Close Farm, Bullamoor, Northallerton, North Yorkshire

geophysical surveys

on behalf of

Arcus Renewable Energy Consulting Ltd

Report 2137
January 2009

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1. Summary

The project

1.1 This report presents the results of geophysical surveys conducted in advance of a proposed wind farm development which spans the parishes of Northallerton and Winton, Stank & Hallikeld. The works comprised 13 geomagnetic surveys totalling 10.25ha in ten land parcels.

1.2 The works were commissioned by Arcus Renewable Energy Consulting Ltd and conducted by Archaeological Services Durham University.

Results

1.3 Probable traces of former ridge and furrow cultivation were identified in Areas 1, 2, 4, 5, 7 and 11.

1.4 Linear soil-filled features, possibly ditches, were identified in Area 1a. Small discrete soil-filled features, possibly pits, were identified in Area 8b.

1.5 A service pipe was detected in Area 2.

2. Project background

Location (Figures 1 & 2)

2.1 The study area was located at Close Farm, Bullamoor, Northallerton (NGR centre: SE 400 960). Thirteen survey areas totalling approximately 10.25ha were surveyed in ten land parcels.

Development proposal

2.2 The development proposal is for a four-turbine wind farm and associated tracks and site compound.

Objective

2.3 The principal aim of the surveys was to assess the nature and extent of any sub-surface features of potential archaeological significance within the proposed development area, so that an informed decision may be made regarding the nature and scope of any further scheme of archaeological works that may be required in advance of development.

Methods statement

2.4 The surveys have been undertaken in accordance with instructions from Arcus Renewable Energy Consulting Ltd.

Dates

2.5 Fieldwork was undertaken between 8th and 14th January 2008. This report was prepared between 15th and 28th January 2009.

Personnel

2.6 Fieldwork was conducted by Ed Davies, Adam Rogers and Natalie Swann (Supervisor). This report was prepared by Natalie Swann with illustrations by David Graham and edited by Duncan Hale, the Project Manager.

Archive/OASIS

2.7 The site code is **BCF09**, for **B**ullamoor **C**lose **F**arm 20**09**. The survey archive will be supplied on CD to the client for deposition with the project archive in due course. Archaeological Services is registered with the **O**nline **A**cces**S** to the **I**ndex of archaeological investigation**S** project (OASIS). The OASIS ID number for this project is **archaeol3-54085**.

3. Archaeological and historical background

3.1 The results of a desk-based study indicate that there are unlikely to be any buried features of importance where construction activities are planned (Novera 2008). However, a Roman road is believed to run north-south just to the east of Close Farm.

4. Landuse, topography and geology

4.1 At the time of survey the proposed development area comprised ten fields of mixed arable and pasture land. It was not possible to collect data in small parts of Areas 4, 5 and 6 due to stockpiles of hay and manure.

4.2 The survey area sloped from 110m OD at its highest point in the east to 80m OD at its lowest point at the northern end of the proposed development area.

4.3 The underlying solid geology of the area comprises Triassic Mudstones which are overlain my boulder clay and morainic drift.

5. Geophysical survey

Standards

5.1 The surveys and reporting were conducted in accordance with English Heritage guidelines, *Geophysical survey in archaeological field evaluation 2nd edition* (David, Linford & Linford 2008); the Institute of Field Archaeologists Technical Paper No.6, *The use of geophysical techniques in archaeological evaluations* (Gaffney, Gater & Ovenden 2002); and the Archaeology Data Service *Geophysical Data in Archaeology: A Guide to Good Practice* (Schmidt 2002).

Technique selection

5.2 Geophysical survey enables the relatively rapid and non-invasive identification of sub-surface features of potential archaeological significance and can involve a variety of complementary techniques such as magnetometry, earth electrical resistance, ground-penetrating radar and electromagnetic survey. Some techniques are more suitable than others in particular situations, depending on a variety of site-specific factors including the nature of likely targets; depth of likely targets; ground conditions; proximity of buildings, fences or services and the local geology and drift.

