AB HERITAGE
ARCHAEOLOGICAL CONSULTANCY

Yalberton, Paignton, Devon

Geophysical Survey Report

Client: COTSWOLD ARCHAEOLOGY

AB Heritage Project No:10746

Date: 29/01/2016

Yalberton, Paignton, Devon

Geophysical Survey Report

Client	**Cotswold Archaeology**
Project Number	**10746**
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PLATES

1. NON TECHNICAL SUMMARY

1.1.1 AB Heritage Limited (herein AB Heritage) were commissioned by Cotswold Archaeology to undertake a programme of geophysical survey over c. 13 ha of land south of Yalberton Road, Paignton from Thursday the 14th to Tuesday the 19th of January 2016, ahead of a proposed development.

1.1.2 The survey identified potential for archaeological features, including possible trackways [**GP 1 A & D**] field boundaries [**GP 1 C, E, M & GP 2**] and potential enclosures [**GP 1 G, H & L**]. Other features identified [**GP 1 B, F, I, J, K & N**] could relate to previous ditches, but are most likely to be cause by previous agricultural activity.

1.1.3 Overall the site as limited potential for the recovery of significant archaeological remains based upon the results of the survey.

2. INTRODUCTION

2.1 Project Background

2.1.1 AB Heritage has been asked to undertake a geophysical survey covering c.13 hectares (ha) of land south of Yalberton Road, Paignton (Figure 1). This was undertaken on behalf of Cotswold Archaeology, ahead of proposed development..

2.1.2 The purpose of this work is to identify any potential surviving archaeological remains.

2.2 Site Location & Description

2.2.1 The proposed development site lies within Torbay, a Unitary Authority within the county of Devon. The land to the east of the proposed development site is primarily urban, with the large town of Paignton c. 2.5km to the north-east, and the small village of Yalberton lying c. 0.6km south-west. The proposed development site is bordered to the north by a minor road (Yalberton Road), beyond which is a large quarry (Cotswold Archaeology, 2015).

2.2.2 The land to the west of the proposed development site consists of an arable landscape made up of irregularly shaped fields with hedgebanks, and dispersed farmsteads. At the time of survey the proposed development site was in use as pasture for sheep grazing.

2.2.3 The proposed development site consists of six fields split over two areas. Fields 2-6 are centred at SX 86931 58900 (c.12ha), and Field 1 at SX 87298 58932 (c. 1ha) (Figure 1).

2.3 Geology & Topography

2.3.1 The solid geology of the proposed development site primarily comprises igneous bedrock of the Devonian Ashprington Volcanic Formation, with restricted areas of limestones of the Brixham and Goodrington formations (BGS 2016). There are no superficial deposits recorded within the proposed development site. This form of geology is likely to have a good response for undertaking geophysical survey.

2.3.2 The proposed development site lies on a north and north-west facing slope, with a high point of c. 90m AOD within the south-eastern corner of the main, central, parcel of land. The lowest area of the site is at the northern boundary at around 50m AOD. This steep incline is likely affect collection of data, with a higher possibility of stagger.

3. AIMS & METHODOLOGY

3.1 Aims of Survey Works

3.1.1 Geophysical survey is a programme of non-intrusive archaeological work. The aims of this geophysical survey were to:

- Identify any geophysical anomalies of possible archaeological origin within the specified survey area;
- Accurately locate these anomalies and present the findings in map form; and
- Provide recommendations for any further archaeological work(s) necessary to contribute to the mitigation of the impacts of proposed development on these potential features.

3.2 Methodology of Survey Works Summary

Site Specific Information

3.2.1 A geophysical survey was undertaken covering an area of c. 13 ha on 14th to the 19th of January 2016.

3.2.2 The AB Heritage staff members who undertook the works were Glenn Rose (Project Officer), Tom Cloherty (Archaeological Technician), and Peter Bonvoisin (Archaeological Technician).

