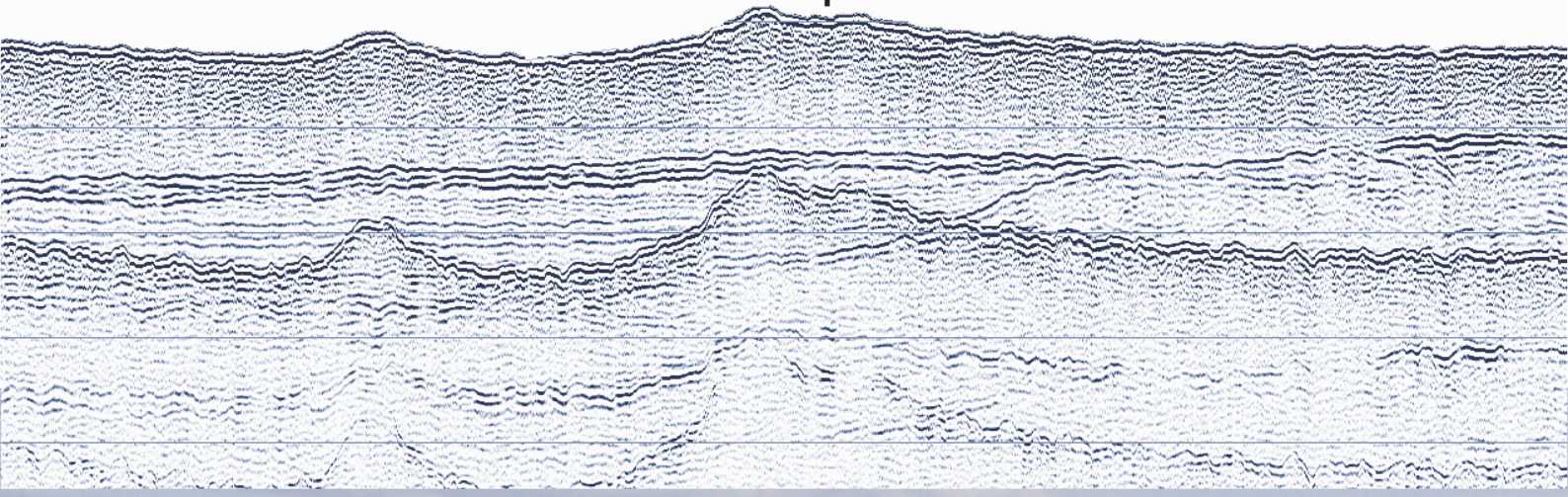
Wessex Archaeology

Race Bank Offshore Wind Farm

Archaeological Assessment

Final Report



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March 2008

RACE BANK OFFSHORE WIND FARM

ARCHAEOLOGICAL ASSESSMENT

Final Report

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Report ref.: 62554.04

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Summary

Wessex Archaeology was commissioned by AMEC Wind Energy, on behalf of Centrica Renewable Energy Limited to prepare an archaeological assessment and to undertake archaeological interpretation of geophysical data for the proposed Race Bank Offshore Wind Farm. The wind farm will be linked to land by a cable route which is discussed in Wessex Archaeology's Wash Cable Route Corridor Archaeological Desk-based Assessment (WA 2006a).

Race Bank Offshore Wind Farm will lie to the north of the proposed Docking Shoal Offshore Wind Farm and to the north-east of the proposed Lincs Offshore Wind Farm. The wind farm will be situated approximately 27km off the north Norfolk coast. To provide archaeological context, the Race Bank Study Area was created for the combined archaeological desk-based assessment of the Race Bank and adjacent Docking Shoal OWFs. It comprised the Race Bank wind farm footprint and a minimum of a 1km buffer around it.

Following the geophysical data audit, it was agreed that the archaeological assessment of the geophysical datasets would be undertaken for an area comprising only the proposed Race Bank wind farm footprint and a 500m buffer zone surrounding it. This area was named the Principal Study Area. During the course of this assessment it became evident that segments of the export cable route from the wind farm fell outside of the areas assessed in the Docking Shoal OWF and Wash Cable Route Corridor Archaeological Assessment (WA 2006e). An assessment of these extra cable areas has been included in this report; these areas form an additional study area named the Extended Cable Route Study Area. Only those sites that fall within the two study areas mentioned above are discussed in this report.

Searches for known archaeological material were conducted within the two study areas. Information was sought from a wide range of local and national bodies, including the Historic Environment Record maintained by Norfolk County Council, the National Monuments Record and the UK Hydrographic Office. Archaeological interpretation and assessment of geophysical data including multibeam bathymetry, sidescan sonar, magnetometer and single beam shallow seismic was undertaken by Wessex Archaeology and is included in this report.

This report sets out the methodology employed in carrying out the study and an account of the policy and legal framework affecting archaeological sites and wrecks in the UK. The archaeological heritage is discussed with particular reference to the maritime and prehistoric archaeology and history of the area. Maritime sites and the potential for the survival of former prehistoric land-surfaces offshore form the main focus of this assessment.