5.3 In this instance, based on desktop evidence, it was considered likely that cut features such as ditches and pits might be present on the site, and that other types of feature such as trackways, wall foundations and fired structures (for example kilns and hearths) might also be present.

5.4 Given the anticipated shallowness of targets and the non-igneous geological environment of the study area a geomagnetic technique, fluxgate gradiometry, was considered appropriate for detecting the types of feature mentioned above. This technique involves the use of hand-held magnetometers to detect and record anomalies in the vertical component of the Earth's magnetic field caused by variations in soil magnetic susceptibility or permanent magnetisation; such anomalies can reflect archaeological features.

Field methods

5.5 A 20m grid was established across each survey area and tied-in to known, mapped Ordnance Survey points using a Trimble Pathfinder Pro XRS global positioning system (GPS) with real-time correction providing sub-metre accuracy.

5.6 Measurements of vertical geomagnetic field gradient were determined using Bartington Grad601-2 dual fluxgate gradiometers. A zig-zag traverse scheme was employed and data were logged in 20m grid units. The instrument sensitivity was set to 0.1nT, the sample interval to 0.25m and the traverse interval to 1.0m, thus providing 1600 sample measurements per 20m grid unit.

5.7 Data were downloaded on site into a laptop computer for initial processing and storage and subsequently transferred to a desktop computer for processing, interpretation and archiving.

Data processing

5.8 Geoplot v.3 software was used to process the geophysical data and to produce both continuous tone greyscale images and trace plots of the raw (unfiltered) data. The greyscale images and interpretations are presented in Figures 2-5; the trace plots are provided in Figure 6. In the greyscale images, positive magnetic anomalies are displayed as dark grey and negative magnetic anomalies as light grey. A palette bars relates the greyscale intensities to anomaly values in nanoTesla.

5.9 The following basic processing functions have been applied to each dataset:

zero mean traverse	sets the background mean of each traverse within a grid to zero; for removing striping effects in the traverse direction and removing grid edge discontinuities.
destagger	corrects for displacement of anomalies caused by alternate zig-zag traverses.
interpolate	increases the number of data points in a survey to match sample and traverse intervals. In this instance the data have been interpolated to 0.25 x 0.25m intervals.

Interpretation: anomaly types

5.10 Colour-coded geophysical interpretation plans are provided in Figure 4. Two types of geomagnetic anomaly have been distinguished in the data:

positive magnetic	regions of anomalously high or positive magnetic field gradient, which may be associated with high magnetic susceptibility soil-filled structures such as pits and ditches.
dipolar magnetic	paired positive-negative magnetic anomalies, which typically reflect ferrous or fired materials (including fences and service pipes) and/or fired structures such as kilns or hearths.

Interpretation: features

5.11 Colour-coded archaeological interpretation plans are provided in Figure 5.

General comments

5.12 Except where stated otherwise in the text below, positive magnetic anomalies are taken to reflect relatively high magnetic susceptibility materials, typically sediments in cut archaeological features (such as furrows, ditches or pits) whose magnetic susceptibility has been enhanced by decomposed organic matter or by burning.

5.13 Small, discrete dipolar magnetic anomalies have been detected in all of the survey areas. These almost certainly reflect items of near-surface ferrous and/or fired debris, such as horseshoes and brick fragments, and in most cases have little or no archaeological significance. A sample of these is shown on the geophysical interpretation plans, however, they have been omitted from the archaeological interpretation plans and the following discussion.

Areas 1a and 1b

5.14 The dipolar magnetic anomaly that runs through Areas 1a and b corresponds to a modern track. Linear positive magnetic anomalies to the east of the track may reflect traces of former ridge and furrow cultivation.

5.15 Two linear positive magnetic anomalies aligned east-west at the northern end of Area 1a could reflect soil-filled features such as ditches.

Area 2

5.16 The chain of dipolar magnetic anomalies aligned northeast-southwest reflects a wire fence. The linear dipolar magnetic anomaly in the south of the survey area aligned approximately north-south almost certainly reflects a ferrous service pipe.

5.17 Several parallel positive magnetic anomalies have been detected aligned north-south across the survey area. These possibly reflect traces of former ridge and furrow cultivation.

