Sheringham Shoal and Dudgeon Offshore Wind Farm Extension Projects

Environmental Statement

Volume 3

Appendix 21.6 - Priority Archaeological Geophysical Survey

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Sheringham Shoal and Dudgeon Offshore Wind Farm Extension Projects

GEOPHYSICAL SURVEY REPORT

PLANNING REF. pre-application

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for Equinor New Energy Limited

12/07/2022

HEADLAND ARCHAEOLOGY

PROJECT INFORMATION:

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PROJECT SUMMARY

Headland Archaeology (UK) Ltd was commissioned by Equinor New Energy Ltd to carry out a geophysical (magnetometer) survey for the Sheringham Shoal Offshore Wind Farm Extension Project (SEP) and Dudgeon Offshore Wind Farm Extension Project (DEP). The surveys covered 37 Priority Areas (PA's), which had been identified mainly following analysis of air photographs and the subsequent identification of cropmarked sites. The PA's covered an estimated 546 hectares at locations along the proposed route of the onshore cable corridor, which runs from Weybourne in the north, where the cable will make landfall, to Norwich Main substation, where a new substation will be built. The PA's were primarily within the 200m wide PEIR onshore cable corridor, which has been refined to 60m wide, increasing to a width of 100m for trenchless crossings for the Development Consent Order (DCO) application. Amendments to the PA's were made during the fieldwork with some PA's expanded in areas and others descoped as the preferred route was refined so that some of the data presented here is currently beyond the preferred onshore cable corridor. Some PA's were not surveyed during the fieldwork window due to unsuitable ground cover (primarily unharvested sugar beet) or restricted access. The surveys were required as part of the overall Environmental Impact Assessment (EIA) work to support the Onshore Archaeology and Cultural Heritage Chapter of the Preliminary Environmental Information Report (PEIR) and subsequent Environmental Statement (ES). This document will form a technical appendix to ES Chapter 21 Onshore Archaeology and Cultural Heritage (document reference 6.1.21). Approximately 426 hectares was surveyed during this preliminary phase of work.

In addition to identifying anomalies of agricultural (drains, former boundaries, ridge and furrow and modern ploughing), modern (pipes, demolished buildings) and geological origin, the survey has identified clear anomalies of probable and possible archaeological origin in nearly all the PA's, successfully defining the extent of features previously identified as cropmarks. As indicated by the preliminary research these anomalies are indicative of activity ranging from the Bronze Age (a possible round barrow cemetery in PA9), medieval tofts in PA12, through to post-medieval brick manufacture (PA4) and 20th century World War II infrastructure (PA37). Most notable perhaps is the extended 'ladder' settlement which extends north/south through PA23, PA24 and PA25. A similar pattern of enclosure is identified in PA28. The possible line of a Roman road and a mortuary enclosure are also tentatively identified.

The fieldwork carried out to date within the onshore cable corridor has successfully evaluated those PA's where survey has been possible. In almost all areas the survey has added significantly to the level of detail of the archaeological

resource, as indicated by the cropmarks, which were the main determining factor in the selection of the PA's. The surveys have also better defined the extent of the resource in each PA.

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GEOPHYSICAL SURVEY REPORT

1. INTRODUCTION

Headland Archaeology (UK) Ltd was commissioned by Equinor New Energy Ltd (the Client) to undertake geophysical (magnetometer) surveys at 37 pre-selected Priority Areas (PA's) along the onshore cable corridor for the Sheringham Shoal Offshore Wind Farm Extension Project (SEP) and Dudgeon Offshore Wind Farm Extension Project (DEP). The onshore cable corridor runs in a southerly direction for approximately 60km from just west of Sheringham at Weybourne, where the cable makes landfall, to a site near the existing Norwich Main substation.

The initial cable route selection exercise identified a 1,000m (1km) wide onshore cable corridor (to inform scoping) which was subsequently refined down to a 200m wide corridor for the Preliminary Environmental Information Report (PEIR). Certain wider areas were retained at landfall and around key crossing locations. The onshore cable corridor has been further refined to a width of 60m, increasing to a width of 100m for trenchless crossings, for the Development Consent Order (DCO) application. The PA's were primarily, but not exclusively, within the 200m wide PEIR onshore cable corridor, as amendments to the survey areas were made during the fieldwork with some PA's expanded in size and others descoped as the limits of the preferred onshore cable corridor were refined.

