uneven area of ground to improve the farmland. There is no evidence for either on any of the maps consulted in the assessment carried out by Archaedia (2012).

3.2.5 There are weakly positive, diffuse ditch-like anomalies running parallel to the modern field boundaries; these are likely to relate to recent agricultural activity.

3.2.6 The adjacent field located to the east contains a number of sub-oval shaped pit-like anomalies at **4012** to **4015**; they all have magnetic values over +5nT and range in length from 3.5m to over 6m. These pits stand out clearly from the noisy background and have

been interpreted as probable archaeology; there are other smaller pit like-anomalies scattered across all three fields but these have been interpreted as possible archaeology.

3.2.7 The other anomalies visible in this field are a number of intermittent ditch like anomalies such as those at **4016** to **4019**; they have magnetic values ranging from +5nT to less than +1nT. Some of these ditches look as though they could link up to form a field system but their fragmentary nature does not allow a firm interpretation; all have been classed as possible archaeology as a geological explanation is possible.

3.2.8 A strong ditch-like anomaly is located near the stream at **4020** with magnetic values over +6nT. This feature runs out of the survey area so its shape in plan cannot be fully defined. It is unclear whether this feature is natural, agricultural or archaeological but has been classed as possible archaeology due to its strong magnetic values.

3.2.9 A fragmentary curving ditch is visible at **4021** that appears to continue into the southern field below to join up with the ditch at **4022** and **4023**. These ditches have magnetic values between +2nT and +5nT and have been classed as probable archaeology, possibly representing part of an earlier field system. More ditches on a similar alignment are visible at **4024** and **4025** that may form part of this field system.

3.2.10 A slight curving ditch with an offshoot is visible at **4026** and **4027**; this does not share an alignment with the ditches discussed above so may represent another phase of landscape division. This ditch has been classed as either probable archaeology or possible archaeology depending on the strength of its magnetic values.

3.2.11 An L-shaped former field boundary is located at **4028**; this is visible on the 1840 tithe map for the parish of St John. Another boundary extends from this at **4029** but this is not present on any of the maps consulted. The form of this anomaly with a negative linear flanked by two positive linears is characteristic of former field boundaries identified in other surveys carried out by Wessex Archaeology across Devon and Cornwall. A similar feature aligned roughly northwest to southeast is present at **4030**; both have been classed as agricultural features.

3.2.12 The remaining anomalies include numerous small sub-oval anomalies of possible archaeological interest, such as at **4031**, and numerous weak linear trends of uncertain origin. As the magnetic background is so variable at this site it is not possible to definitively state whether these anomalies are archaeological, modern or are natural.

3.3 Gradiometer Survey Results and Interpretation: Modern Services

3.3.1 No modern services have been identified in the geophysical data. It should be noted that 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 CONCLUSION

4.1.1 The detailed gradiometer survey has been successful in detecting anomalies of likely, probable and possible archaeological interest; the majority of the anomalies being interpreted as former field boundaries of varying date.

4.1.2 Two former field boundaries have been identified at **4010** and **4028** that appear in historic mapping displayed in the DBA (Archaedia 2012) but no longer exist above ground. The rest of the ditches appear to show more than one phase of land division exists at this Site and seem to suggest this land has always served an agricultural function.

4.1.3 There is a possibility that the enclosures at **4004** and **4005** may form part of a settlement complex but evidence for a dense settlement in the form of concentrated pits and postholes cannot be seen in the dataset. However, the anomalies are clearly defined from the magnetic background and their form is consistent with such settlement, although it is not possible to determine their likely date.

4.1.4 In the central portion of the survey area, several pit-like responses were identified at **4012** to **4015** but their distribution is not concentrated and they could relate to agricultural activity.

4.1.5 Within the former field boundary defined by **4010** and **4011** is an area of relatively quiet magnetic background, and it is interesting to note that it coincides with a former field seen in historic mapping (Archaedia 2012). Potentially this area has been altered by some form of industrial or landscaping activity, although little more can be said about this from the geophysical data alone.

4.1.6 Superficial geological responses are visible in the survey data but this has not significantly affected the detection of archaeological anomalies.