3.2.3 The weather conditions varied between wet and dry throughout the survey; these conditions had no material impact upon the survey.

Equipment

3.2.4 The magnetic survey equipment used was two Bartington Grad-601 (fluxgate magnetometers).Please see Appendix A, which contains a detailed methodology for the works undertaken; however, briefly, Table 1, below, shows site specific information on how the magnetometer was set up:

Table 1: Setting Parameters of Magnetometer

Grid Size	30x30 metres
Data Capture Distances	1m x 0.25m
Sensors	2
Sensitivity	0.1nT

3.2.5 A Trimble Geo XR GPS was used to setup the geophysical survey. This has sub-centimetre accuracy suitable for this survey.

3.3 Known Constraints

3.3.1 Field 1 is surrounded by modern buildings which are likely to cause magnetic disturbance within the survey up to a range of c.4-5m.

3.3.2 Field 4 is on a steep slope, see topography section above, which can cause stagger within the data. Field 4 also contains a pylon which can cause magnetic disturbance within range of 5-10m (Plate 1).

Plate 1 View of Field 4 from the south, facing north west showing pylon and slope to the north

4. RESULTS

4.1.1 For the purposes of this detailed magnetic survey, results for the geophysics data have been shown within Figure 2 to 3, with interpretations shown in Figures 4. The site has been split into six separate fields (shown on Figure 1) and below is a factual account of the results.

4.2 Geophysical Survey Results

Field 1

4.2.1 Within Field 1, two negative linears [**GP 1 M**] are located in a north west to south east direction extending to c. 100m in length with readings varying from -2 nanotesla (nt) to -0.1nt.

4.2.2 A positive sub rectangular feature [**GP 1 N**] located with the southern end of Field 1 has a reading of up to 6nt and covers an area of c. 100m^2.

4.2.3 Large areas of varied negative and positive readings [**GP 3**] are located toward the western side of the site and also along the eastern boundary.

Field 2

4.2.4 In the south eastern corner of Field 2 a positive linear feature [**GP1 A**], with a reading of 1nt to 3nt extends in a north west direction up to c.200m in length.

4.2.5 A positive linear feature [**GP 1 B**] with an average reading of 1nt extends c.75m in a north to south direction, with an adjoining linear feature running in an east to west direction to a length of c.50m.

4.2.6 A positive linear with readings of between 1-2nt [**GP 1 C**] extends in a north west to south east direction c.100m in length.

4.2.7 In the centre of Field 2 a broken linear [**GP 1 D**] is located in a south east to north west direction to a length of c.100m.

4.2.8 Located to the south of the building within Field 3, a negative linear [**GP 1 E**] orientated in a north to south direction, with a length of c. 100m and readings of -3nt is located adjacent to a positive linear either side measuring up to 5nt.

4.2.9 A small linear [**GP 1 F**] is located on the western side of the site, measuring c.30m in length with a reading of 2nt to 5nt.

4.2.10 A sub rectangular feature [**GP 1 G**] is situated within the south western corner of the site with three linear sides with the longest side to the south measuring c. 75m. and a range or readings from 1nt to 7nt.

4.2.11 A high positive linear [**GP 5**] with associated negative readings [**GP 3**] which extends through the north eastern corner of the field and carries on in a north west direction through the site.

4.2.12 Di-polar [**GP 4**] anomalies are also situated in amorphous pattern within the field.

Field 3

4.2.13 Across Field 3 runs a modern utility [**GP 5**] with associated negative readings [**GP 3**] to a length of c.75m

4.2.14 Di-polar [**GP 4**] anomalies are also situated in the eastern side of the field.

Field 4

4.2.15 A 'right angle' linear [**GP 1 H**] is situated centrally within Field 4 covering a distance of c.100m in length and has an average reading of 1.5nt.

4.2.16 Within the north west corner of the site a small linear [**GP 1 I**] runs in a north west to south east direction to a length of c.30m.

