

Norfolk Vanguard Offshore Wind Farm

Appendix 28.5

Onshore Geophysical Survey Results

APPENDICES 1-6

Environmental Statement

Volume 3 - Appendices

Applicant: Norfolk Vanguard Limited
Document Reference: 6.2.28.5
RHDHV Document Reference: PB4476-005-0285
Pursuant to APFP Regulation: 5(2)(a)

Date: June 2018
Revision: Version 1
Author: Headland Archaeology

Photo: Kentish Flats Offshore Wind Farm

Environmental Impact Assessment Environmental Statement

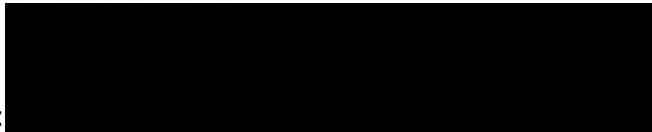
Document Reference: PB4476-005-0285

June 2018

For and on behalf of Norfolk Vanguard Limited

Approved by: Ruari Lean, Rebecca Sherwood

Signed:



Date: 8th June 2018

7 APPENDICES

APPENDIX 1 MAGNETOMETER SURVEY

Magnetic susceptibility and soil magnetism

Iron makes up about 6% of the Earth's crust and is mostly present in soils and rocks as minerals such as maghaemite and haematite. These minerals have a weak, measurable magnetic property termed magnetic susceptibility. Human activities can redistribute these minerals and change (enhance) others into more magnetic forms so that by measuring the magnetic susceptibility of the topsoil, areas where human occupation or settlement has occurred can be identified by virtue of the attendant increase (enhancement) in magnetic susceptibility. If the enhanced material subsequently comes to fill features, such as ditches or pits, localised isolated and linear magnetic anomalies can result whose presence can be detected by a magnetometer (fluxgate gradiometer).

In general, it is the contrast between the magnetic susceptibility of deposits filling cut features, such as ditches or pits, and the magnetic susceptibility of topsoils, subsoils and rocks into which these features have been cut, which causes the most recognisable responses. This is primarily because there is a tendency for magnetic ferrous compounds to become concentrated in the topsoil, thereby making it more magnetic than the subsoil or the bedrock. Linear features cut into the subsoil or geology, such as ditches, that have been silted up or have been backfilled with topsoil will therefore usually produce a positive magnetic response relative to the background soil levels. Discrete feature, such as pits, can also be detected.

The magnetic susceptibility of a soil can also be enhanced by the application of heat. This effect can lead to the detection of features such as hearths, kilns or areas of burning.

Types of magnetic anomaly

In the majority of instances anomalies are termed 'positive'. This means that they have a positive magnetic value relative to the magnetic background on any given site. However some features can manifest themselves as 'negative' anomalies that, conversely, means that the response is negative relative to the mean magnetic background.

Where it is not possible to give a probable cause of an observed anomaly a '?' is appended.

It should be noted that anomalies interpreted as modern in origin might be caused by features that are present in the topsoil or upper layers of the subsoil. Removal of soil to an archaeological or natural layer can therefore remove the feature causing the anomaly.

The types of response mentioned above can be divided into five main categories that are used in the graphical interpretation of the magnetic data:

Isolated dipolar anomalies (iron spikes) These responses are typically caused by ferrous material either on the surface or in the topsoil. They cause a rapid variation in the magnetic response giving a characteristic 'spiky' trace. Although ferrous archaeological artefacts could produce this type of response, unless there is supporting evidence for an archaeological interpretation, little emphasis is normally given to such anomalies, as modern ferrous objects are common on rural sites, often being present as a consequence of manuring.

Areas of magnetic disturbance These responses can have several causes often being associated with burnt material, such as slag waste or brick rubble or other strongly magnetised/fired material. Ferrous structures such as pylons, mesh or barbed wire fencing and buried pipes can also cause the same disturbed response. A modern origin is usually assumed unless there is other supporting information.

Linear trend This is usually a weak or broad linear anomaly of unknown cause or date. These anomalies are often caused by agricultural activity, either ploughing or land drains being a common cause.

Areas of magnetic enhancement/positive isolated anomalies Areas of enhanced response are characterised by a general increase in the magnetic background over a localised area whilst discrete anomalies are manifest by an increased response (sometimes only visible on an XY trace plot) on two or three successive traverses. In neither instance is there the intense dipolar response characteristic exhibited by an area of magnetic disturbance or of an 'iron spike' anomaly (see above). These anomalies can be caused by infilled discrete archaeological features such as pits or post-holes or by kilns. They can also be caused by pedological variations or by natural infilled features on certain geologies. Ferrous material in the subsoil can also give a similar response. It can often therefore be very difficult to establish an anthropogenic origin without intrusive investigation or other supporting information.

