Archaeological Services
University of Durham

Westnewton Wind Farm, Cumbria

geophysical surveys

on behalf of
Oxford Archaeological Associates

Report 2111
November 2008

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Contents

1. Summary

The project

1.1 This report presents the results of geophysical surveys conducted in advance of a proposed wind farm development at Westnewton in Cumbria. The works comprised six geomagnetic surveys covering a total area of approximately 4.2ha.

1.2 The works were commissioned by Oxford Archaeological Associates and conducted by Archaeological Services Durham University.

Results

1.3 Extremely weak anomalies in some areas could possibly reflect the remains of soil-filled features, though these are not necessarily of archaeological origin.

2. Project background

Location (Figures 1 & 2)

2.1 The study area was located on land at Warwick Hall Farm, Westnewton, near Aspatria, Cumbria (NGR centre: NY 134 436). The site is bounded by Westnewton village and fields to the north, the B5301 and fields to the east, Lancarr Beck to the south and fields to the west. Six surveys were conducted, comprising a total of *c*.4.2ha, in four land parcels.

Development proposal

2.2 The development proposal is for the installation of three wind-turbines, access tracks and associated infrastructure.

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 provided by Oxford Archaeological Associates (OAA), following discussions with the Historic Environment Service at Cumbria County Council and based on current English Heritage (2008) guidelines.

Dates

2.5 Fieldwork was undertaken between 21st and 28th October 2008. This report was prepared between 30th October and 11th November 2008.

Personnel

2.6 Fieldwork was conducted by Natalie Swann (Supervisor), Jamie Armstrong, Edward Davies, David Graham, Duncan Hale and Andy Platell. This report was prepared by Duncan Hale, the Project Manager, with illustrations by Janine Wilson.

Archive/OASIS

2.7 The site code is **WWH08**, for **W**estnewton **W**arwick **H**all 20**08**. 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 **archaeol3-51373.**

3. Archaeological and historical background

3.1 A desk-based archaeological assessment was undertaken by Archaeological Services (2006); the paragraphs below summarise the findings of that report:

- Westnewton Castle, a Scheduled Ancient Monument, lies to the north of the proposed development site. There are several historic or statutorily protected buildings in the vicinity of the site. Hadrian's Wall Roman Frontier, a World Heritage Site, lies to the north and east of the study area.
- Cropmarks identified by aerial photography to the south and east of Warwick Hall (though outside the survey areas) suggest that the development area may have been occupied during the prehistoric and/or Romano-British periods.
- Deposits relating to medieval and post-medieval agricultural practices may exist. Because of a lack of 19th- and 20th-century development, the potential for archaeological deposits to survive is good.

3.2 Geophysical surveys were recently undertaken in the same fields for an earlier wind farm design of five turbines (Archaeological Services 2007). The surveys detected a few anomalies which could reflect features of possible archaeological origin such as ditches and pits.

4. Landuse, topography and geology

4.1 At the time of survey the proposed development area comprised six fields of pasture and arable land. The soils were generally soft and waterlogged with areas of standing water.

4.2 The site lies in farmland to the south of Westnewton and north-west of Aspatria. The mean elevation is 25m OD in the north, rising to 60m OD in the south-east. Westnewton Beck and Sandwith Beck cross the northern part of the site and Lancarr Beck traverses the southern part.

4.3 The underlying geology of the area comprises Permian and Triassic sandstones, which are overlain by 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 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 The study area was divided into six individual survey areas. Where the current survey areas overlap with the previous survey areas, such as the access track to Turbine 1, these have not been resurveyed.

5.6 A 20m grid was established across each survey area and tied-in to known, mapped Ordnance Survey points using a Leica GS50 global positioning system.

5.7 Measurements of vertical geomagnetic field gradient were determined using Geoscan FM256 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.

5.8 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

5.9 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 bar relates the greyscale intensities to anomaly values in nanoTesla.