4.2.17 Within the south east corner of the site a small linear [**GP 1 J**] runs from the eastern boundary towards the modern utility [**GP 5**] running through the site.

4.2.18 Magnetic disturbance [**GP 3**] is shown within the site mainly associated with the pylon located along the eastern boundary of the field.

4.2.19 A modern utility [**GP 5**] runs through the field from the south east corner running in a north west direction up to c. 200m in length.

4.2.20 Di-polar [**GP 4**] anomalies are also situated in a sporadic nature within the field.

Field 5

4.2.21 Located on the western boundary of the field is a semi-circular feature [**GP 1 L**] with a radius of c.10m and an average positive reading of 3.5nt

4.2.22 Within the centre of Field 5 there is a small negative linear [**GP 2**] enclosed by two positive linears which extends to a length of c. 30m and is orientated in a north west to south east direction with an average reading of -3nt.

4.2.23 Di-polar [**GP 4**] anomalies are also situated throughout mainly along the eastern boundary.

Field 6

4.2.24 A positive linear [**GP 1 K**] runs in a roughly east to west direction to a length of c.150m long and a reading of 1-2nt.

4.2.25 On the western side of Field 6 a negative linear [**GP 2**] enclosed by two positive linears runs in a north west to south east direction to a length of c.100m from the northern to southern boundary with an average reading of -3nt.

4.2.26 Di-polar [**GP 4**] anomalies are situated within the field mainly along the south and eastern sides.

5. INTERPRETATIONS AND DISCUSSION

5.1.1 Interpretation of the results of geophysical survey is based on professional judgement as to the likely/probable cause of an anomaly or reading. For example, strong dipolar discrete anomalies of small size are often associated with ferrous debris or similarly magnetic debris. In addition, where a positive linear anomaly is recorded, which has a negative anomaly associated alongside either side of it, is often likely to relate to the line of a modern utility.

5.1.2 GP numbers have been used to place interpretations into categories. Below is a discussion of the results, there has also been applied a confidence rating to the features identified (See Appendix 1). As with English Heritage 2008 guidelines for geophysical survey for archaeological field evaluation, this is an acceptable additional option only on the clear understanding that such ratings are subjective and potentially fallible assessments which can only really be tested through excavation.

Table 2: Interpretation of Geophysical Anomalies

AB No	Appearance	Potential Cause
GP 1 (A-N)	Positive/negative features	Possible Archaeology
GP 2	Negative linears enclosed by positive linears either side	Former field boundaries identified on the 1840 Tithe map of Paignton
GP3	Area of strong negative and positive readings	Magnetic disturbance, caused by disturbed ground or nearby metallic objects
GP 4	Di-polar Anomalies	Amorphous Magnetic debris
GP 5	Strong Positive Linear surrounded by negative	Modern Utility

5.1.3 Within the site there is the potential for archaeological features to remain; some of these features identified are likely to be associated with agricultural activity [**GP 1 B, F, I, J, K & N**], due to their linear nature and location within the site, there is a high confidence that these features are not likely to be representative of significant archaeology, however their form and function would require invstigation.

5.1.4 Features [**GP 1 A, D, G, H & L**] identified within Fields 2 and 5 are likely to hold the highest archaeological potential. Feature **GP 1 L** is distinguished by its a semi-circular form; cut by a trackway running through the centre of the site, this feature could be attributed to previous activity relating to the nurseries identified on the 1890 Ordnance survey map.

5.1.5 Two other features [**GP 1 A & D**] identified are most likely trackways based on their form, but could also be caused by a variation in geology. A third feature [**GP 1 G**] identified within the south western corner of Field 2 could be a possible enclosure or due agricultural activity.

5.1.6 Within Field 4 the site drops away with a steep north west facing slope, while a 'right angled' feature [**GP 1 H**] is situated at the top of the hill and is situated just under the highest point. The topography and setting of this feature could be of interest, though the low readings and incomplete nature of the feature suggests it is more likely due to agricultural activity.