Linear and curvilinear anomalies Such anomalies have a variety of origins. They may be caused by agricultural practice (recent ploughing trends, earlier ridge and furrow regimes or land drains), natural geomorphological features such as palaeochannels or by infilled archaeological ditches.

APPENDIX 2 SURVEY LOCATION INFORMATION

An initial survey base station was established using a Trimble VRS differential Global Positioning System (dGPS). The magnetometer data was georeferenced using a Trimble RTK differential Global Positioning System (Trimble R8s model).

Temporary sight markers were laid out using a Trimble VRS differential Global Positioning System (Trimble R8s model) to guide the operator and ensure full coverage. The accuracy of this dGPS equipment is better than 0.01m.

The survey data were then super-imposed onto a base map provided by the client to produce the displayed block locations. However, it should be noted that Ordnance Survey positional accuracy for digital map data has an error of 0.5m for urban and floodplain areas, 1.0m for rural areas and 2.5m for mountain and moorland areas. This potential error must be considered if coordinates are measured off hard copies of the mapping rather than using the digital coordinates.

Headland Archaeology cannot accept responsibility for errors of fact or opinion resulting from data supplied by a third party.

APPENDIX 3 GEOPHYSICAL SURVEY ARCHIVE

The geophysical archive comprises an archive disk containing the raw data in XYZ format, a raster image of each greyscale plot with associated world file, and a PDF of the report.

The project will be archived in-house in accordance with recent good practice guidelines (http://guides.archaeologydataservice.ac.uk/g2gp/Geophysics_3). The data will be stored in an indexed archive and migrated to new formats when necessary.

APPENDIX 4 DATA PROCESSING

The gradiometer data has been presented in this report in processed greyscale and minimally processed XY trace plot format.

Data collected using RTK GPS-based methods cannot be produced without minimal processing of the data. The minimally processed data has been interpolated to project the data onto a regular grid and de-striped to correct for slight variations in instrument calibration drift and any other artificial data.

A high pass filter has been applied to the greyscale plots to remove low frequency anomalies (relating to survey tracks and modern agricultural features) in order to maximise the clarity and interpretability of the archaeological anomalies.

Data is also clipped to remove extreme values and to improve data contrast.

APPENDIX 5 DATA REPEATABILITY

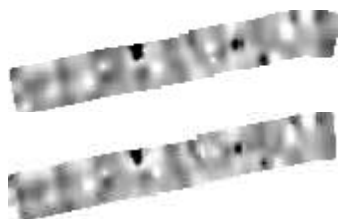
At the completion of each day of survey, a 30m traverse from the start of the final area covered that day was repeated prior to leaving site in order to demonstrate the repeatability of the results.



AREA 151
Surveyed at 09:13 and 11:37 on 18/01/2018



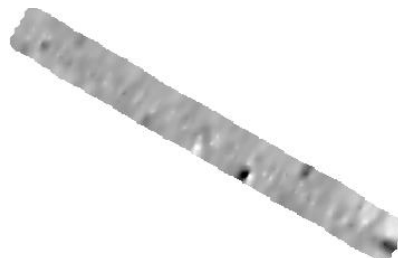
AREA 14
Surveyed at 10:16 and 12:21 on 03/11/2017



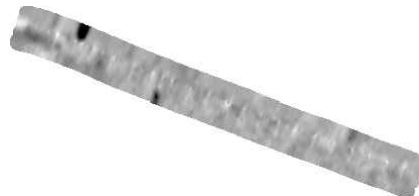
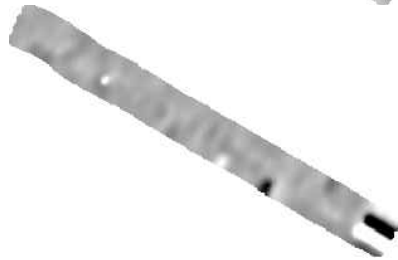
AREA 165
Surveyed at 08:44 and 10:27 on 19/10/2017



AREA 165
Surveyed at 09:23 and 16:13 on 17/10/2017



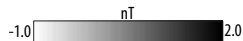
AREA 10
Surveyed at 09:42 and 14:43 on 31/01/2018