The geophysical surveys were required as part of the overall Environmental Impact Assessment work to support the Onshore Archaeology and Cultural Heritage Chapter of the PEIR and subsequent Environmental Statement (ES). This document will form a technical appendix to ES Chapter 21 Onshore Archaeology and Cultural Heritage (document reference 6.1.21).

The surveys were undertaken in accordance with a Written Scheme of Investigation for Priority Archaeological Geophysical Survey (WSI) (Royal HaskoningDHV 2020) and in line with current best practice (Chartered Institute for Archaeologists 2014, Europae Archaeologia Consilium 2016).

At the commencement of the fieldwork there were 37 PA's covering approximately 546 hectares, an overall area based on the evolving DCO boundary. This area only covered the extent of the assets recorded within the DCO boundary at the time of the surveys. However, restricted access and a changing scope of works reduced the actual area that was surveyed to approximately 426 hectares at this stage, including areas previously surveyed for other projects. The surveys were carried out in three phases (to accommodate various cropping regimes and land access) between September 7th, 2020, and December 15th, 2021.

1.1. LOCATION, TOPOGRAPHY AND LAND USE

The onshore cable corridor extends almost due south for approximately 60km, from Weybourne on the north Norfolk coast where the cable will make landfall, to near to the existing Norwich Main substation, where a proposed new substation will be constructed. The PA's are located throughout the length of the onshore cable corridor (Illus 1). The NGR for each PA together with Norfolk Historic Environment Record (NHER) references and a summary description of the previously known heritage assets are set out in the Table of Results below, together with descriptions of the results and interpretation of the geophysical data.

Most of the onshore cable corridor is agricultural land, interspersed with predominantly small rural settlements, including the towns of Weybourne, Bodham, Little Barningham, Brandiston, Morton, Attlebridge, Weston Longville, Colton, and Ketteringham as well as watercourses, areas of woodland and hedgerows. Most of the PA's comprised fields under arable cereal crops, mostly wheat with occasional areas of barley, hence the surveys were programmed to commence immediately post-harvest when the fields were mostly still stubble or had been cultivated and re-seeded. A few fields were under potatoes or carrots with a single field of maize (PA8). These fields were surveyed in October. Two or three fields contained sugar beet that was not due for harvest until early 2021 and could not be surveyed during this survey window. There was also a single field (PA7) planted with commercial fir trees that also could not be surveyed. Access to several

other PA's was also not agreed (for varying reasons) at this time. Overall, due to lack of access and re-scoping/de-scoping the total survey area reduced to approximately 426 hectares.

1.2. GEOLOGY AND SOILS

The solid bedrock geology beneath the onshore cable corridor comprises White Chalk and Crag Group deposits (white or grey limestone), which principally outcrops as a low, rolling plateau in west Norfolk, along the north Norfolk coast and near Norwich where the Rivers Yare and Wensum have cut down through overlying beds to expose it. The Crag Group deposits are a sequence of sandy, marine deposits which outcrop in the eastern parts of the onshore cable corridor (NERC 2020).

These solid deposits are overlain predominantly by superficial deposits of glacial till dating from the Anglian glaciation, interspersed with sheets of glacial sands and gravels. There are also small, isolated pockets or channels of superficial deposits of Alluvium adjacent to watercourses (NERC 2020).

The soils along the onshore cable corridor fall into four soil associations (SA's). In all the northern half of the onshore cable corridor they are classified in either Soil Association 10 or Soil Association 6, being characterised as freely draining, slightly acid sandy or loamy soils, respectively. There is a small area of naturally wet, very acid sandy and loamy soils north-west of Norwich (SA15) but at the southern end of the onshore cable corridor slightly acid and loamy and clayey soils with impeded drainage (SA8) predominate (Cranfield University 2020).

2. ARCHAEOLOGICAL BACKGROUND

An Archaeological Desk-Based Assessment (ADBA) has been produced (Royal HaskoningDHV 2020) to inform the Onshore Archaeology and Cultural Heritage Chapter of the ES. Designated and non-designated heritage data has been obtained from Historic England's National Heritage List for England (NHLE) and from the NHER for assessment.

Due to Coronavirus restrictions a three-staged approach was undertaken. The results of Stage 1 (an overview assessment of currently available online aerial imagery) informed the locations of the PA's for archaeological geophysical survey. Sources available for assessment at the commencement of the surveys included the National Mapping Programme (NMP) for Norfolk Coast and Norfolk - Thetford A11, Norfolk Aggregates Levy Sustainability Fund (ALSF), Environment Agency (EA) Lidar data, GoogleEarth and Bing Aerial Maps.