5.1.7 There is a medium to low confidence that features [**GP 1 A, D, G, H & L**] have archaeological origins.

5.1.8 Features [**GP 1 B, C & M**] identified are likely to relate to previously field boundaries, based on their linear form and location, and are not shown on the 1840 Tithe Map. Another linear feature [**GP 1 E**] is likely to be a possible previous extension of the trackway, which extends through the centre of the site and is also not shown this far south on the 1840 Tithe map. There is a medium confidence for the interpretation of these features as they are not noted within any previously seen mapping of the site.

5.1.9 There is a high confidence that negative linears [**GP 2**] identified within Fields 1, 4 and 5 are previous field boundaries, as they have been identified within the 1840 Tithe map of Paignton and run along the same orientation.

5.1.10 Modern utilities [**GP 5**] cross the site from the south east corner to the north west corner. In addition, at the northern end of the site pylons have created a high degree of magnetic disturbance [**GP 3**] along with the associated overhead cables. Field 1 has the highest amount of disturbance, and is likely to have been due to building of banks that surround the field.

6. CONCLUSION

6.1.1 A geophysical survey was undertaken by AB Heritage at the proposed development site of land south of Yalberton Road. This took place over 4 days, from the 14th to the 19th of January 2016.

6.1.2 The purpose of this work was to understand the potential for any archaeological remains to survive within the site, and, where possible, identify the form, function and extent of any potential remains.

6.1.3 Based on the geophysical survey it is likely that there is potential for the recovery of archaeological remains with the site.

6.1.4 There is a high confidence for recovery of field boundaries [**GP 2**] noted in the 1840 Tithe map. There is a medium confidence for recovery of features; likely to pre date the 1840 Tithe map, with the majority of these feature unlikely to be representative of significant archaeological features. Said features are more likely to relate to agricultural activity, [**GP 1 B, F, I, J, K & N**] previous field boundaries [**GP 1 B, C & M**] trackways [**GP 1 A & D**] and potential enclosures [**GP 1 G, H & L**].

7. ARCHIVE

7.1.1 The Site Archive will contain the following, as a minimum:

Table 3: Site Archive Data

Archive	Format
Raw Geophysical Data files	XYZ and Text
Processed geophysical data files	JPEG, BMAP
Archaeological Interpretation	Shape Files ARC GIS
Final Report	PDF
Final Images	PDF

7.1.2 A physical and digital archive will be stored in a suitable format at AB Heritage Limited offices in Taunton, Somerset.

8. REFERENCES

BGS (British Geological Society) 2015.*Geology of Britain viewer.* http://mapapps.bgs.ac.uk/geologyofbritain/home.html.

Cotswold Archaeology,2012.Yalberton Paignton Torbay Heritage Desk-Based Assessment.

CIFA, 2014.Standard and Guidance for archaeological geophysical survey.

Cranfield Soil and Agrifood Industry, 2015.*Soilscapes viewer*, http://www.landis.org.uk/soilscapes/

Jones, D.M. (ED) 2008.Geophysical Survey in Archaeological Field Evaluation.English Heritage.

Schmidt, A. 2002.Geophysical Data in Archaeology*: a Guide to Good* Practice. Oxford. Oxbow.

1840 Tithe map of Paington

1890 First edition Ordnance Survey Map

Appendix 1 Technical Information on Geophysical Survey

FLUXAGTE MAGNETOMETRY SURVEY

The magnetic survey is carried out using a fluxgate gradiometer, which is a passive instrument consisting of two sensors mounted vertically 1m apart. The instrument is carried about 30cm above the ground surface and the top sensor measures the Earth's magnetic field, whilst the lower sensor measures the same field but is also more affected by any localised buried field. The difference between the two sensors will relate to the strength of a magnetic field created by a buried feature, if no field is present the difference will be close to zero as the magnetic field measured by both sensors will be the same.