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

clip	clips, or limits data to specified maximum or minimum values; to eliminate large noise spikes; also generally makes statistical calculations more realistic.
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

5.11 Colour-coded geophysical interpretation plans are provided for each survey area. Three 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.
negative magnetic	regions of anomalously low or negative magnetic field gradient, which may correspond to features of low magnetic susceptibility such as wall footings and other concentrations of sedimentary rock or voids.
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

General comments

5.12 Colour-coded archaeological interpretation plans are provided.

5.13 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.

5.14 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 1 - 3

5.15 A few extremely weak positive magnetic anomalies in each of these areas could possibly reflect the remains of soil-filled features such as gullies or small ditches. However, in this instance the anomalies are so slight that they could simply reflect relatively recent wheel ruts.

5.16 Intense dipolar magnetic anomalies at the eastern end of Area 3 almost certainly reflect two ferrous pipes, as well as the adjacent wire fences.

Area 4

5.17 Nothing of potential archaeological interest has been identified here.

Areas 5 and 6

5.18 As above, a few extremely weak positive magnetic anomalies in these areas could possibly reflect the remains of soil-filled features such as gullies or small ditches.

6. Conclusions

6.1 A second phase of geomagnetic survey has been conducted at Warwick Hall Farm, Westnewton, prior to the proposed construction of a wind farm.

6.2 Extremely weak anomalies in some areas could possibly reflect the remains of soil-filled features, though these are not necessarily of archaeological origin.

7. Sources

Archaeological Services 2006 *Warwick Hall, Westnewton, Cumbria, archaeological desk-based assessment and walkover survey,* unpublished report **1553** for PB Power, Archaeological Services Durham University

Archaeological Services 2007 *Warwick Hall, Westnewton, Cumbria, geophysical surveys,* unpublished report **1765** for PB Power, Archaeological Services Durham University

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

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
Study area

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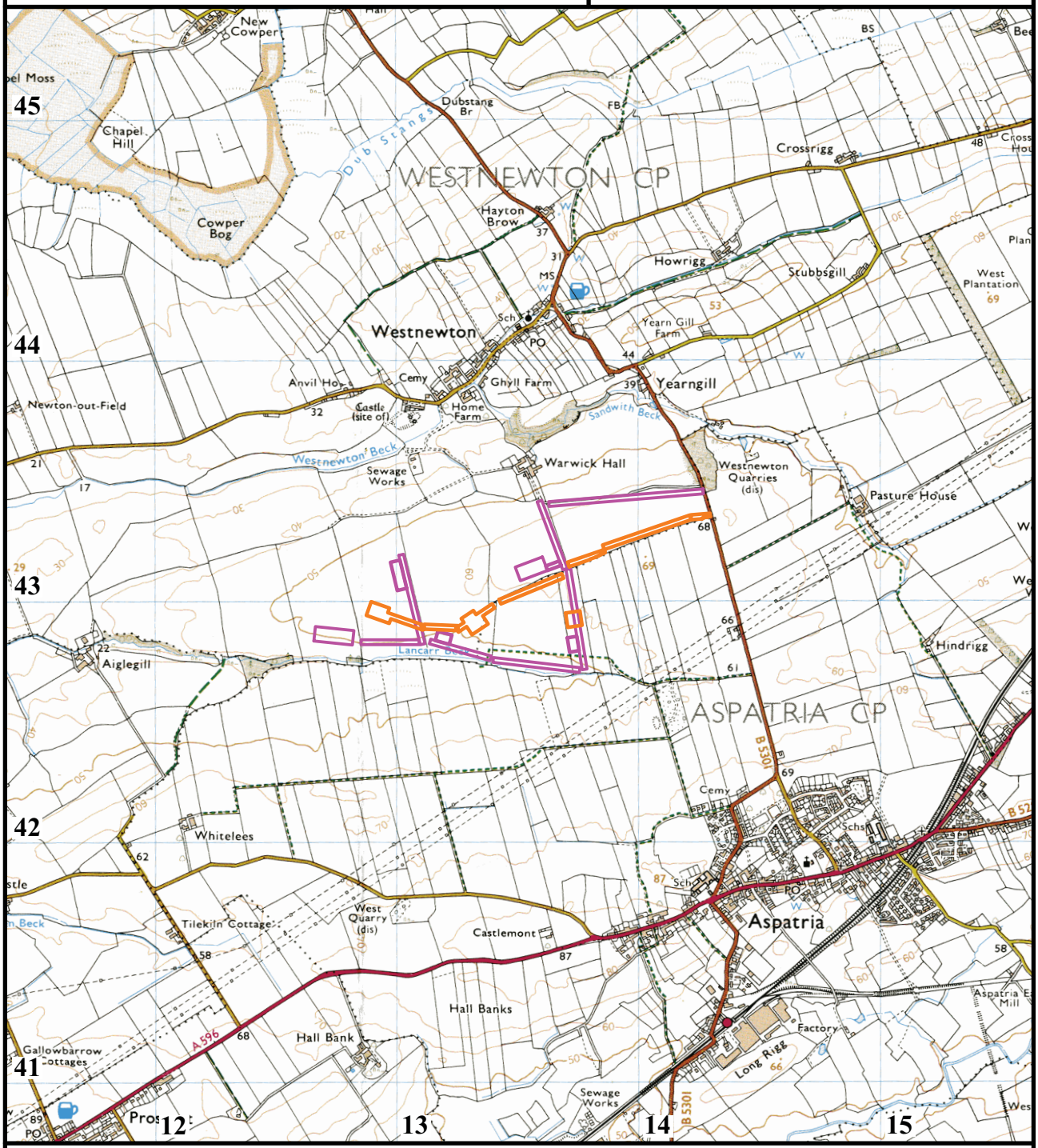