In summary, the known and potential archaeology within the study areas can be summarised as:

- 193 known wrecks and geophysical anomalies;
- 118 documented losses, the precise location of which are unknown;
- Potential submerged prehistoric landscapes and associated archaeological deposits;
- Unknown and undocumented losses from various periods possibly dating back to the Mesolithic;
- Stray finds of shipborne debris from various periods

RACE BANK OFFSHORE WIND FARM

ARCHAEOLOGICAL ASSESSMENT

Report ref.: 62554.04

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This report was commissioned by AMEC Wind Energy on behalf of Centrica Renewable Energy Limited. Wessex Archaeology would like to thank Dr Genevra Harker and Anthony Hunt of AMEC for their co-operation during the compilation of this report. Geophysical data was collected and supplied by Emu Limited and Osiris Projects. The assistance provided by the staff of these companies is gratefully acknowledged.

Datasets were provided by the National Monuments Record, Metoc plc (Seazone), the UK Hydrographics Office and Norfolk Historic Environment Record. Wessex Archaeology is grateful to the staff of all these organisations for their co-operation.

Niall Callan and Brian Hession carried out the assessment and compiled this report and Kitty Brandon prepared the illustrations. Louise Tizzard and Cristina Serra processed and interpreted the geophysical data which were collected and supplied by Emu Limited and Osiris Projects. The project was managed for Wessex Archaeology by John Gribble and Paul Baggaley.

Data Usage and Copyright

Chart 108 has been added to Schedule 1 Annex A of the above licence.

RACE BANK OFFSHORE WIND FARM

ARCHAEOLOGICAL ASSESSMENT

Report ref.: 62554.04

Contents

Tables:

Figures:

Plates:

RACE BANK OFFSHORE WIND FARM

ARCHAEOLOGICAL DESK-BASED ASSESSMENT

Report ref.: 62554.04

1. INTRODUCTION

1.1. PROJECT BACKGROUND

1.1.1. Wessex Archaeology (WA) was commissioned by AMEC Wind Energy, on behalf of Centrica Renewable Energy Limited to prepare an assessment of potential impacts upon archaeological remains arising from the construction of the proposed Race Bank Offshore Wind Farm (OWF).

1.1.2. The wind farm will be situated to the east (seaward) of the consented Lynn and Inner Dowsing and proposed Lincs Wind Farms and to the north (seaward) of the proposed Docking Shoal Offshore Wind Farm. It is proposed that it will be connected to the coast via the Wash Cable Route Corridor (**Figure 1**).

1.1.3. This assessment includes an additional study area to encompass segments of the proposed export cables which fall outside of the areas previously considered in the archaeological desk-based assessments of the Wash Cable Route Corridor (WA 2006a) and Docking Shoal Offshore Wind Farm (WA 2007). The study areas used in this report are described in detail in **Section 3.2**.

1.2. AIMS AND OBJECTIVES

1.2.1. This assessment outlines the known and potential archaeological resource within the study areas defined for the Race Bank OWF and the adjacent segments of the extended Wash cable route. The assessment included a desk-based study and interpretation and assessment of geophysical data. The full range of data searches include maritime sites and those elements of the local terrestrial archaeology that may be represented in or on the seabed as a result of sea-level change.

1.2.2. An assessment of the proposed wind farm upon the archaeological resource was undertaken and measures for mitigation are recommended. This assessment will form part of the Environmental Statement on the potential impact of the offshore elements of the wind farm scheme.

2. LEGISLATION, POLICY AND GUIDANCE

2.1. INTRODUCTION

2.1.1. England's heritage-related planning guidance and legislation is currently going through a period of major review. As a consequence, it is appropriate to note that changes, to both legislation and the planning process, may be made over the next three to five years. The majority of what is set out in this section reflects the situation as of October 2007.

2.2. PROTECTION OF WRECKS ACT (1973)

2.2.1. Under the Protection of Wrecks Act (1973) (PWA), wrecks and wreckage of historical, archaeological or artistic importance can be protected by way of designation. It is an offence to carry out certain activities in a defined area surrounding a wreck that has been designated, unless a licence for those activities has been obtained. Generally, the Secretary of State must consult appropriate advisors prior to designation (English Heritage in the case of the Race Bank OWF), though it is also possible to designate a wreck in an emergency without first seeking advice.

2.2.2. There are no sites presently designated under this legislation within the study areas defined for the Race Bank OWF and the adjacent segments of the extended Wash cable route. However, if any important wreck or shipborne artefact is discovered during the construction of the wind farm, the designation of an area around the find remains a possibility.

2.3. MERCHANT SHIPPING ACT (1995)

2.3.1. Within the context of the Merchant Shipping Act (1995), 'wreck' refers to flotsam, jetsam, derelict and lagan found in or on the shores of the sea or any tidal water. It includes a ship, aircraft or hovercraft, parts of these, their cargo or equipment. It may be of antique or archaeological value such as gold coins, a yacht or dinghy abandoned at sea, or items such as drums of chemicals or crates of foodstuffs (definition from the Receiver of Wreck website).