Factors affecting the magnetic survey may include soil type, local geology, previous human activity, disturbance from modern services etc.

Survey equipment

The Bartington Grad 601-2 dual magnetic gradiometer is capable of surveying to an accuracy of 0.1 nanotesla (nT).

Sample interval and depth of scan

The magnetometer data is collected in 30mx30m grids at a resolution of 1m x 0.25m. This sample density is recommended for site evaluation (English Heritage, 2008). This equates to 3600 points per 30mx30m grid. The magnetometer has a typical depth of penetration of 0.5m to 1.0m. This would be increased if strongly magnetic objects are buried within the site.

Data capture

The readings are logged continually by the data logger during the survey, which is then downloaded on site to a site laptop. At the end of each job, data is transferred to the office PC's for processing and presentation.

This 'regular xy' data is then downloaded into specialist data processing software, at user defined sample intervals (in this case 1 m by 0.25 m). This is processed as standard magnetometer data.

Processing

Standard Raw Magnetometer data processing consists of:

Zero mean Traverse- This process sets the background mean of each traverse within each grid to zero, the operation allows for the removal of striping effects.

Destagger- The collection of geophysical data can lead to errors with time due to a slight variation in speed of traverses or time lag within the collection of data. The process corrects the erros of stagger within the data.

Non-Standard Magnetometer processing:

Interpolation- The results of greyscale geophysical data can sometimes appear blocky in nature. Interpolation is a process which calculates and inserts values between existing data to give a smoother grey scale image.

Cliping – The clipping process will clip extreme values from the data set and increase the contrast in the data values closer to the mean. As most data within a data set is concentrated around the mean clipping can produce a better visualisation of standard data sets, particularly very weak signals that tend to be lost in a myriad of grey shades.

Some degree of heading error is inevitable when using a fluxgate gradiometer with such an acute sensitivity to the direction of travel in bi directional manner i.e. zigzag traverses. The error displays as a series of alternating lighter and darker stripes in the traverse direction and the function asses and corrects the mean for each line of data to bring them in to the same mean range and remove any visible artefacts.

Display of data

Greyscale-This is display takes a range of reading and divides into a set number of classes. Each class is represented by a specific shade of grey and the higher the positive reading the darker the grey.

Colour- Colour can be applied to Greyscale plots to show high and low data collection points in a more direct way.

XY Trace Plot- Data is represented by a line, which is incremented along the Y axis. This produces a stepped effect, thus the data can be viewed to show a possible shaping of a feature. Typically features are clipped to limit odd readings.

Assigned ranges can be adjusted to give the best display of the data.

Some degree of heading error is inevitable when using a fluxgate gradiometer with such an acute sensitivity to the direction of travel in bi directional manner i.e. zigzag traverses. The error displays as a series of alternating lighter and darker stripes in the traverse direction and the function asses and corrects the mean for each line of data to bring them in to the same mean range and remove any visible artefacts.

GPS METHODOLOGY

An RTK GPS (Real-time Kinematic Global Positioning System) can locate a point on the ground to sub-cm accuracy, a far greater accuracy than a standard GPS unit. An RTK system uses a base station receiver and a number of mobile units (rovers). The base station takes measurements from satellites in view and then broadcasts them along with its known position to the rover receivers. The rover receiver also collects measurements from the satellites in view and processes them with the base station data. The rover then computes its location relative to the base.

During such a survey a Trimble GeoXR Differential Global Positioning System (dGPS), capable of Real Time Kinematic (RTK) is used to set out a nominal grid prior to the survey. This increases the accuracy and efficiency of the survey. The data is then downloaded from the unit on the day, using a USB stick.

CONFIDENCE RATING OF INTERPRETATION

Categories for interpretations when there is corroborative evidence from mapping/desk based or excavation data can be assigned to magnetic anomalies (for example, Utility, Road, Wall, etc.) and where appropriate, such interpretations will be applied.