[redacted]

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0 250m

scale 1:5000 - for A3 plot

2008 survey areas

2007 survey areas

3.00
2.50
2.00
1.50
1.00
0.50
0
-0.50
-1.00
-1.50
-2.00
-2.50
-3.00 nT

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Figure 2

Survey locations

Area 6

Area 5

Area 4

Area 5

Area 2

Area 1

Area 3

Area 3 (east end)

outline of survey area

previous geophysical surveys

3.00
2.50
2.00
1.50
1.00
0.50
0
-0.50
-1.00
-1.50
-2.00
-2.50
-3.00 nT

0 50m

scale 1:1000 - for A2 plot

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[redacted]

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Figure 3

Geophysical surveys

Area 6

Area 5

Area 4

Area 5

Area 2

Area 1

Area 3

Area 3 (east end)

outline of survey area

previous geophysical surveys

positive magnetic anomalies

negative magnetic anomalies

dipolar magnetic anomalies

0 50m

scale 1:1000 - for A2 plot

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[redacted]

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Figure 4

Geophysical interpretations

Area 6

Area 5

Area 4

Area 5

Area 2

Area 1

Area 3

Area 3 (east end)

wire fence

outline of survey area

previous geophysical surveys

soil-filled features

service pipes

0 50m

scale 1:1000 - for A2 plot

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[redacted]

