AB HERITAGE
ARCHAEOLOGICAL CONSULTANCY

Chapelfield, St Mabyn, Cornwall

Geophysical Survey Report

Client: LJ ARCHITECTURE

AB Heritage Project No:10798

Date: 06/04/2016

Chapelfield, St Mabyn, Cornwall

Geophysical Survey Report

Client	**LJ Architecture**
Project Number	**10798**
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1. NON TECHNICAL SUMMARY

1.1.1 AB Heritage Limited (herein AB Heritage) were commissioned by LJ Architecture to undertake a programme of geophysical survey covering c.1.8ha of land at Chapelfield, St Mabyn, Cornwall, ahead of a proposed development.

1.1.2 The survey identified potential for archaeological features to exist within the proposed development site. These potential features are likely to include ditches, boundaries, and a possible enclosure.

1.1.3 Therefore it is concluded that the proposed development site has high potential for the recovery of archaeological remains.

2. INTRODUCTION

2.1 Project Background

2.1.1 AB Heritage has been asked to undertake a geophysical survey covering a proposed residential development at Chapelfield, St Mabyn, Cornwall.

2.1.2 The purpose of the survey is to identify any potential surviving archaeological remains within the proposed development site.

2.2 Site Location & Description

2.2.1 The proposed development site (hereafter referred to as the site) at Chapelfield in St Mabyn covers approximately 1.8 hectares (ha) and is centred at National Grid Reference (NGR) SX 04281 73383. The site is situated c. 60m north of Chapel Lane (Figure 1).

2.2.2 The site consists of a sub rectangular pasture field covering an area of c. 1.8 ha. A lane bounds the site on the western side, with agricultural fields to the north and east. A small residential development along Chapel Lane is located immediately to the south of the site.

2.2.3 The field boundaries are a combination of mature/semi-mature hedgerows on the north, east, and western edges of the site. The southern boundary comprises of modern fencing. Agricultural buildings are located in the south-west and south-east corners of the site.

2.3 Geology & Topography

2.3.1 The underlying geology of the site is Trevose Slate Formation and Rosenum Formation, Slates and Siltstones. The Trevolse Slate Formation also contains basaltic lava. There are no superficial deposits recorded within the site boundary (BGS 2016).

2.3.2 There is not likely to be any significant disturbance from the local sedimentary geology. However, thermoremanent effects can occur over basaltic bedrock (Historic England, 2008).

2.3.3 Topographically the area gradually drops from c.114m AOD (Above Ordnance Datum) along the eastern side of the site to c. 109m AOD along the western edge of the site.

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

3.2 Methodology of Survey Works Summary

Site Specific Information

3.2.1 A geophysical survey was undertaken covering c.1.8 ha of ground at Chapelfield, St Mabyn on the 31st of March 2016.

3.2.2 The AB Heritage staff member who undertook the works was Glenn Rose (Project Officer).

3.2.3 The weather conditions were 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 In the south-east corner of the site a sheep pen was present (Plate 1); consisting of metallic fencing, which did not allow for this area to be surveyed. .

Plate 1: Sheep pen in south-east of site, looking south.

3.3.2 Along the southern edge of the site modern housing and fencing is present (Plate 2), this caused some magnetic disturbance within c.1-2m along the southern edge. Also a vehicle was present within the survey, which created magnetic disturbance within 4-5m from the vehicle.

Plate 2: South edge of site, looking west.

3.3.3 In the south-west corner of the site a small building is present (Plate 3), meaning that this corner of the site couldn't be fully surveyed and magnetic disturbance was created within the c.3-5m from the building.

Plate 3: Building in SW corner of site, looking north-west.

4. RESULTS

4.1.1 For the purposes of this detailed magnetic survey, results for the geophysics data have been shown within Figures 2-3, with interpretations shown in Figure 4.