Table 2: Table of Confidence with interpretation

Interpretation Confidence	**Evidence**
High	Backed by mapping/desk based work/ excavation. A clear feature with a clear form.
Medium	A feature which has an unclear structure though has grouped potential or associated potential.
Low	Unknown provenance entirely based on form.

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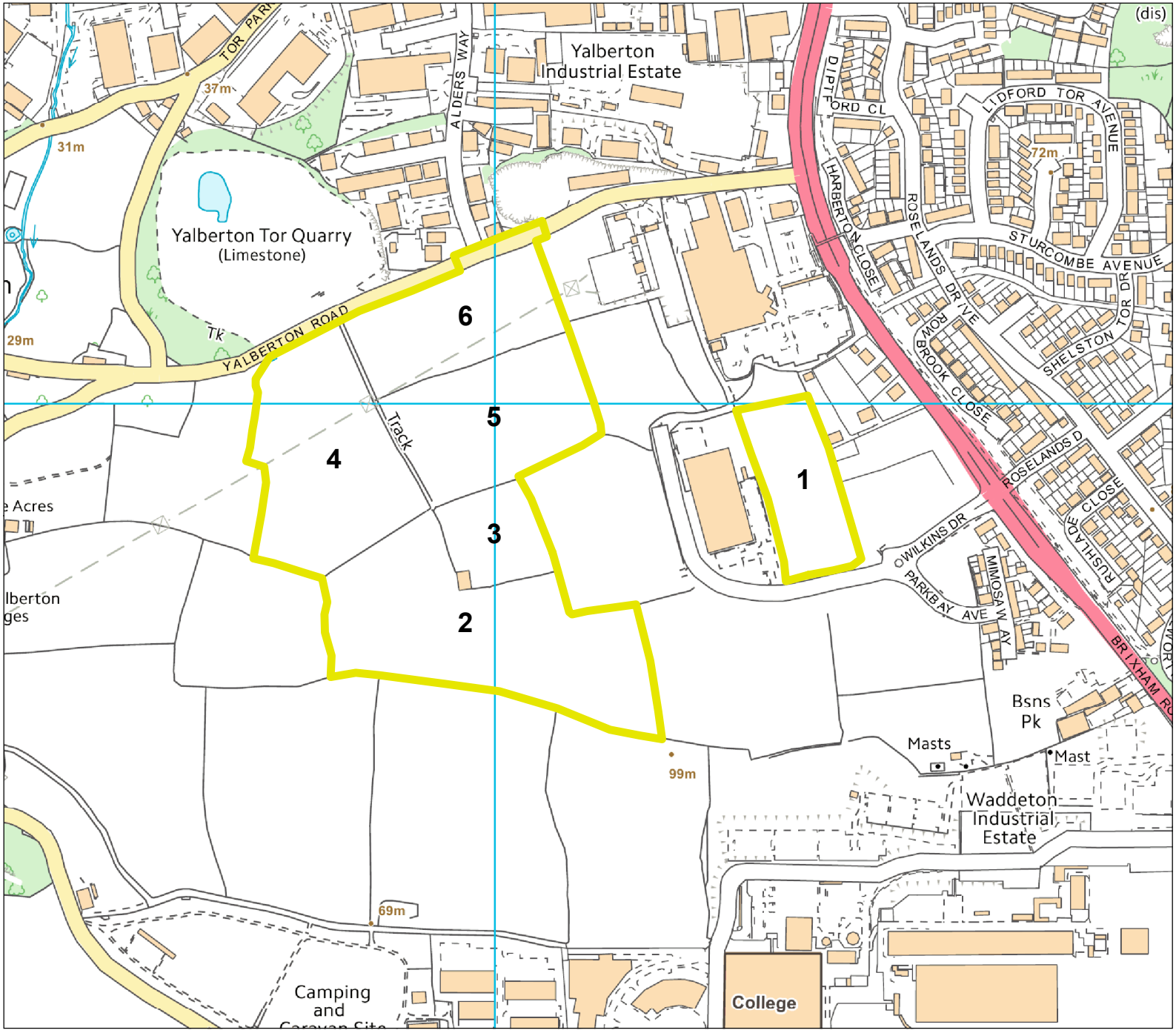