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Figure 5

Archaeological interpretations

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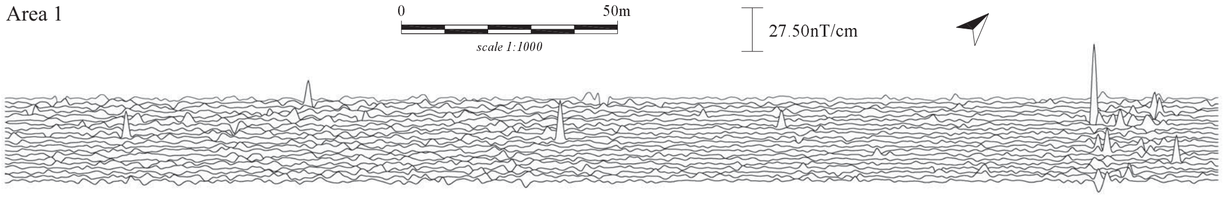
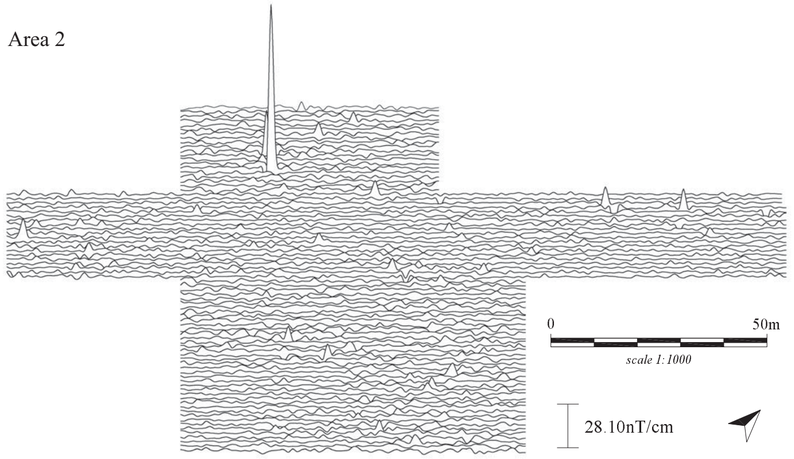
Figure 6: Trace plots of geomagnetic data

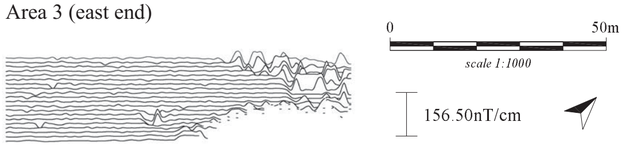
Area 1



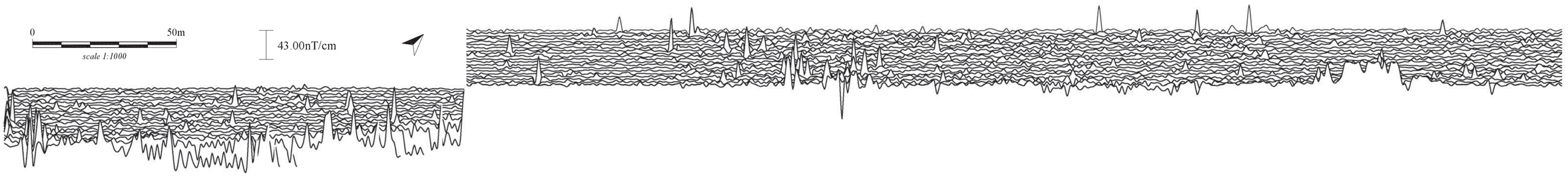
Area 2



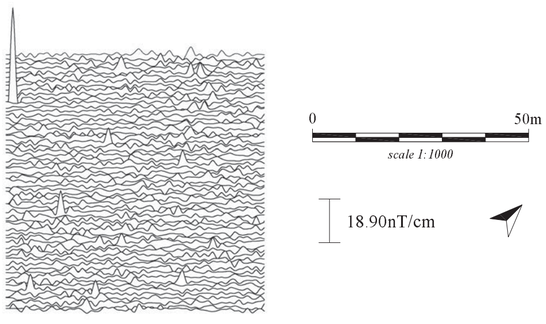
Area 3 (east end)



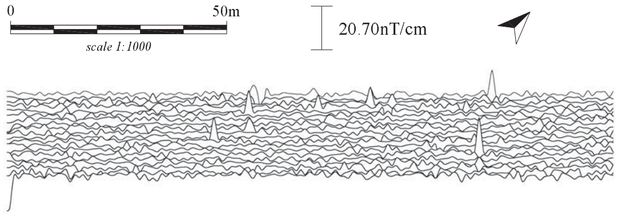
Area 3



Area 4



Area 5



Area 6