This Stage 1 overview assessment identified a series of cropmark sites indicative of settlement, agricultural and military activity dating from the Iron Age through to modern periods. Most of the cropmark sites correspond with those recorded on the NHER with a few additional potential 'new' sites revealed. The assessment concluded that '*the potential for buried archaeological remains to be present across the onshore project area is considered to be high*' (Royal HaskoningDHV 2020).

3. AIMS, METHODOLOGY AND PRESENTATION

The general aims of the surveys in the PA's were to:

- Undertake a programme of priority (targeted) detailed magnetometry across the 37 identified PA's,
- corroborate, identify, and characterise sub-surface anomalies that may have an archaeological origin (including defining the spatial limits of already known or suspected heritage assets),
- discount areas within the survey area that are found to have been subject to previous 'modern' disturbance, for example where the geophysical survey data indicate the presence of 'made' or previously heavily disturbed ground,
- provide an interpretation of all recorded geophysical anomalies to inform the onshore project boundary refinement process, as well as the design of a

scheme-wide programme of archaeological evaluation trial trenching, proposed to be undertaken post-consent, and

- prepare a fully illustrated report on the results of the surveys that is compliant with all relevant standards, guidance, and good practice.

3.1. MAGNETOMETER SURVEY

Magnetic survey methods rely on the ability of a variety of instruments to measure very small magnetic fields associated with buried archaeological remains. A feature such as a ditch, pit or kiln can act like a small magnet, or series of magnets, that produce distortions (anomalies) in the earth's magnetic field. In mapping these slight variations, detailed plans of sites can be obtained as buried features often produce reasonably characteristic anomaly shapes and strengths (Gaffney & Gater 2003). Further information on soil magnetism and the interpretation of magnetic anomalies is provided in Appendix 1.

The survey was undertaken using four Bartington Grad601 sensors mounted at 1m intervals (1m traverse interval) onto a rigid carrying frame. The system was programmed to take readings at a frequency of 10Hz (allowing for a 10-15cm sample interval) on roaming traverses (swaths) 4m apart. These readings were stored on an external weatherproof laptop and later downloaded for processing and interpretation. The system was linked to a Trimble R8s Real Time Kinetic (RTK) differential Global Positioning System (dGPS) outputting in NMEA mode to ensure a high positional accuracy for each data point.

MLGrad601 and MultiGrad601 (Geomar Software Inc.) software was used to collect and export the data. Terrasurveyor V3.0.35.1 (DWConsulting) reporting.

An overall location plan of the OCC is presented at a scale of 1:50,000 in Illus 1, being broken down into section along the OCC at a scale of 1:25,000 in Illus 2 to Illus 7 respectively. These plots display all PA's whether fully or partly surveyed or not surveyed at all. The data is displayed in fully processed greyscale format, minimally processed X-Y trace plot format with accompanying interpretation plots at both 1:2,500 and 1:1,000 scales in Illustrations 8 to 463 inclusive.

Technical information on the equipment used, data processing and magnetometer survey methodology is given in Appendix 1. Details of the survey location information are in Appendix 2. A note on the format of the geophysical data archive is present in Appendix 3. Data processing details for the magnetometer survey are presented in Appendix 4. A copy of the OASIS entry is reproduced in Appendix 5.

The survey methodology, report and any recommendations comply with the Written Scheme of Investigation (Royal HaskoningDHV 2020), guidelines outlined by Europae Archaeologia Consilium (EAC 2016) and by the Chartered Institute for Archaeologists (CIfA 2014). All Illustrations from Ordnance Survey (OS) mapping are reproduced with the permission of the controller of Her Majesty's Stationery Office (© Crown copyright).

The illustrations figures in this report have been produced following analysis of the data in 'raw' (minimally processed) and processed formats (see above) and over a range of different display levels. All illustrations are presented to display and interpret the data from this site to best effect based on the experience and knowledge of management and reporting staff.

4. RESULTS

Overall, the magnetic background was homogenous across all the PA's with consequent very good definition of anomalies. Consequently, a high degree of reliance can be placed on the results and interpretation of the survey data.

The anomalies can be classified in several different categories (see below). Individual ferrous ('spike') anomalies may not be displayed on the interpretation illustrations but where they coalesce into wider areas of magnetic disturbance they are mentioned where appropriate to the overall discussion. The archaeological anomalies are

reported on in Table 1 where they are discussed in relation to the cropmark data.