Area 3

5.18 No features of likely archaeological origin have been identified.

Area 4

5.19 Several parallel positive magnetic anomalies have been detected aligned northwest-southeast; these probably reflect former ridge and furrow cultivation of the area.

5.20 The dipolar magnetic anomaly on the eastern edge of the survey area reflects an adjacent wire fence.

Area 5

5.21 The strong dipolar magnetic anomaly at the eastern end of this survey area reflects a piece of farm machinery; west of this a linear dipolar anomaly reflects a wire fence across the survey corridor.

5.22 At the western end of the survey area some linear positive magnetic anomalies probably reflect former ridge and furrow cultivation.

Area 6

5.23 Dipolar magnetic anomalies at the eastern and western ends of this survey area reflect wire fences. The current plough regime is evident in the data aligned north-south.

Area 7

5.24 A number of parallel positive magnetic anomalies were detected in this area aligned northeast-southwest, evenly spaced at about 7m intervals. These are likely to reflect former ridge and furrow cultivation of the area.

5.25 The pair of linear positive magnetic anomalies aligned northwest-southeast correspond to a change in landuse.

Area 8a and 8b

5.26 along the southern edge of this survey area there are weak linear anomalies which correspond to wheel ruts in a track along the edge of the field.

5.27 In Area 8b there are a number of small discrete positive magnetic anomalies. These may reflect soil-filled features such as pits.

Area 9

5.28 A number of linear positive magnetic anomalies have been detected across this area; these are likely to reflect ridge and furrow cultivation.

5.29 There are also a number of strong dipolar magnetic anomalies at the southern end of the survey area. It is possible these represent sub-surface ferrous objects, possibly associated with horse jumps of which there were a number in the field.

Area 10

5.30 The strong dipolar magnetic anomaly that runs through the centre of this survey area reflects an existing track and wire fence.

5.31 It has not been possible to identify any anomalies which might reflect the former Roman road which is believed to run through the eastern end of this survey. However, its presence could be obscured by anomalies associated with the existing track here.

Area 11

5.32 The linear dipolar magnetic anomalies aligned northwest-southeast across this survey area are likely to reflect former ridge and furrow cultivation.

5.33 At the western end of the area a strong dipolar magnetic anomaly reflects a piece of farm machinery.

6. Conclusions

6.1 10.25ha of geomagnetic survey was undertaken at Close Farm, Bullamoor, Northallerton, prior to proposed development.

6.2 Probable traces of former ridge and furrow cultivation were identified in Areas 1, 2, 4, 5, 7 and 11.

6.3 Linear soil-filled features, possibly ditches, were identified in Area 1a. Small discrete soil-filled features, possibly pits, were identified in Area 8b.

6.4 A service pipe was detected in Area 2.

7. Sources

David, A, Linford, N, & Linford, P, 2008 *Geophysical survey in archaeological field evaluation, 2nd edition,* English Heritage

Gaffney, C, Gater, J, & Ovenden, S, 2002 *The use of geophysical techniques in archaeological evaluations*, Technical Paper **6**, Institute of Field Archaeologists

Novera 2008 Bullamoor Wind Farm Proposal, *Newslette*r 2, Novera Energy Plc

Schmidt, A, 2002 *Geophysical Data in Archaeology: A Guide to Good Practice*, Archaeology Data Service, Arts and Humanities Data Service