4.1.2 Below is a factual account of the results.

4.2 Geophysical Survey Results

4.2.1 Features have been identified into separate categories by GP numbers (Table 3), below are the results for Possible archaeological features **GP 1 -6**

Table 2: Results of Geophysical Survey

GP	Feature/Feature Group	c. Total length (m) or area (m²)	c. Reading (nT)	Orientation	Form
GP1 - Strong Positive Linears	A1 - A7	76m	20 to 5	NW to SE	Linear
	B	20m		NE to SW	
	C	14m		NE to SW	
	D	10m		NW to SE	
	E1 - E7	95m	40 to 5	NE to SW	
	F	10m	20 to 5	NE to SW	
	G	3.6m		NE to SW	
	H	11.4m		N to S	
	I1 -I2	21.5m		N to S	
	J1 - J2	20m		N to S	
	K	35m		N to S	
	L	15m		N to S	
	M	8m		N/A	Curvi-linear
	N	12m		N/A	
	O	15m		N/A	
GP2 - Strong Positive Linear with assoc. Negative Response	A	150m	50 to minus 12	NE to SW	Linear
	B1 - B2	(of feature) 114m	40 to minus 15	N/A	Curvi-linear
GP3 - Strong Positive Feature	A	10m²	20 to 4	N to S	Semi-Rounded Area
	B	12m²		N/A	Irregular Area
	C	14m²			
	D	10.5m²		E to W	Semi-Rounded Area
	E	13m²		N/A	Irregular Area
	F	10m²			Semi-Rounded Area
	G	9m²			
	H	10m²			
	I	12m²			
	J	42m²			Irregular Area
	K	9m²			
	L	7m²			
	M	12m²			
	N	21m²		N to S	Semi-Rounded Area
	O	44m²		N/A	Irregular Area
	P	13m²			Semi-Rounded Area
	Q	14m²			Irregular Area
	R	8m²			Semi-Rounded

GP	Feature/Feature Group	c. Total length (m) or area (m²)	c. Reading (nT)	Orientation	Form
	S	8m²			Area
	T	10m²			
	U	60m²			Irregular Area
	V	6m²			Semi-Rounded Area
	W	12m²			
GP4 - Strong Positive and Negative Feature	A	25m²	91 to minus 36	N/A	Rounded Area
	B	23m²	46 to minus 13	N/A	
GP5 - Low Positive Feature	A	12m²	5 to 3	N to S	Irregular Area
	B	6m²	1 to 6	N/A	Semi-Rounded Area
GP6 - Negative Feature	A	14m²	minus 3 to minus 9	NE to SW	Irregular Area

4.2.2 A bi-polar feature of alternate negative and positive readings [**GP 7**] extends on a north to south axis cutting across the site with a length of c. 130m.

4.2.3 Negative and positive readings [**GP 8**] and Di-Polar anomalies [**GP 9**] occur across the site in an amorphous pattern with the majority shown in the north western side of the site.

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 3: Interpretation of Geophysical Anomalies

AB No	Appearance	Potential Cause
GP 1 (A-O)	Strong Positive Linears	Possible archaeology, earthworks/ditches
GP 2 (A-B)	Strong Positive Linears with associated Negative response	Possible archaeology, earthworks
GP 3 (A-W)	Strong Positive Feature	Possible archaeology, in filled pits/hollows
GP 4 (A-B)	Strong Positive and Negative Feature	Possible archaeology
GP 5 (A-B)	Low Positive Feature	Possible archaeology/raised area
GP 6	Strong Negative Feature	Possible archaeology, Thermoremanent
GP 7	Alternate Negative and Positive Readings	Modern Utility
GP 8	Negative and positive readings	Magnetic Disturbance
GP 9	Di-polar Anomalies	Amorphous Magnetic debris

5.1.3 Based on the results of the geophysical survey there is a high potential for the survival of archaeology within the site. As possible extensive archaeological features [**GP1 - 6**] have been identified, covering the majority of the site.

5.1.4 These features consist of multiple strong positive linears and curvi-linears [**GP1**], which are present across the site, these linears are potentially ditches or similar earthwork features of archaeological origin, there is a medium confidence in this interpretation.

5.1.5 On site there are also strong positive linears with associated negative responses [**GP2**]; these features could relate to possible field boundaries or enclosures. One of these linear features [**GP2 A**] follows a north-east to south-west axis; it also extends along the same line of the boundary to the north-east outside of the site. This indicates that the linear [**GP2 A**] is likely to be a continuation of a previous field boundary, though based on mapping it is likely to pre-date the 1842 tithe map. However, a strong positive with associated negative response feature is more likely to represent a ditch or possible bank giving this interpretation medium confidence.

5.1.6 A feature in the southern half of the site [**GP2 B**] has a form that suggests this feature represents a possible archaeological enclosure split into two sections; this interpretation has a medium confidence. Also based on surrounding aerial photography identified within the Cornwall Historic Environment Record, similarly shaped enclosures are dated to the prehistoric period MCO 21834 c.3km to the west of the site.