4.1. FERROUS AND MODERN ANOMALIES

Ferrous anomalies, characterised as individual 'spikes', are typically caused by ferrous (magnetic) material, either on the ground surface or in the plough-soil. Little importance is normally given to such anomalies, unless there is any supporting evidence for an archaeological interpretation, as modern ferrous debris is common on most sites, often being introduced into the topsoil during manuring or tipping/infilling. These anomalies are of no archaeological interest. Only the most prominent of these anomalies have been displayed. They have been assessed and there is no obvious clustering to these ferrous anomalies in any of the PA's which might indicate an archaeological origin. Far more probable is that the 'spike' responses are likely caused by the random distribution of ferrous debris in the upper soil horizons. Magnetic disturbance around the field edges is due to ferrous material within, or adjacent to, the boundaries and is also of no archaeological interest.

4.2. AGRICULTURAL ANOMALIES

Agricultural anomalies are ubiquitous across most of the PA's. These anomalies are due to either modern or post-medieval (ridge and furrow) ploughing, field drains or former boundaries that have been removed over the last 150 years as field sizes have been increased.

4.3. ARCHAEOLOGICAL ANOMALIES

The archaeological anomalies are described in the Table of Results below and compared against the cropmark information.

Table 1. Table of Results

Priority Area & NGR	Description and Results	NHER PreRef	Survey Interpretation
PA1 TG 2111 0155	**Cropmarks of ditches, intersects Roman pits and possible field system south of Mangreen Farm.**	52076	There is no coherent pattern of anomalies although there are enough linear trends to suggest a likely field system as assessed from the cropmarks. There are three north/south linear trends to the north of the PA and the possible north-western corner of a large enclosure to the south-east corner of the field. A few discrete anomalies are also highlighted. All the anomalies in PA1 are interpreted as of possible archaeological origin. Ploughing trends are recorded around the eastern and southern field edge as well as a few geological responses.
PA2 TG 2136 0200	**Site of medieval village of Gowthorpe, and cropmarks of ring ditches and sub-rectangular enclosures.**	54877, 57922, 52071, 55197, 52069, 9750, 9717, 52070	Multiple anomalies adjacent to and abutting the eastern edge of the extant lane, comprising a series of sub-rectangular enclosures with divisions and multiple discrete anomalies (indicative of settlement activity), clearly locate the site of the former medieval village of Gowthorpe. The cropmarks of ring ditches and sub-rectangular enclosures

Priority Area & NGR	Description and Results	NHER PreRef	Survey Interpretation
			are clearly visible as magnetic anomalies. To the east less coherent linear anomalies are suggestive of a field system extending to the east of the settlement. Field drains are recorded in the easternmost field. There are also a few anomalies in the field to the west of the lane although no coherent pattern is evident. Magnetic disturbance in this field (bordering the lane) locates the demolished remains of a former building as indicated on historic mapping.
PA3 TG 2085 0191	**Post-medieval brickworks, and ring ditch, trackway and field boundaries.**	52066, 9752, 52069, 52084	A sub-square enclosure with small square enclosure appended to the south-eastern corner in PA3 almost certainly locates the post-medieval brickworks. There are numerous high magnitude anomalies within both enclosures and immediately adjacent to the main enclosure that are consistent with heat affected or burned features (brick clamps?) or accumulations of fired material (thermoremanent anomalies). Linear north/south anomalies to the north-east and south-west of the brick working area possibly demarcate ditched boundaries possibly defining a trackway to/from the brick working areas. A low magnitude amorphous anomaly on the south-western corner of the brick working area may locate a small, backfilled clay extraction pit.
PA4 TG 1627 0291	**Former WWII military site / accommodation.**	28710, 54616, 28163, 28164, 28165, 28157, 28158	Pipes lead to/from the extant structure in the centre of the field. To the north of this building three conjoining anomalies locate the former sides of a large enclosure, possibly the former WWII site. This feature is on a slightly different alignment to the extant structure.
PA5 TG 1481 0341	**Cropmarks over Roman road from Venta Icenorum to Watton**	19725, 59846	Two parallel linear anomalies aligned broadly east/west are tentatively interpreted as ditches defining the line of the Roman road. Clusters of discrete anomalies may locate small quarry pits from which material was excavated for