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Figure 1
Site location

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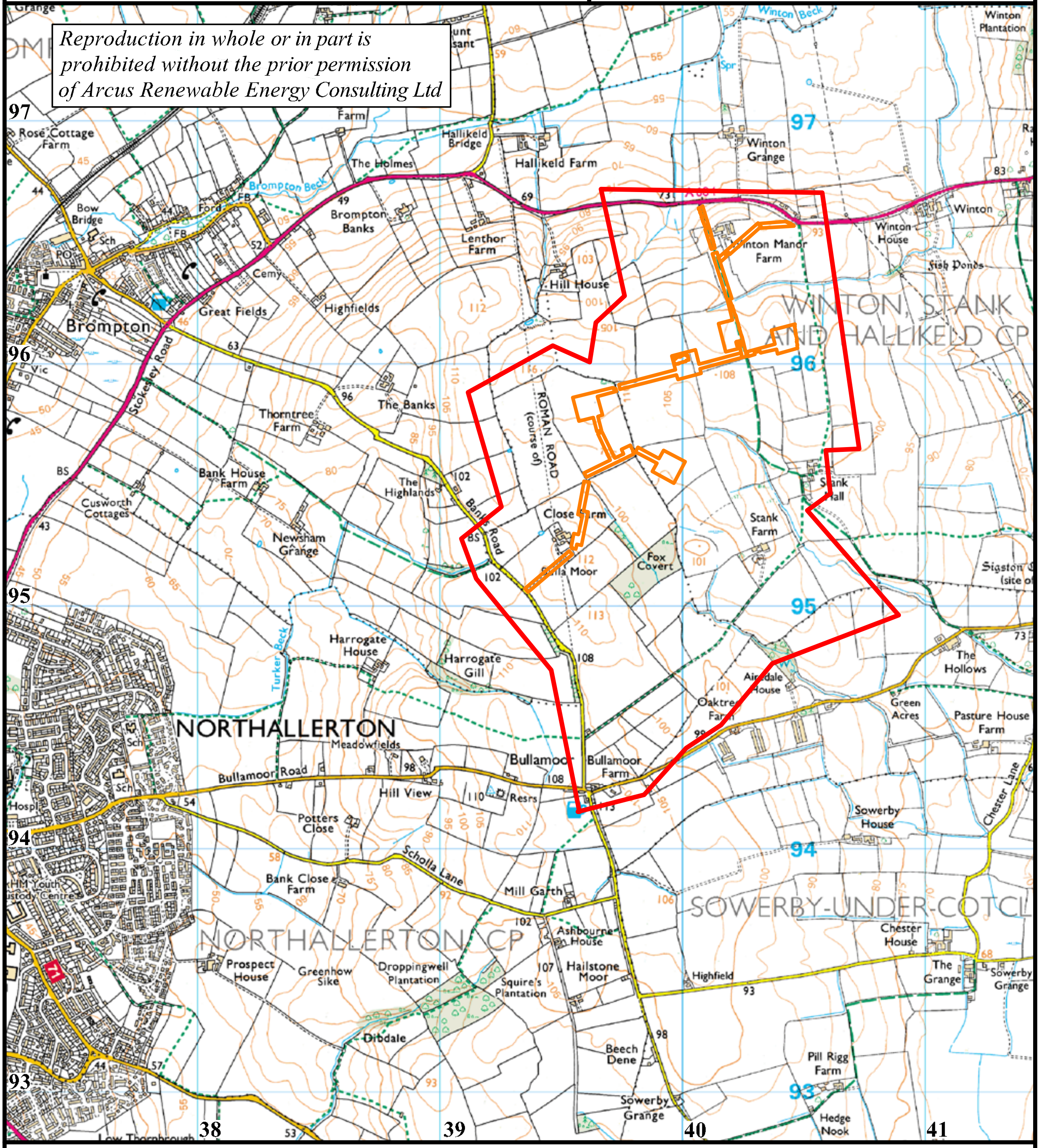
0 1km
scale 1:25 000 - for A4 plot