5.1.7 There are numerous non linear features across the site that have been interpreted as potential archaeology; strong positive features [**GP 3**], and low positive features [**GP 5**].These positive features are possible pits of archaeological origin. However, some of these features may simply represent the geology of the local area; any basaltic intrusions in the Trevolse Slate Formation affect the geophysical survey, this could also be the case with negative features [**GP 6**]. As a result of this the possible archaeological interpretation of these features has a low confidence rating.

5.1.8 Strong positive and negative features [**GP 4**] are also present on the site. The most western of these two features [**GP4 A**] has a high reading, c. -36 to 91nT. This could indicate a thermoremanent response, which would mean an area of burning. Alternatively the readings could indicate a metallic object. The readings for the east feature [**GP4 B**] are not as extreme so it is simply interpreted as possible archaeology. These interpretations have a low confidence.

5.1.9 A Modern utility is identified in the western side of the site and [**GP 7**] extends in a north to south orientation, this is likely due to a modern utility that cuts across the site.

5.1.10 Also negative and positive readings [**GP 8**] representing magnetic disturbance, along with Di-Polar anomalies [**GP 9**] these features indicate magnetic disturbance or debris across the site. The Di-Polar anomalies [**GP 9**] appear to be in particular pattern or concentration. There is a high confidence in the interpretation of these three features.

6. CONCLUSION

6.1.1 A geophysical survey was undertaken by AB Heritage at the proposed development site of Chapelfield, St Mabyn.

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 Overall the geophysical survey has identified a high potential for recovery of archaeological features [**GP 1-6**]. Some of these features have the potential to contain significant archaeology, especially in relation to the possible enclosure [**GP 2B**] identified within the southern half of the site.

7. ARCHIVE

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

Table 4: 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.

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.

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 errors 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.

Clipping – 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.

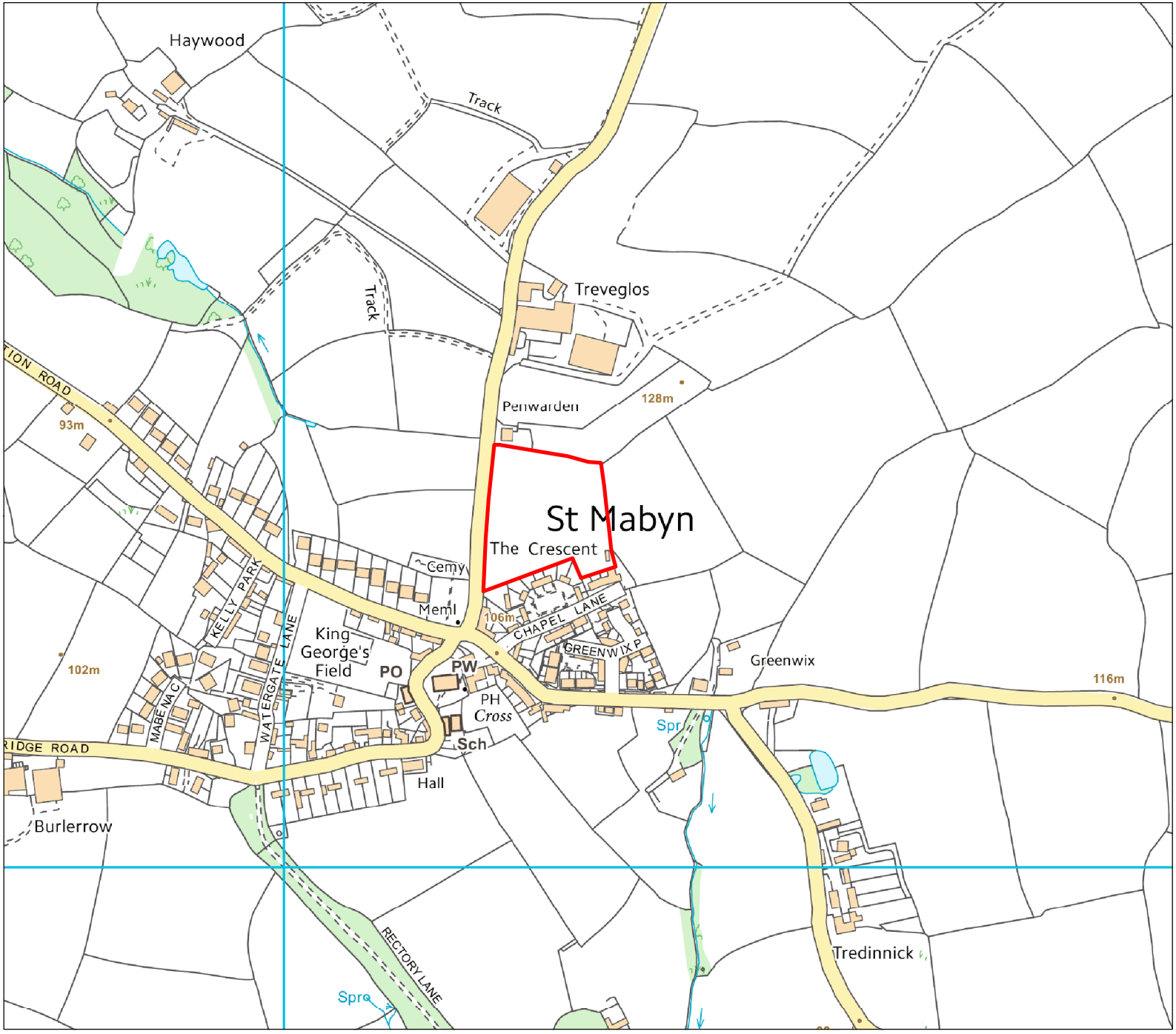
During such a survey a Trimble GeoXR Differential Global Positioning System (dGPS), capable of Real Time Kinematic (RTK) is used to set out a nominal grid prior to the survey. This increases the accuracy and efficiency of the survey. The data is then downloaded from the unit on the day, using a USB stick.