2.3.2. The ownership of underwater finds that turn out to be 'wreck' is decided according to procedures set out in the 1995 Act. If any such finds are brought ashore the salvor is required to give notice to the Receiver of Wreck that he/she has found or taken possession of them and, as directed by the Receiver, either hold them pending the Receiver's order or deliver them to the Receiver. This applies whether material has been recovered from within or outside UK Territorial Waters, unless the salvor can prove that title to the property has been vested in him/her (e.g. by assignment to him/her of rights devolving from the owner of the vessel or its contents at the time of loss). Even if ownership can be proved the salvor is still required to notify the Receiver.

2.3.3. The Crown makes no claim on wreck found outside UK Territorial Waters that remains unclaimed at the end of the statutory one year, and the property is returned to the salvor. Ownership of unclaimed wreck from within Territorial Waters lies in the Crown, or in a person to whom rights of wreck have been granted.

2.3.4. The Receiver of Wreck has a duty to ensure that finders who report their finds as required receive an appropriate salvage payment. In the case of material considered being of historic or archaeological importance, a suitable museum is asked to buy the material at the current valuation and the finder receives the net proceeds of the sale as a salvage payment. If the right to, or the amount of salvage cannot be agreed, either between owner and finder, or between competing salvors, the Receiver of Wreck will hold the wreck until the matter is settled, either through amicable agreement or by court judgement.

2.4. PROTECTION OF MILITARY REMAINS ACT (1986)

2.4.1. Under the Protection of Military Remains Act (1986) (PMRA), all aircraft that have crashed in military service are protected and the Ministry of Defence (MoD) has powers to protect vessels that were in military service when they were wrecked. The MoD can designate named vessels as Protected Places, even if the position of the wreck is not known. In addition, the MoD can designate Controlled Sites around wrecks whose position is known. In the case of Protected Places, the vessel must have been lost after 4th August 1914, whereas in the case of a wreck protected as a Controlled Site no more than 200 years must have elapsed since the loss.

2.4.2. In neither case is it necessary to demonstrate the presence of human remains on the site. Diving is not prohibited at a Protected Place but it is an offence to tamper with, damage, move or remove items from the wreck. However, diving, salvage and excavation are all prohibited on Controlled Sites, though licences for restricted activities can be sought from the MoD. Additionally, it is an offence carry out unauthorised excavations for the purpose of discovering whether any place in UK waters comprises any remains of an aircraft or vessel which has crashed, sunk or been stranded while in military service.

2.4.3. In November 2001, the MoD reported on the *Public Consultation on Military Maritime Graves and the Protection of Military Remains Act 1986*. The report recommended that a rolling programme of identification and assessment of vessels against set criteria be established to designate all other British vessels in military service when lost, as Protected Places. These criteria include:

- Whether or not human remains are known or likely to be present;
- Whether or not there is evidence of sustained disturbance and looting;
- Whether or not designation is likely to curb or put a stop to such disturbance and looting;

- Whether or not diving on the vessel or site attracts sustained and significant public criticism or approval.

2.4.4. There are five documented losses of aircraft attributed to the study areas defined for the Race Bank OWF and the adjacent segments of the extended Wash cable route which would be considered Protected Places under the PMRA (1986). All of these sites are British military aircraft from World War II for which the precise point of loss is not known. They are:

NMR ID	Name	Location
1354212	Wellington MK IV Z1285	Not known
1325173	Spitfire MK I L1051	Not known
1323066	Blenheim MK IV R3765	Not known
1354038	Hampden MK I X3021	Not known
1354383	Whitley MK VII Z6960	Not known

Table 2.1: Sites Protected under the Protection of Military Remains Act (1986)

2.5. PLANNING POLICY GUIDANCE

2.5.1. Planning law only applies within local authority regions which, as a general rule, extend only to the mean low water mark. However, English Heritage (EH) included the following statement in *England's Coastal Heritage* (1996):

> 'Although it remains government policy not to extend the Town and Country Planning system to the territorial sea, the principles set out in Planning Policy Guidance Note 16: Archaeology and Planning (PPG16) (Department of the Environment 1990) should be applied to the treatment of sub-tidal archaeological remains in order to secure best practice'.

2.5.2. PPG16 sets out the Secretary of State's policy on archaeological remains. It acknowledges the potentially fragile and finite or irreplaceable nature of such remains (para. 6), and states that the desirability of preservation of archaeological remains and their setting is a material consideration within the planning process (para. 18). PPG16 provides that there is a presumption in favour of the physical preservation of nationally important archaeological remains (para. 8), and that where preservation in situ is not justified it is reasonable for planning authorities to require the developer to make appropriate and satisfactory provision for excavation and recording of remains (para. 25).

2.5.3. Paragraph 19 of PPG16 suggests that it is in developers' own interests to include an initial assessment of whether the site is known or likely to contain archaeological remains as part of their research into the development potential of a site. Paragraph 22 adds: 'Local planning authorities can expect developers to provide the results of such assessments as part of their application for sites where there is good reason to believe there are remains of archaeological importance'.