Priority Area & NGR	Description and Results	NHER PreRef	Survey Interpretation
			use constructing the road although this interpretation is tentative. Former field boundaries and drains are prominent in all three fields in this PA.
PA6 TG 1253 0564	Cropmarks of rectilinear enclosure, ditches and large infilled pits.	22038, 18294	Three sides of a possible large square enclosure identified in the east of the field aligned on a north/south axis are identified. Linear anomalies within the main enclosure indicate partition/sub-division with a couple of small discrete anomalies (possible pits or areas of burning?) also noted. Three sides of a larger rectilinear enclosure are identified immediately to the west (the cropmark previously identified) abutting the extant field boundary. This enclosure is not on the same alignment as the other. It is not clear whether the two enclosures are contemporaneous. Several linear trend anomalies have also been interpreted as of possible archaeological origin.
PA7 TG 1224 0709	Multi-period cropmarks; former field boundaries, enclosures, and possible settlement.	18115, 17924, 17925	Unsuitable for survey – planted with semi-mature conifers.
PA8 TG 1193 0837	Probable ditched enclosures forming focus of prehistoric settlement.		No anomalies of archaeological potential have been identified in this PA confirming the absence of any entries on the NHER.
PA9 TG 1148 1056	Cropmarks of a Bronze Age barrow cemetery with at least four barrows, an undated rectangular enclosure, and ditches.	53682, 56180, 54365, 12809, 20008, 53683	Three definite barrows are clearly identified confirming the cropmark data and interpretation as a possible barrow cemetery. Also, other fragmentary linear and discrete anomalies have been interpreted as of possible archaeological origin although there is no coherent pattern that would suggest a definite archaeological origin. The data in the northern part of PA9 was recorded during a previous survey and has been included with the permission of Highways England.
PA10 TG 1247 1069	Cropmarks of a possible ring ditch of Bronze Age	19755, 53628, 15898,	No anomalies of possible or probable origin have been identified in this PA although it is not clear whether the

Priority Area & NGR	Description and Results	NHER PreRef	Survey Interpretation
	date and enclosures of Roman date.	12808, 53679, 25701	noted cropmarks are from the area subsequently de-scoped from the onshore cable corridor.
PA11 TG 1247 1123	Northern extent of cropmarks of Roman date.	25701	PA11 consisted of the cable corridor and an access track. No anomalies of probable archaeological potential have been identified in PA11. Discrete anomalies of possible archaeological origin have been identified in the southern part of the access track.
PA12 TG 1205 1139	Extant platforms and ditched enclosures relating to former medieval tofts.	28552	Anomalies possibly indicative of the medieval tofts are identified to the western side of the PA. It is difficult to discern an overall pattern but the general magnetic variation across this area (furthest from the stream) is supportive of a likely archaeological origin. At the eastern side of the PA the broad anomalies are caused by the deposition of alluvium adjacent to the stream.
PA13 TG 1127 1145	Cropmarks of enclosures and ditches of probable Roman date, possible temporary camp, or domestic site.	28684, 53627, 29708	A possible large rectangular enclosure (possibly the temporary camp referred to on NHER) is identified aligned north/south along its long axis. Two linear ditch type anomalies within the interior of the enclosure are recorded as well as several large discrete anomalies within and immediately outside the enclosure that suggest domestic activity of some sort, possibly hearths or bread ovens. The data in the western part of PA13 is again from a previous survey and is included with the permission of Highways England.
PA14 TG 1211 1264	Cropmarks of probable Bronze Age barrow and undated fragmentary field boundaries and trackways.	53678, 44183, 23773	A single ring-ditch, indicative of a barrow has been identified within this PA. This anomaly corresponds to cropmarks of a Bronze Age round barrow. Two discrete anomalies of possible archaeological origin are identified towards the southern end of the survey area.

Priority Area & NGR	Description and Results	NHER PreRef	Survey Interpretation
PA15 TG 1145 1377	Cropmarks of possible enclosures and associated field boundaries of possible Iron Age to Roman date.	50615, 50618	No anomalies of likely or possible archaeological potential have been identified in this PA. This is one of only two PA's where there appears to be no correlation between the magnetic data and the cropmark data.
PA16 TG 1202 1491	Cropmarks of ditches, former field boundaries, trackways, and small square enclosure.		This PA was not suitable for survey as it was planted with carrots. It has subsequently been de-scoped as it is no longer within onshore cable corridor.
PA17 TG 1200 1597	Cropmarks of multi-period linear ditches.		No anomalies of likely or possible archaeological potential have been identified in this PA. A former field boundary has been recorded in the data, along with parallel and oblique linear anomalies which are indicative of ploughing.
PA18 TG 1255 1659	Cropmarks of ring ditch and oval enclosure of possible Bronze Age date, and medieval building platforms.	35933, 29962, 7741	There are various anomalies within this PA although no clear pattern except in the northernmost field where a possible boundary with irregularly shaped enclosures (probable building platform) appended to the southern side are identified. Elsewhere a disparate pattern of linear and curvilinear anomalies provides no coherent pattern. The cropmark ring ditch and oval enclosure have not been identified. The central part of this PA (aligned north-west/south-east) has a very 'flat' homogenous magnetic background probably due to alluvium deposited following episodes of inundation from the stream that flows through this PA from north-west to south-east.
PA19 TG 1264 1697	Cropmarks of a possible Bronze Age round barrow cemetery.	21719, 50649, 50648	Linear anomalies perpendicular to the adjoining road likely demarcate medieval plots with discrete anomalies along the road frontages (the PA is sandwiched between two roads) and within the plots associated with domestic activity. This later activity is superimposed over part of a possible barrow cemetery; a single circular anomaly (probable barrow) is identified