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 5: 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.



Legend

Site Boundary

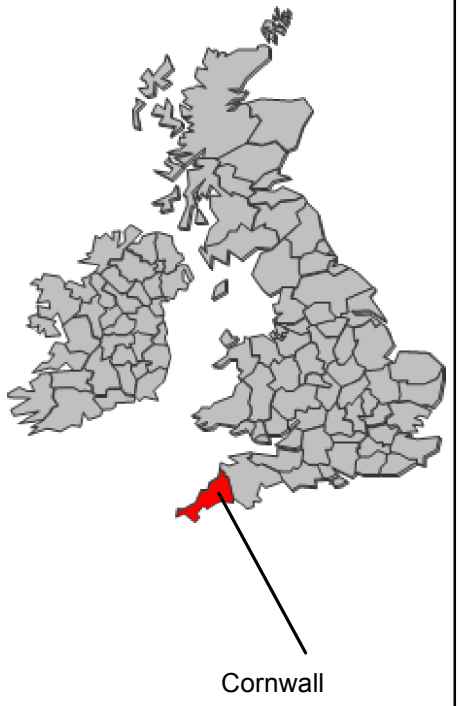


Figure 1: Site Location and Field Identification

Project: Chapelfields

Date: 21/03/16	Job Number: 10798
Drawn by: PB	Approved by: GR

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N

Legend

Site Boundary

+2

Plotting Perameters

-2

0 15 30 60 m

Figure 2: Raw Geophysical Data

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N

Legend

Site Boundary

+7

-7

Plotting Perameters

0 15 30 60 m

Figure 3: Processed Geophysical Data

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N

Legend

- Site Boundary
- Strong Positive Linears [GP1]
- Strong Positive Linears with associated Negative response [GP2]
- Strong Positive Feature [GP3]
- Strong Positive and Negative Feature [GP4]
- Low Positive Feature [GP5]
- Negative Feature [GP6]
- Modern Utility [GP7]
- Magnetic Disturbance [GP8]
- Di-Polar Anomolies [GP9]

0 15 30 60 m

Figure 4: Interpretation of Geophysical Data, Labelled

Project: Chapelfield

Date: 11/04/16	Job Number: 10798
Drawn by: ZE/PB	Approved by: GR

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N

Legend

- Site Boundary
- Strong Positive Linears [GP1]
- Strong Positive Linears with associated Negative response [GP2]
- Strong Positive Feature [GP3]
- Strong Positive and Negative Feature [GP4]
- Low Positive Feature [GP5]
- Negative Feature [GP6]
- Modern Utility [GP7]
- Magnetic Disturbance [GP8]
- Di-Polar Anomolies [GP9]

0 15 30 60 m

Figure 5: Interpretation of Geophysical Data

Project: Chapelfield

Date: 11/04/16	Job Number: 10798
Drawn by: ZE/PB	Approved by: GR

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