PPG16 also notes that in spite of the best pre-planning application research, there may be occasions when the presence of archaeological remains only becomes apparent once development has commenced (para. 31).

2.6. JNAPC *CODE OF PRACTICE FOR SEABED DEVELOPMENT*

2.6.1. The Joint Nautical Archaeology Policy Committee *Code of Practice for Seabed Development* was first published in 1995. The Code has recently been reviewed and an updated version published in April 2006.

2.6.2. The Code sets out archaeological principles applicable to seabed developments which are similar to those to be found in current policy and practice on land. Procedures for consultation and co-operation between seabed developers and marine archaeologists are outlined, as are their respective roles in the development process. The aim of the Code is to ensure a best practice model for seabed development both within and beyond the remit of the formal Environmental Impact Assessment (EIA) process.

2.6.3. The document offers guidance to developers on issues such as risk management and legislative implications and provides a comprehensive list of expert contacts for further advice. The Code also highlights the responsibility of developers in protecting the UK's marine heritage and identifies the potential benefits to companies which follow best practice.

2.7. COWRIE HISTORIC ENVIRONMENT GUIDANCE FOR THE OFFSHORE RENEWABLE ENERGY SECTOR

2.7.1. There is a specific requirement to address the historic environment – the architectural and archaeological heritage and landscape – as part of the Environmental Impact Assessment process. The requirements of EIA are defined in European Council Directive 85/337/EEC as amended by Directive 97/11/EC and Directive 2003/35/EC.

2.7.2. The guiding principles for cultural heritage in EIA are presented in the COWRIE Guidance (WA 2006b) and include:

- Assessing all beneficial and adverse impacts on cultural heritage, including direct, indirect, temporary, permanent and cumulative effects.
- Evaluate the significance of any impacts on the cultural heritage resource to take account of both the intrinsic value of the resource and how much it will be changed.
- Use relevant international, national and local legislation and policy to explain the significance, and make explicit the basis for any statements concerning value or importance.
- Consider a variety of approaches to mitigation, including design modification, appropriate investigation and recording measures.

- Propose realistically achievable mitigation measures and fully monitor and document any agreed actions, including responsibility for their implementation.

2.7.3. Mitigation measures applicable to archaeological sites generally take the form of prevention or avoidance; reduction; and remedying and offsetting (WA 2006b). The measures proposed for this scheme reflect these three options.

2.7.4. It is noted that at the time of writing, COWRIE has commissioned a new guidance document, *Guidance for Assessment of Cumulative Impact on the Historic Environment from Offshore Renewable Energy* (Final draft October 2007). The guidance is currently out to public consultation but when published is likely to become the standard for the assessment of cumulative effects in relation to the historic environment.

2.8. *ENGLAND'S COASTAL HERITAGE*

2.8.1. *England's Coastal Heritage: A Statement on the Management of Coastal Archaeology* was published in 1996 by EH and the Royal Commission on the Historical Monuments of England (RCHME). The document sets out a number of principles for managing coastal archaeology:

- The coastal zone of England includes a finite, irreplaceable, and, in many cases, highly fragile archaeological resource which by virtue of its value, variety, and vulnerability justifies a presumption in favour of the physical preservation in situ of the most important sites, buildings, and remains;
- Although archaeological remains situated within inter-tidal and sub-tidal areas may be less visible and accessible than remains on dry land, this does not affect their relative importance and they should be managed in accordance with the principles which apply to terrestrial archaeological remains;
- As historic landscapes can extend seamlessly from dry land, through the inter-tidal zone, and into sub-tidal areas, effective management of the coastal archaeological resource cannot be achieved without due consideration of marine as well as terrestrial archaeological remains.

2.8.2. The document also made a number of detailed recommendations, which include the following notes under the heading Development Control and Environmental Assessment:

> 'Coastal archaeological interests should be adequately reflected in structure and local plans, and consistently and comprehensively included in Environmental Assessment procedures for coastal and marine developments (including harbour works, mineral extraction, oil and gas related projects, capital dredging projects, cable projects, and

> waste water treatment and disposal) and other activities requiring sectoral consent'.

2.8.3. *England's Coastal Heritage* identifies the Norfolk and Lincolnshire coasts and the Wash as areas of High Archaeological Potential. It goes on to state that within such areas:

> 'Survey priorities will be determined through a consideration of the level of threat to important archaeological remains and the need to contribute adequate archaeological data to wider coastal zone management initiatives such as Coastal Zone Management Plans, River Catchment Management Plans, Estuary Management Plans, Shoreline Management Plans and Coastal Planning Strategies, in partnership with other agencies'.

2.8.4. Although the distance of the Race Bank OWF from the Norfolk and Lincolnshire coasts limits the applicability of these survey priorities to the wind farm footprint, they are relevant to the cable route corridor through the Wash.