Priority Area & NGR	Description and Results	NHER PreRef	Survey Interpretation
			with linear anomalies, aligned south-west/north-east, to the north and south of it. The southern ditch clearly deviates to respect the circular (barrow) feature. Other linear anomalies on the same alignment are recorded to the south. Several discrete anomalies of possible archaeological origin are also identified.
PA20 TG 1305 1734	Cropmarks of fragmentary ditches and former field boundaries.	54355	Two small possible enclosures are identified abutting (and respecting) the southern field in PA20. Linear anomalies possibly defining larger fields are recorded in this field. Three sides of a much larger field that straddles the current boundary are identified in the north of the PA. This field is perpendicular to and respects the track that forms the current northern field boundary. Other linear trends that are aligned south-west/north-east may also be former field boundaries.
PA21 TG 1320 1764	Undated ditches and a former road/trackway and field boundaries of medieval to post-medieval date.	54354, 54353, 53700, 22887	No anomalies of obvious archaeological origin have been identified in PA21.
PA22 TG 1332 1809	Cropmarks of fragmentary ditches and soil marks of buried walls of uncertain date.	51115, 53699, 53700	A meandering ditch-type anomaly extends from south to north through PA22 with two ditches extending to the east from it. A horseshoe-shaped possible enclosure is also identified on the most northerly of these two ditches, opening to the east side. Part of an enclosure or barrow is clearly identified on the north-eastern edge of the field. Discrete anomalies of possible archaeological origin are identified within both enclosures as well as immediately west of the north/south ditch. Possibly part of the 'ladder' settlement identified to the north (see below).
PA23 TG 1470 2464	Cropmarks of ditches and possible enclosures.		The southern end of 'ladder' settlement extending north/south and continuing into and through PA24 and PA25,

Priority Area & NGR	Description and Results	NHER PreRef	Survey Interpretation
			approximately 1km in length and at least 200m wide is present parallel with the track that forms the western edge of PA23. In PA23 the 'settlement' is only one enclosure wide, although there are numerous discrete anomalies within the enclosures indicating settlement activity. Fainter linear anomalies to the east of the settlement are likely part of an outlying field system. There are also multiple ploughing trends in the data.
PA24 TG 1447 2496	Cropmarks of enclosures, boundaries, and pits. NCC HER records a probable Roman fort.	21849, 58762, 29841	The settlement widens significantly to the west and increases in complexity in PA24 with numerous interconnecting enclosures of varying size and shape. Dozens of discrete anomalies are clearly representative of domestic activity, pits or areas of burning. Outlying linear anomalies indicate the continuation of the associated field system to the east of the settlement. Two sides of a possible larger enclosure on a slightly different alignment may locate the probable Roman fort identified on the NHER.
PA25 TG 1443 2536	Straight sided enclosures, one visible terminal defined entrance, ditches, and pits.	7353, 22903, 21154, 7346, 20475	The settlement continues north into PA25 but having reduced in width again to one or two enclosures before it terminates halfway up the field. Again, there are numerous discrete anomalies within the enclosures which suggest settlement activity throughout.
PA26 TG 1344 2900	Cropmarks of ditched boundaries and possible trackways.		A single sub-circular enclosure is identified in the north-western corner of PA26 with two discrete anomalies within and a couple immediately to the east.
PA27 TG 1349 2938	An ovoid single ditched enclosure, possibly Neolithic, and linear and curvilinear ditches.	35935, 37629, 7350	Not surveyed and no longer within the DCO boundary.
PA28 TG 1279 3198	Settlement enclosures with a central trackway and outlying enclosures and boundaries.	51455, 63420, 11339	The southern half of PA28 is not surveyable until early 2021 when the sugar beet will be harvested. The northern half contains settlement enclosures (previously recorded as cropmarks) and trackway and is very