AREA 49
Surveyed at 13:53 and 15:28 on 23/01/2018



AREA 123
Surveyed at 09:10 and 11:40 on 30/01/2018



PROJECT NVOW17
Priority Archaeological Geophysical
Survey
(Terrestrial Archaeology)
Norfolk Vanguard Offshore Wind Farm
Royal HaskoningDHV

CLIENT
Royal HaskoningDHV



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APPENDIX 6 OASIS DATA COLLECTION FORM: ENGLAND

OASIS ID: *headland5-315394*

Project details	
Project name	PRIORITY ARCHAEOLOGICAL GEOPHYSICAL SURVEY (TERRESTRIAL ARCHAEOLOGY)
Short description of the project	Headland Archaeology (UK) Ltd undertook a geophysical (magnetometer) survey, covering approximately 600 hectares, along the onshore cable corridor and associated onshore project area for the Norfolk Vanguard Offshore Wind Farm, in order to provide further information about the archaeological potential of the cable route. This work was focussed on areas identified in the Archaeological Desk-Based (baseline) Assessment (DBA), as potentially containing buried archaeological remains following preliminary analysis of aerial photographs, LiDAR, and Historic Environment Record (HER) data. The survey successfully evaluated 127 Priority Archaeological Geophysical Survey Areas, identifying twenty distinct areas of clear archaeological activity ranging from isolated ring-ditches to extensive areas of settlement and enclosure. Most of these areas were previously known, although some were less extensive than has been identified by the geophysical survey, whilst several others were not known at all. These areas are assessed as being of high archaeological potential. Anomalies at numerous other locations have been interpreted as being of possible archaeological potential, including possible field systems, trackways, isolated ditches and pits. However, the weak, fragmentary nature of these possible archaeological anomalies, or an absence of supporting archaeological information (cropmarks or HER data), precludes a more confident interpretation. These anomalies are ascribed a moderate archaeological potential.
Project dates	Start: 17-10-2017 End: 09-03-2018
Previous/future work	Yes / Yes
Any associated project reference codes	NVOW17 - Contracting Unit No.
Any associated project reference codes	ENF142815 - HER event no.
Type of project	Field evaluation
Site status	None
Current Land use	Cultivated Land 4 - Character Undetermined
Current Land use	Grassland Heathland 5 - Character undetermined
Monument type	N/A None
Monument type	N/A None
Significant Finds	N/A None
Significant Finds	N/A None
Methods & techniques	"Geophysical Survey"
Development type	Wind farm developments
Prompt	National Planning Policy Framework - NPPF
Position in the planning process	Pre-application
Solid geology	CHALK (INCLUDING RED CHALK)

Solid geology (other)	Crag Group
Drift geology	GLACIAL SAND AND GRAVEL
Drift geology	ALLUVIUM
Drift geology	RIVER TERRACE DEPOSITS
Drift geology	BOULDER CLAY AND MORAINIC DRIFT
Drift geology	SAND AND GRAVEL OF UNCERTAIN AGE OR ORIGIN
Techniques	Magnetometry
Project location	
Country	England
Site location	NORFOLK BROADLAND AYLHAM NORFOLK VANGUARD OFFSHORE WIND FARM
Study area	600 Hectares
Site coordinates	TF 8863 1082 52.661807930992 0.789564636405 52 39 42 N 000 47 22 E Line
Site coordinates	TG 3894 3046 52.818099133426 1.546490768235 52 49 05 N 001 32 47 E Line
Project creators	
Name of Organisation	Headland Archaeology
Project brief originator	Consultant
Project design originator	Headland Archaeology
Project director/manager	Harrison, S
Project supervisor	Bishop, R
Type of sponsor/funding body	Developer
Project archives	
Physical Archive Exists?	No
Digital Archive recipient	In house
Digital Contents	"Survey"
Digital Media available	"Geophysics"; "Survey"
Paper Archive Exists?	No
Project bibliography 1	
Publication type	Grey literature (unpublished document/manuscript)
Title	PRIORITY ARCHAEOLOGICAL GEOPHYSICAL SURVEY (TERRESTRIAL ARCHAEOLOGY) NORFOLK VANGUARD OFFSHORE WIND FARM

Author(s)/Editor(s)	Harrison, D.
Date	2018
Issuer or publisher	Headland Archaeology
Place of issue or publication	Leeds
Description	PDF/A
Entered by	David Harrison (david.harrison@headlandarchaeology.com)
Entered on	Entered on 25 April 2018



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