4.1.7 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 encountered than have been identified through geophysical survey. A specific issue for this survey might have been the height of the crop at the time of surveying and therefore anomalies interpreted as trends in the data might potentially be archaeological in origin.

5 REFERENCES

5.1 Bibliography

Archaedia, 2012. *Archaeological assessment of land to the east of Higher Tregantle Farm, Antony, Cornwall* Unpublished report Ref 12.22 Project 1067

English Heritage, 2008. *Geophysical Survey in Archaeological Field Evaluation*. Research and Professional Service Guideline No 1, 2nd edition.

Institute for Archaeologists, 2011. *Standards and Guidance for Archaeological Geophysical Survey* Unpublished Guidance

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5.2 Cartographic Sources

British Geological Survey
http://www.bgs.ac.uk/discoveringgeology/geologyofbritain/viewer.html [accessed July 2014]

Soil Survey of England and Wales, 1983. *Sheet 5, South West England*. Ordnance Survey, Southampton.

Tithe map, 1840/1841. *Antony Tithe Map*.

Tithe map, 1840. *St John Tithe Map.*

APPENDIX 1: SURVEY EQUIPMENT AND DATA PROCESSING

Survey Methods and Equipment

The magnetic data for this project was acquired using a Bartington 601-2 dual magnetic gradiometer system. This instrument has two sensor assemblies fixed horizontally 1m apart allowing two 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 0.03nT over a ±100nT range, and measurements from each sensor are logged at intervals of 0.25m. All of the data are stored on an integrated data logger for subsequent post-processing and analysis.

Wessex Archaeology undertakes two types of magnetic surveys: scanning and detail. Both types depend upon the establishment of an accurate 20m or 30m 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 0.02m in real-time and therefore exceed the level of accuracy recommended by English Heritage (2008) for geophysical surveys.

Scanning surveys consist of recording data at 0.25m 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 20m x 20m or 30m x 30m grids, and data are collected at 0.25m intervals along traverses spaced 1m apart. These strategies give 1600 or 3600 measurements per 20m or 30m 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 0.125m intervals along traverses spaced up to 0.25m apart, resulting in a maximum of 28800 readings per 30m grid, exceeding that recommended by 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 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.

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.
- Probable archaeology – used for features which give a clear response but which form incomplete patterns.
- 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:

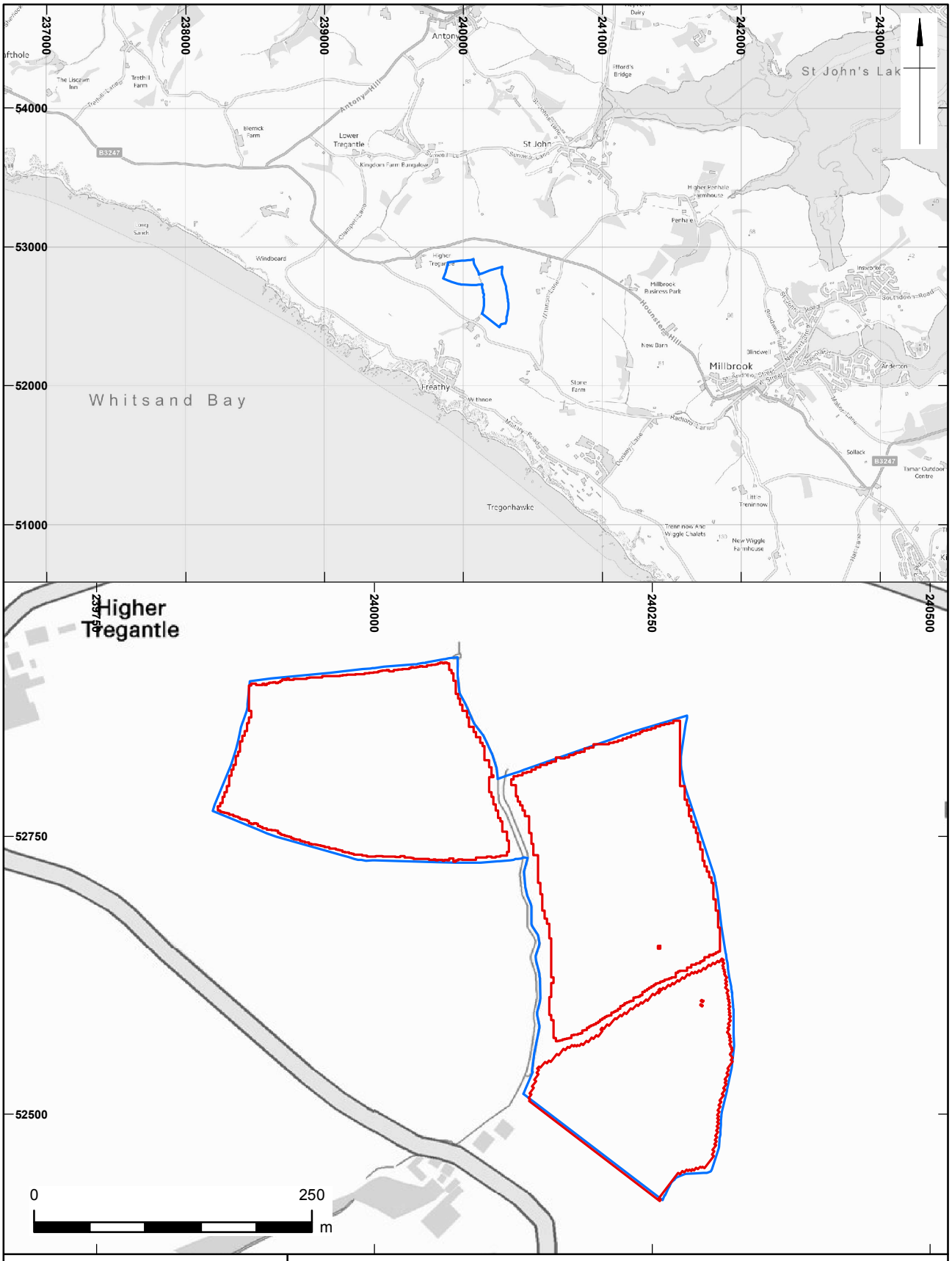
- Ferrous – used for responses caused by ferrous material. These anomalies are likely to be of modern origin.
- Modern service – used for responses considered relating to cables and pipes; most are composed of ferrous/ceramic material although services made from non-magnetic material can sometimes be 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.
- Agricultural ditches – used for ditch sections that are aligned parallel to existing boundaries and former field boundaries that are not considered to be of archaeological significance.
- 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.



Detailed Survey Extents

Site Boundary

Date:	19/08/2014	Revision Number:	0
Scale:	1:40000 and 1:5000 at A4	Illustrator:	RDL
Path:	X:\PROJECTS\105520\GIS\FigsPDF\Geophysics_2014_08_19		

Site location and detailed survey extents

Figure 1

240000

240250

53000

52750

52500

+6nT

-4nT

Detailed Survey Extents

0 100 m

Date:	19/08/2014	Revision Number:	0
Scale:	1:2000 at A3	Illustrator:	RDL
Path:	X:\PROJECTS\105520\GIS\FigsPDF\Geophysics_2014_08_19		

Greyscale plot

Figure 2

240000

240250

53000

52750

52500

Detailed Survey Extents

+50nT

-50nT

0

100

m

Date:	19/08/2014	Revision Number:	0
Scale:	1:2000 at A3	Illustrator:	RDL
Path:	X:\PROJECTS\105520\GIS\FigsPDF\Geophysics_2014_08_19		

XY trace plot

Figure 3

240000

240250

53000

52750

52500

4005
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Archaeology
Probable Archaeology
Possible Archaeology
Former Field Boundary
Agricultural
Ferrous
Trend
Ploughing
Increased Magnetic Response
Superficial Geology
Detailed Survey Extents

0 100 m

Date:	19/08/2014	Revision Number:	0
Scale:	1:2000 at A3	Illustrator:	RDL
Path:	X:\PROJECTS\105520\GIS\FigsPDF\Geophysics_2014_08_19		

Interpretation

Figure 4

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