2.9. *IDENTIFYING AND PROTECTING PALAEOLITHIC REMAINS*

2.9.1. *Identifying and Protecting Palaeolithic Remains; Archaeological Guidance for Planning Authorities and Developers* (English Heritage 1998) draws attention to the importance of Palaeolithic remains and states that they must be considered in line with PPG16 when potentially affected by development proposals. Palaeolithic archaeological sites are defined as any land where artefacts or traces of a human presence of Pleistocene date have been found. The document notes that Palaeolithic remains have particular importance if:

- Any human bone is present in relevant deposits;
- The remains are in an undisturbed, primary context;
- The remains belong to a period or geographic area where evidence of a human presence is particularly rare or was unknown;
- Organic artefacts are present;
- Well-preserved indicators of the contemporary environment (floral, faunal, sedimentological) can be directly related to the remains;
- There is evidence of lifestyle (such as interference with animal remains);
- One deposit containing Palaeolithic remains has a clear stratigraphic relationship with another;
- Any artistic representation, no matter how simple, is present;
- Any structure, such as a hearth, shelter, floor, securing device, etc. survives;
- The site can be related to the exploitation of a resource, such as a raw material;

- Artefacts are abundant.

2.9.2. The document goes on to note that sites containing any of these features are so rare in Britain that they should be regarded as of national importance and whenever possible should remain undisturbed.

2.9.3. The advice offered to developers and planning officers includes the following:

- It is advisable for prospective developers to research the archaeological potential of their sites (including that for Palaeolithic remains) at an early stage;
- It is the responsibility of developers to supply the relevant planning authority on the archaeology of their sites, with proposals for the way in which this will be accommodated within the development scheme, so that an informed planning decision can be reached. Information on the Palaeolithic remains or the potential for such remains within a certain site may be acquired from a desk-based assessment but when this is inadequate it may be necessary to obtain further information from a limited field evaluation by suitably qualified archaeologists;
- Planning authorities may apply a condition to a consent which prohibits the start of development until the applicant has ensured appropriate provision has been made for an adequate record of the site's archaeological remains.

2.10. STRATEGIC ENVIRONMENTAL ASSESSMENT

2.10.1. In 2002 the Department of Trade and Industry produced a document: *The scope of Strategic Environmental Assessment of North Sea areas SEA3 and SEA2* in regard to prehistoric archaeological remains. Although not legislative the paper makes suggestions for discussion of protocols and a reporting regime for the commercial sector:

> 'The ideal structure would require or encourage the industry and its sub-contractors to check whether their activities are in archaeological prospective zones, and to identify, and report, when their activities positively detect prehistoric artefacts, or, in the case of acoustic surveys, provide very strong evidence. If this can be achieved at a minimal or acceptable cost/delay to industry, then there is a positive advantage in allowing operators to start activities in zones of archaeological potential, while avoiding positively identified sites, if any.' (8.6).

2.11. *PROTECTING OUR MARINE HISTORIC ENVIRONMENT*

2.11.1. In March 2004, a consultation document was circulated setting out the key issues and questions in relation to legislation and the management of the marine historic environment (DCMS, 2004). The document includes various suggestions for change, including a more unified

designation scheme (combining the PWA and the Ancient Monuments and Archaeological Areas Act 1979). The document also includes provision for publishing the criteria that marine cultural heritage sites will need to satisfy in order to be designated. Standardised restrictions are also proposed, so that all sea-users can broadly anticipate what activities are allowed.

2.12. MARITIME DESIGNATIONS

2.12.1. There are no sites within the study areas defined for the Race Bank OWF and the adjacent segments of the extended Wash cable route subject to designation under the PWA (1973).

2.12.2. There are five documented losses of World War II British military aircraft recorded study areas defined for the Race Bank OWF and the adjacent segments of the extended Wash cable route which would be considered Protected Places under the PMRA (1986) (see **2.4.4** above).

2.12.3. No WWII German and American aircraft losses are represented in the aircraft remains recorded from the Race Bank area in the NMR database. However, such aircraft are likely to be present on the seabed off the east coast of England and would be considered Protected Places under the PMRA (1986) if found.

3. METHODOLOGY

3.1. INTRODUCTION

3.1.1. This assessment is intended to inform the preparation of the Environmental Statement that will accompany the licence application for the Race Bank OWF. The methodology adopted reflects best practice in carrying out archaeological desk-based assessments, as codified by the Institute of Field Archaeologists (IFA) Standard and Guidance for Archaeological Desk-based Assessment (IFA 2001) and as laid out in the COWRIE Guidance Note (WA 2006b).

3.1.2. The approach adopted also reflects the requirements of Environmental Assessment arising from European Council Directive 85/337/EEC as amended by Directive 97/11/EC and Directive 2003/35/EC.

3.2. SEARCH AREAS

3.2.1. The proposed site of the Race Bank OWF lies in an area off the Lincolnshire and Norfolk coasts in which a number of other offshore wind farms have been proposed or are in the process of being developed (see **Figure 1**). WA has conducted the following studies in the area, for which large areas have been subject to archaeological assessment, and which provide context for the Race Bank OWF:

- the Docking Shoal Study Area (DSSA) (created for the Race Bank and Docking Shoal Offshore Wind Farms Archaeological Desk-based Assessment, WA 2006c);
- the Cable Route Study Area (CRSA) (created for the Wash Cable Route Corridor Archaeological Desk-based Assessment, WA 2006a);
- the Lincs Data Search Area (created for the Lincs Offshore Wind Farm: Archaeological Desk-based Assessment, WA 2006d);
- the Lynn and Inner Dowsing Data Search Area (created for the adjacent Lynn and Inner Dowsing Offshore Wind Farms: Maritime Archaeological Assessment and Terrestrial Archaeological Assessment, WA 2002a and 2002b).