Priority Area & NGR	Description and Results	NHER PreRef	Survey Interpretation
			similar to the 'ladder' settlement located in PA23, PA24 and PA25 to the south. This settlement is also aligned north/south with a possible field system extending to the east of the 'settlement' into the south-western end of PA29. Numerous discrete anomalies are indicative of settlement activity.
PA29 TG 1334 3245	Cropmarks of enclosures and former field system.	28024, 28026	Possible enclosures of varying size and shape in the north, south and centre of PA29 reflect the cropmarks. Other fragmentary linear ditch type anomalies possibly locate parts of the field system which was also identified as cropmarks.
PA30 TG 1367 3387	Single ditched ovoid enclosure and fragmentary ditches, possible prehistoric site.	36779, 39704	Two overlapping L-shaped anomalies located in the centre of the field may indicate parts of single large enclosure in the centre of PA30. It is not clear whether this is the ditched ovoid enclosure identified as a cropmark.
PA31 TG 1195 3970	Possible enclosure, ditches, and trackway.		Not currently accessible.
PA32 TG 1224 4102	Cropmarks of elongated mortuary enclosure, ring ditch, linear ditches, and possible mounds.	27993, 53757, 22883	Two parallel linear trends in the data correlate with two sides of the cropmark interpreted as the elongated mortuary enclosure. Elsewhere a possible small barrow and small square enclosure are noted in the south-eastern corner of PA32 and several other fragmentary linear and discrete anomalies which have been tentatively identified as of possible archaeological origin are recorded. All the anomalies in this PA are extremely weak and all interpretations should be viewed as tentative at this stage.
PA33 TG 1120 4196	Cropmarks of a possible ditched settlement enclosure and possible oval or round barrow.	32047, 51432, 62305	No access agreement is currently in place.
PA34 TG 1112 4235	Probable Bronze Age round barrow, and part of medieval moated complex.	51432, 62305, 6304	No anomalies of probable archaeological potential have been identified in this PA. Discrete anomalies of possible archaeological origin are identified in the east of the survey area.

Priority Area & NGR	Description and Results	NHER PreRef	Survey Interpretation
			A former field boundary has been recorded within the PA. The southern part of the PA was constrained by bird cover.
PA35 TG 1079 4258	Medieval moated complex with enclosures, fishponds, old road, and field system. Adjacent to Scheduled moated site – NHLE 1013097.	6304, 51430, 63388	No access agreement is currently in place.
PA36 TG 1073 4328	Site of Weybourne Camp (NHER MNF11335).	11335, 39345, 51724, 56090	Several high magnitude linear anomalies are caused by sub-surface pipes probably associated with Weybourne Camp. Also recorded is a very high magnitude linear anomaly, with much magnetic disturbance either side of it, which is probably caused by the cable for the current Dudgeon Offshore Windfarm. No anomalies of likely archaeological origin have been identified.
PA37 TG 1138 4344	WWI and WWII slit trenches. Multi-period findspots.	11335, 39345, 51724, 56090	No access agreement is currently in place.

5. DISCUSSION AND CONCLUSIONS

Ground conditions were generally very good in all PA's with most of the fields either still under stubble following the recent harvest or having been ploughed and re-sown (see above). Exceptions were in fields where potatoes had been lifted leaving the ground uneven and heavy underfoot. Overall, rates of progress were very good, and the minimally processed data quality was also very good requiring very little additional post-processing leading to a high degree of confidence in the data.

In addition to identifying anomalies of agricultural (drains, former boundaries, ridge and furrow and modern ploughing), modern (pipes, demolished buildings) and geological origin, the survey has identified clear anomalies of probable and possible archaeological origin in nearly all the PA's corroborating and enhancing the cropmark data in most PA's. As indicated by the preliminary research carried out prior to the start of the surveys these anomalies are indicative of activity ranging from the Bronze Age (a possible round barrow cemetery in PA9), medieval tofts in PA12, through to post-medieval brick manufacture in PA4 and 20th century World War II infrastructure in PA37. Most notable perhaps is the extended 'ladder' settlement which extends north/south through PA23, PA24 and PA25. A similar pattern of enclosure is also noted in PA28. The line of a Roman road (PA5) and the location of a mortuary enclosure (PA32) are also tentatively identified.