Legend

Site Boundary

Figure 1: Site Location and Field Identification

Project: Land South of Yalberton Road

Date: 08/01/16	Job Number: 10746
Drawn by: ZE	Approved by: AB

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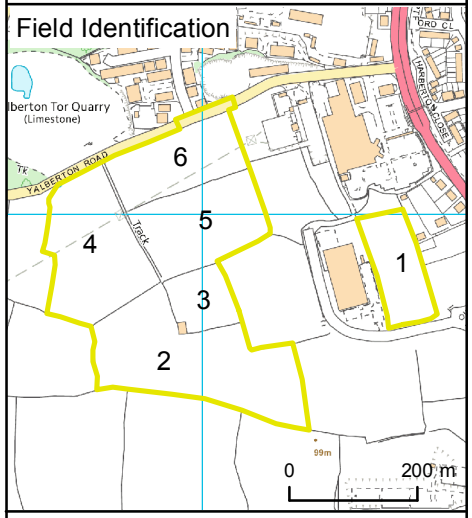
Legend

Site Boundary

Field Identification



+2

Plotting Perameters

-2

Figure 2: Raw Geophysical Data

Project: Land South of Yalberton Road

Date: 21/01/16	Job Number: 10746
Drawn by: ZE	Approved by: GR

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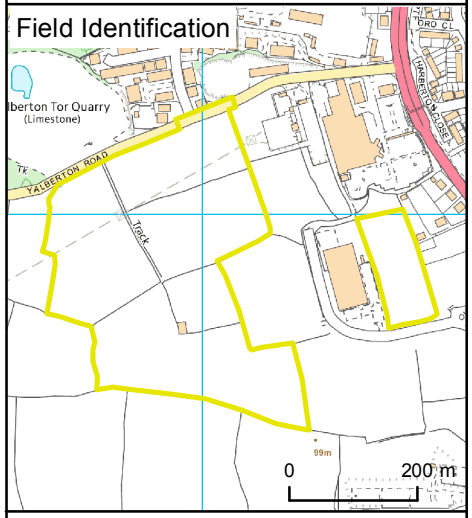
Legend