3.2.2. The Race Bank Study Area (RBSA) was originally created for a combined archaeological desk-based assessment of the Race Bank and adjacent Docking Shoal OWFs (WA 2006c) and comprised the Race Bank OWF development footprint and a minimum of a 1km buffer around it. The Race Bank Study Area and the adjacent study areas for the Docking Shoal OWF and the Wash Cable Route Corridor are illustrated in **Figure 1**.

3.2.3. Following a geophysical data audit (WA 2006e) WA and AMEC agreed that the archaeological assessment of the geophysical datasets for the Race Bank OWF would be undertaken for an area comprising only the proposed wind farm footprint and a 500m buffer zone surrounding it. This area has been named the Principal Study Area (PSA) (**Figure 2**), and is the major area considered by this report. The co-ordinates for the PSA are contained in **Appendix I**.

3.2.4. This approach accords with that taken with the archaeological assessments of the Wash Cable Route Corridor (WA 2006a) and Docking Shoal OWF (WA 2007) where the footprint of each development was buffered and then only those sites which fell within the resultant areas were considered in the assessments (**Figure 3**).

3.2.5. The interpreted geophysical data and archaeological evidence for the remaining segments of the cable route which fell between the buffered area considered in the Docking Shoal OWF archaeological assessment and the Race Bank PSA have been incorporated into this report. This area will be referred to as the Extended Cable Route Study Area (ECRSA) throughout this report. The co-ordinates of the ECRSA are contained in **Appendix I** and this area is illustrated alongside the PSA in **Figure 2**.

3.2.6. Records of known maritime sites and casualty positions within the two study areas have been overlaid on a base map of the development area in ArcMap9, a Geographical Information System (GIS) software package.

3.2.7. In order to assess the potential for submerged prehistoric sites within the two study areas, available models of sea-level change in the

southern North Sea were analysed to establish the periods when the area was dry land and suitable for human inhabitation (**Figure 4**).

3.3. SOURCES

3.3.1. The principal sources consulted in this assessment are as follows:

- Records of wrecks and obstructions collated by the UK Hydrographic Office (UKHO) and obtained from Metoc plc as Seazone data;
- Records of known wrecks and documented losses held in the maritime section of the National Monuments Record (NMR);
- Records of known terrestrial archaeological sites and finds from the NMR;
- Records of known archaeological sites and finds from the Norfolk Historic Environment Record (NHER);
- Various secondary sources relating to submerged palaeolandscapes and archaeology and the wider Palaeolithic and Mesolithic archaeology of Northern Europe;
- Secondary sources relating to known and potential wreck sites and casualties, including historical charts and sailing directions held by the UKHO;
- The MoD (Naval Staff Directorate) with respect to the PMRA (1986);
- The Receiver of Wreck, at the Maritime and Coastguard Agency, regarding reports of historic wrecks.

3.4. MARITIME RECORDS

3.4.1. In order to assess the maritime archaeological resource within the two Race Bank study areas, records of wrecks and casualties were obtained, principally from the NMR, UKHO, Seazone, and NHER, and from the geophysical data assessed by WA.

3.4.2. Known wreck sites and geophysical anomalies in the PSA were tabulated under a numerical sequence **7000**-**7180** and those identified in the ECRSA were listed in the number sequence **7181**-**7194 (Appendix II**). All sites were superimposed on a base map of the two study areas (**Figure 2**). All geophysical anomalies deemed to be natural in origin were discounted at an early stage in the geophysical assessment of the data. Therefore, only those that are of possible anthropogenic origin are listed in this report.

3.5. TERRESTRIAL RECORDS

3.5.1. As part of the Wash Cable Route Corridor report (WA 2006a) records of archaeological sites of all time periods for the adjacent coastline were obtained from the NMR and NHER. Although the majority of these records describe terrestrial archaeological sites and therefore are located well outside of the PSA and ECRSA, they have been reused for

this report in order to provide a context for potential archaeological activity in the study areas.

3.6. CHRONOLOGY

3.6.1. Archaeological dating of remains relies on three distinct chronologies. These are as follows:

- Absolute (or calendar) dates, which are suffixed with **BC** (**B**efore **C**hrist), generically known as **big BC**. Such dates can be considered as part of our present day calendar, i.e. a date of 3,523 BC occurred 5,530 years ago.
- Calibrated radiocarbon dates, which are either related to our modern calendar as BC (**calBC**) dates, or presented as **BP** (**B**efore **P**resent) dates. BP dates are calculated in years before 1950, and take into account the increased radioactivity background count following the proliferation of nuclear testing after this date. Therefore, a calibrated date of 4,500 BP indicates a point in time 4,557 years before today (i.e. 2,550 BC).
- Uncalibrated radiocarbon dates, which are suffixed with **bc** (i.e. **little bc**), and are the original radiocarbon determinations based on the half-life of C14 without compensating for changes in the background count.