The fieldwork carried out to date within the onshore cable corridor has successfully evaluated those PA's where survey has been possible. In almost all areas the survey has added significantly to the detail of the archaeological resource, as identified by the cropmarks, which were the main determining factor in the selection of the PA's. The surveys have also better defined the extent of the resource in each PA.

6. REFERENCES

Chartered Institute for Archaeologists (CIfA) 2014 Standard and guidance for archaeological geophysical survey (Reading) https://www.archaeologists.net/sites/default/files/CIfAS%26GGeophysics_3.pdf accessed 16th December 2020

Natural Environment Research Council (NERC) 2018 British Geological Survey http://www.bgs.ac.uk/ accessed 16th December 2020

Europae Archaeologia Consillium (EAC) 2016 EAC Guidelines for the Use of Geophysics in Archaeology: Question to Ask and Points to Consider (Namur, Belgium) https://www.europae-archaeologiae-consilium.org/eac-guidlines accessed 25th November 2020

Gaffney, C & Gater, J 2003 Revealing the Buried Past: Geophysics for Archaeologists Stroud

Ministry of Housing, Communities and Local Government (MHCLG) 2019 National Planning Policy Framework https://assers.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/81017/NPPF_Feb_2019_revised.pdf accessed 16th December 2020

Royal HaskoningDHV 2020 Dudgeon and Sheringham Offshore Wind Farm Extensions Projects: Written Scheme of Investigation for Priority Archaeological Geophysical Survey 2020

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 the topsoil, subsoil and rock 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 (clay) can also be enhanced by the application of heat. This effect can lead to the detection of heat affected features such as hearths, kilns or areas of burning.

Types of magnetic anomaly

In most cases 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 introduced into the soil during 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.

Lightning-induced remnant magnetisation (LIRM)

LIRM anomalies are thought to be caused in the near surface soil horizons by the flow of an electrical current associated with lightning strikes. These observed anomalies have a strong bipolar signal which decreases with distance from the spike point and often appear as linear or radial in shape.

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 associate 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 MAGNETOMETER 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) to maximise the clarity and interpretability of the archaeological anomalies.

The data has also been clipped to remove extreme values and to improve data contrast.

APPENDIX 5 OASIS ARCHIVE

OASIS ID: headland5-412665

Project details

Project name Dudgeon and Sheringham Shoals Extension Projects

Short description of the project Headland Archaeology (UK) Ltd was commissioned by Equinor New Energy Ltd to carry out a geophysical (magnetometer) survey for the Dudgeon and Sheringham Shoals Extension Projects. The surveys covered 37 Priority Areas (PA's) covering 333 hectares along 60 km of survey corridor. In addition to identifying anomalies of agricultural (drains, former boundaries, ridge and furrow and modern ploughing), modern (pipes, demolished buildings) and geological origin, the survey has identified clear anomalies of probable and possible archaeological origin in nearly all the PA's successfully defining the extent of features previously identified as cropmarks. These anomalies are indicative of activity ranging from the Bronze Age (a possible round barrow cemetery), medieval tofts and post-medieval brick manufacture and World War II infrastructure the extent of the resource in each PA. Overall, the surveys have provided additional information that will enable the final route of the OCC to be selected to minimise the impact on the archaeological resource.

Project dates Start: 07-09-2020 End: 06-11-2020

Previous/future work No / Yes

Any associated project reference codes DUDG - Contracting Unit No.

Type of project Field evaluation

Site status (other) various

Current Land use Cultivated Land 2 - Operations to a depth less than 0.25m

Monument type CROPMARKS Medieval

Monument type CROPMARKS Roman

Significant Finds NONE None

Significant Finds NONE 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 (other) various

Drift geology (other) various

Techniques Magnetometry

Project location

Country England

Site location NORFOLK NORTH NORFOLK WEYBOURNE various

Postcode VARIOUS

Study area 500 Hectares

Site coordinates TG 11500 42500 52.937717013212 1.147744720957 52 56 15 N 001 08 51 E Point

Height OD / Depth Min: 5m Max: 15m

Project creators

Name of Organisation Headland Archaeology

Project brief originator Headland Archaeology

Project design originator Headland Archaeology

Project director/manager Alistair Webb

Project supervisor Neil Paveley

Type of sponsor/funding body Developer

Name of sponsor/funding body Equinor

Project archives

Physical Archive Exists? No

Digital Archive recipient Headland Archaeology

Digital Contents ''other''

Digital Media available
''GIS'',''Geophysics'',''Text''

Paper Archive Exists? No

Entered by Alistair.Webb (alistair.webb@[redacted])

Entered on 18 January 2021