Site Boundary

Field Identification



+5

Plotting Perameters

-5

Figure 3: Processed Geophysical

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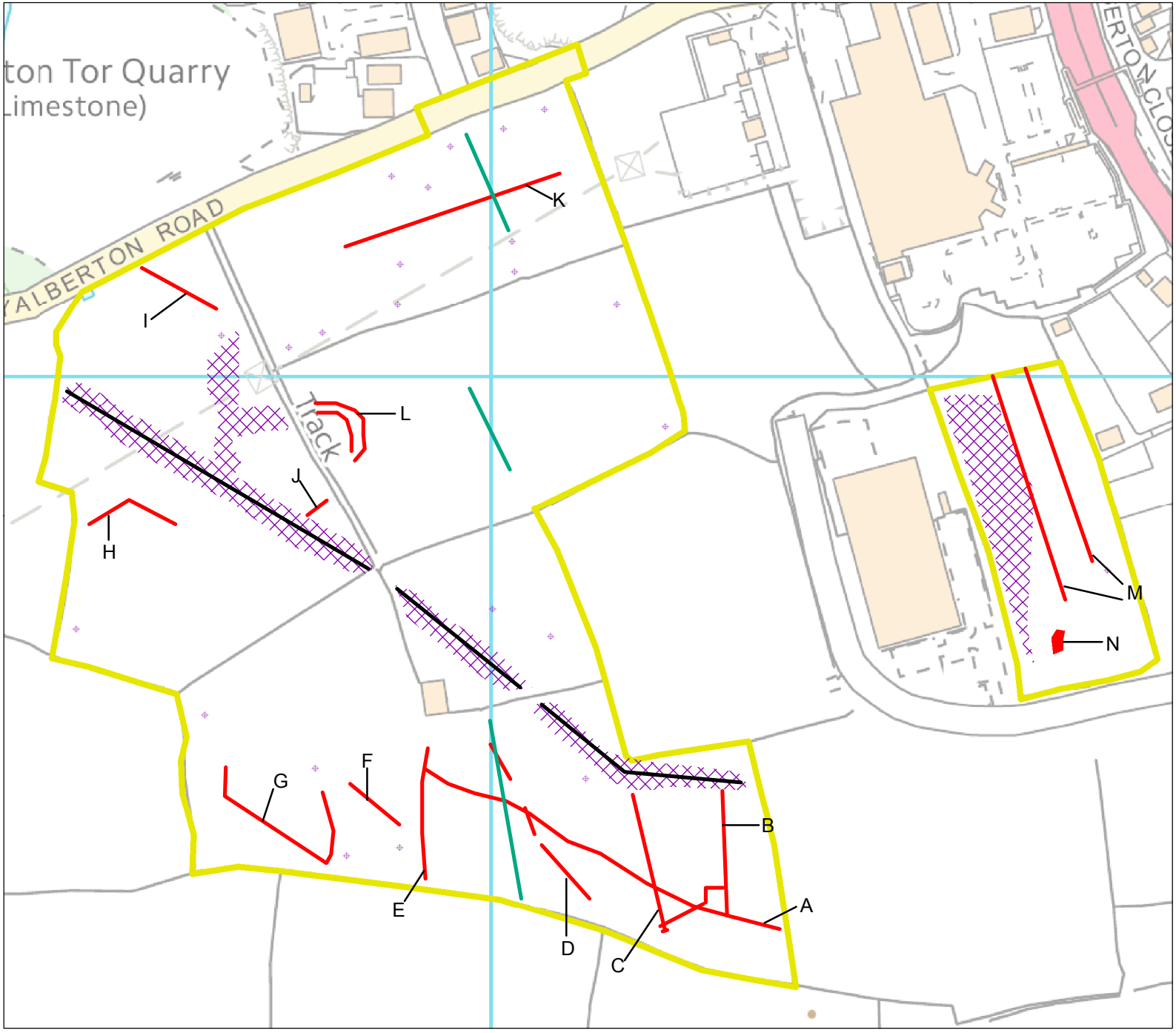

N

0 62.5 125 250 m

Legend

- Possible Archaeology [GP1] (a-n)
- Former Field Boundaries [GP2]
- Magnetic Disturbance [GP3]
- Di-Polar Anomalies [GP4]
- Modern Utility [GP5]
- Pylon
- Building
- Site Boundary

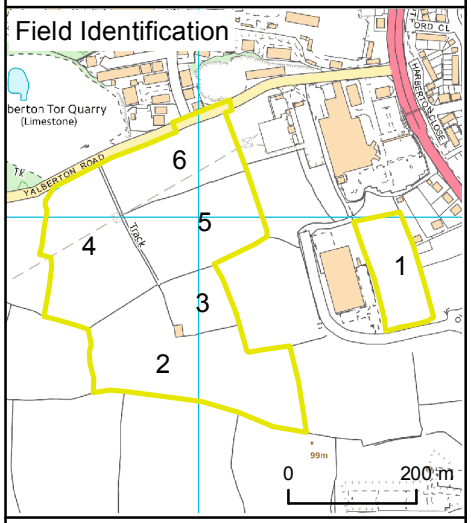

Figure 4: Interpretation of Geophysical Data

Project: Land South of Yalberton Road

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