site outline
survey outline

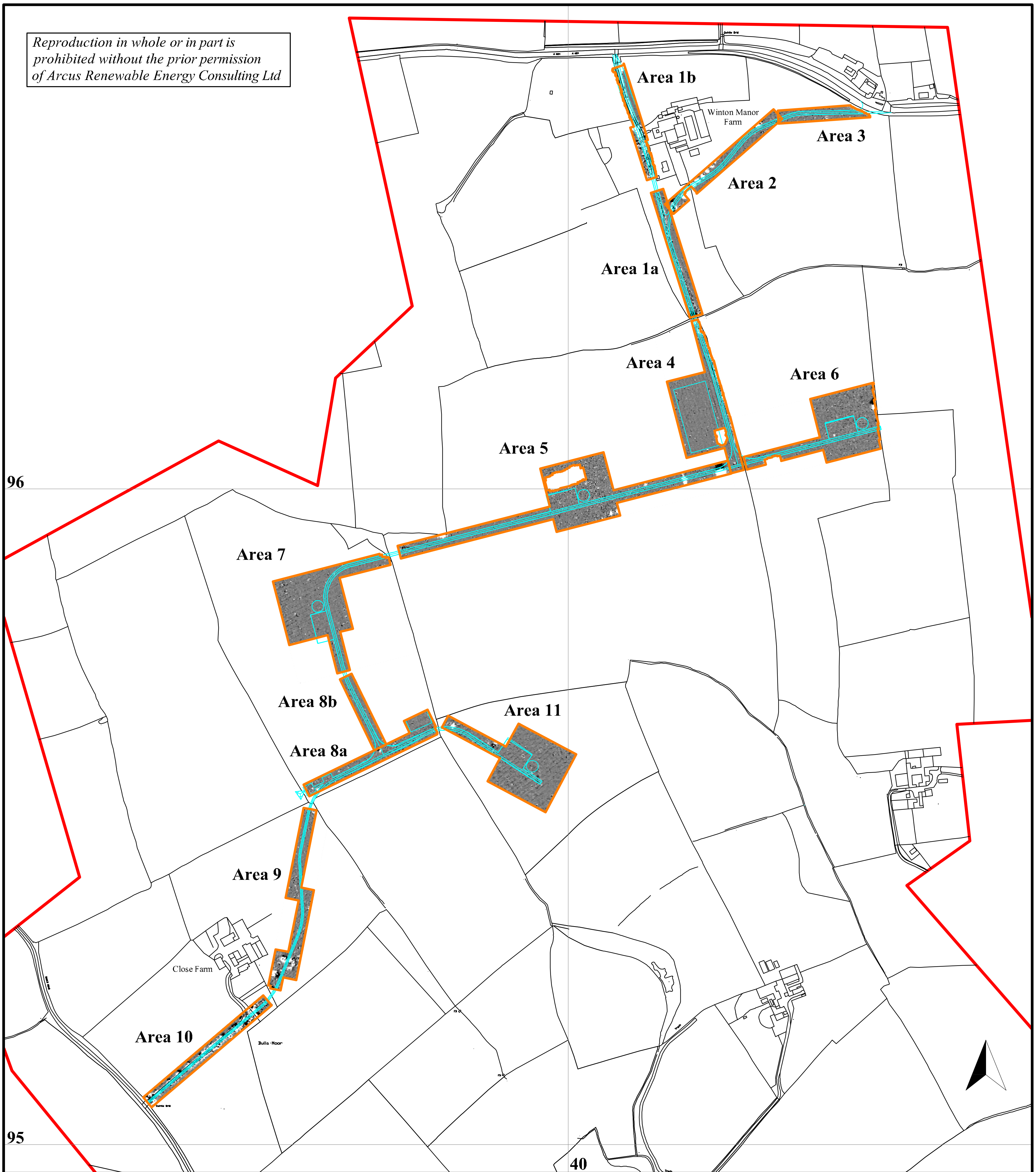


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Figure 2

Overview of surveys and proposed development

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0 300m

scale 1:6000 - for A3 plot

outline of survey area

site outline

proposed development

Figure 3

Geophysical surveys

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Figure 4

Geophysical interpretations


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Cattle Grid
Area 1b
Winton Manor Farm
Area 3
Area 2
Area 1a
track
Area 4
Area 6
haystack
manure heap
Area 5
Area 7
Area 5
manure heap
Area 8b
Area 11
Area 8a
Area 9
Close Farm
Area 9
Area 10
Bulla Moor
Cattle Grid
outline of survey area
possible soil-filled features
orientation of ridge and furrow
proposed development
0
50m
scale 1:1000 - for A0 plot
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Figure 5
Archaeological interpretation

Figure 6: Trace plots of geophysical data