3.7. MARINE GEOPHYSICAL ASSESSMENT

3.7.1. Geophysical surveys for the Race Bank OWF were undertaken by Emu Ltd. and Osiris Projects between December 2005 and September 2006. Sidescan sonar, multibeam bathymetry, single beam, shallow seismic and magnetometer datasets were collected. Although the data were not collected specifically for archaeological purposes, they were audited and reviewed by WA and, in general, were considered suitable for archaeological interpretation (WA 2006e).

3.7.2. WA was then commissioned to archaeologically assess and interpret the geophysics within the PSA and ECRSA. The data were analysed for anomalies of archaeological potential by WA in September and October 2007. The dataset covering the southern portion of the ECRSA was originally interpreted as part of the Docking Shoal OWF Archaeological Assessment. All anomalies were plotted in ArcMap9 and compared to existing records of wrecks and obstructions from the UKHO and NMR.

3.7.3. An anomaly can be defined as something which differs from the surrounding seabed and which has characteristics which suggest that it is a.) anthropogenic or of human origin and b.) of archaeological interest, as opposed to modern debris.

3.7.4. The form, size and/or extent of an anomaly is a guide to its nature. A single small but prominent anomaly may be part of a much more extensive feature that is largely buried. Similarly, a scatter of minor anomalies may define the edges of a buried but intact feature, or it may

be all that remains as a result of past impacts from, for example, dredging or fishing.

3.7.5. In order to assess the applicability of the datasets for archaeological purposes the quality of the data were assessed and graded. The data were graded as good, average or variable using the following criteria:

Good	Data which are clear and unaffected by weather conditions or sea state. The dataset is suitable for the interpretation of standing and partially buried metal wrecks and their character and associated debris field. These data also provide the highest chance of identifying wooden wrecks and debris.
Average	Data which are affected by weather conditions and sea state to a slight or moderate degree. The dataset is suitable for the identification and partial interpretation of standing and partially buried metal wrecks, and the larger elements of their debris fields. Wooden wrecks may be visible in these data, but their identification as such is likely to be difficult.
Variable	This category contains datasets with the quality of individual lines ranging from good or average to below average. The dataset is suitable for the identification of standing and some partially buried metal wrecks. Detailed interpretation of the wrecks and debris field is likely to be problematic. Wooden wrecks are unlikely to be identified.

Table 3.1: Data quality rating criteria in considering suitability for assessing archaeological potential.

3.7.6. Details on the methodology employed and quality of each dataset are discussed in more detail below.

Magnetic Data

3.7.7. The magnetic data were processed to give an x,y,z file comprising grid co-ordinates (x,y) and total magnetic field strength (z). Each line of data was then processed to remove the regional magnetic field and also any large diurnal variations, which may have masked small magnetic anomalies of interest to this survey. The data were then gridded to produce a contour map of the survey area and plotted with the magnetic field strength values represented by graded colour bands to show changes in the magnetic field strength.

3.7.8. The magnetic anomalies were then assessed and the position and magnitude of all anomalies with an amplitude of 5nT or more were recorded as potential anomalies.

3.7.9. The quality of the magnetic data was variable, with many lines affected by excessive noise which would have been caused by electrical interference or due to environmental conditions. Although the entire magnetic dataset was assessed and interpreted, in areas where the data were noisy small anomalies may not have been identified.

Sidescan Sonar Data

3.7.10. The sidescan sonar data were processed by WA using Coda Geosurvey software. This allowed the data to be replayed with various gain settings in order to optimise the quality of the images. The data were initially scanned to gain an understanding of the geological nature

of the area and were then interpreted for any objects of possible anthropogenic origin and the position and dimensions of any such objects recorded.

3.7.11. The sidescan sonar data cover the area of the scheme with the exception of a 1.7 km^2 area in the northeast corner of the easternmost section of the wind farm footprint. Line spacing varies between 75 and 100m range. All data lines within the study areas were interpreted during the archaeological evaluation. However, the records listed in **Appendix II** are unlikely to reflect all of the archaeological sites in the area for the following reasons:

3.7.12. The quality of the sidescan sonar data was variable, particularly in respect to data coverage (WA 2006e). The data acquired by Osiris were of generally good quality and based on the line spacing and sidescan sonar towfish range seabed coverage of 140% was achieved. However, the Emu acquired data were of variable quality throughout and data were received out to approximately two thirds of the sonar range resulting in effective seabed coverage of between 80 and 110%. As a result, further archaeological sites may exist where full data coverage was not achieved. Also, the quality of the data was at times not high enough for reasonable archaeological assessment, as a result of adverse weather conditions.

3.7.13. Large sand waves (averaging 6m in height, with areas of up to 8m) were observed within the PSA and ECRSA. The extent of these sandwaves was assessed from the multibeam bathymetry dataset and they are estimated to cover approximately 60% of the PSA (primarily the western sector) and the majority of the ECRSA (**Figure 5**). Archaeological sites may be buried within these sandwaves and due to the potential thickness of the sand even quite large sites may not be visible on the surface of the seabed or detected by sidescan sonar.

3.7.14. The presence of large sandwaves has implications for the survival and condition of archaeological sites as well as the identification of their presence. The presence of sandwaves indicates that the environment is mobile, with archaeological sites possibly subject to cycles of exposure and burial which will make them vulnerable to deterioration.

3.7.15. Furthermore, anomalies that are not upstanding and are highly degraded, particularly those made of wood, can be difficult to identify even with data acquired at high frequency.

Seismic Data

3.7.16. The shallow seismic data were studied in order to detect any in-filled palaeochannels, ravinement surfaces and peat/fine-grained sediment horizons that may have archaeological potential.

3.7.17. The shallow seismic data were processed by WA using Coda Geosurvey software. This software allows the data to be replayed with user selected filters and gain settings in order to optimise the

appearance of the data for interpretation. The software then allows an interpretation to be applied to the data by identifying and selecting a sedimentary boundary that might be of archaeological interest.

3.7.18. The shallow seismic data were interpreted with two-way travel time (TWTT) along the z-axis. In order to convert from TWTT to depth the velocity of the seismic waves was estimated to be 1,600 m/s. This is a standard estimate for shallow, unconsolidated sediments.

3.7.19. For the purpose of this project every second line (50%) of data were assessed. Where palaeochannels or other features were identified the adjacent lines were assessed in order to trace the features of interest. For the purpose of recording features, only those recorded on two or more lines were documented in the gazetteer, in order not to over-interpret the data. For example, a channel feature recorded on only one line may indicate a depression rather than a channel.

3.7.20. Generally, the data were of variable quality, being poor where affected by adverse weather conditions.

Multibeam Bathymetry Data

3.7.21. The bathymetric data were provided to WA in xyz file format, gridded to 2m cell size. The data were made into a surface using IVS Fledermaus software and used to identify the larger, upstanding features observed on the sidescan sonar data.

4. BASELINE CONDITIONS

4.1. MORPHOLOGY, GEOLOGY AND SEASCAPE

4.1.1. The PSA and ECRSA form two adjacent irregular shaped polygons approximately 27km off the north Norfolk coast (**Figures 1** and **3**). The PSA is situated to the east (seaward side) of the ECRSA. The ECRSA extends into the original Docking Shoal Study Area and abuts the northern edge of the buffered development footprints considered in the assessments for the Wash Cable Route Corridor (WA 2006a) and Docking Shoal OWF (WA 2007).

4.1.2. The seabed morphology of the PSA consists of Race Bank sandbank in the south and North Ridge and Dudgeon Shoal in the north, with areas of deeper seabed between these banks. The primary seabed morphology in the ECRSA also consists of Race Bank, and both the ECRSA and PSA partially encompass the channel between Race Bank and Docking Shoal. The area ranges in depth from 2.3m below Chart Datum (CD) on Race Bank to 21.5m below CD in the channel between the Race Bank and Docking Shoal sandbanks.

4.1.3. The underlying sediment within the study areas is the Bolders Bank Formation (BDK) laid down in the late Pleistocene. This has been described by the British Geological Survey (BGS) in their Spurn Quaternary Sheet as red-brown, calcareous, gravelly sandy clay with

erratics predominately of chalk, red-brown sandstone and grey mudstone (British Geological Survey 1991). Modern seabed sediments directly overlie the BDK Formation.

4.2. PREHISTORIC ARCHAEOLOGY

Glaciation and Sea-Level Change

4.2.1. The archaeological potential of the PSA and ECRSA is closely related to relative sea-level change through time. For long periods since approximately 700,000 BP much of the North Sea Basin was dry land, and at times is likely to have been suitable for human occupation (Wenban-Smith 2002: 2).

4.2.2. The North Sea Basin has been shaped by numerous periods of glaciation and associated marine transgressions, including three major glaciations: the Anglian (c.478,000 BP to 423,000 BP), the Wolstonian (c.380,000 BP to 130,000 BP) and the Devensian (c.70,000 BP to 13,000 BP). Ice sheets would have affected the landscape in a number of different ways:

- Erosion caused by glaciers;
- Erosion caused by glacial outwash;
- Deposition of sediment caused by glacial outwash;
- Isostatic change resulting from the effect of the ice sheet upon the landmass.

4.2.3. Relatively small changes in sea-level would have had a marked effect on the coastline. Any coastline models therefore can only be approximate. **Table 4.1** provides an indication of the main warm and cold periods and estimates the sea-level stands that prevailed during these periods:

Oxygen Isotope Stage	Age in years BP/BC	British Conventional Chronology	Archaeological Period	Climate	Sea-Level Age	Relative Sea-Level
–	4,000 BC	Flandrian		Warm	c. 4,000 BC	-6m
	5,500 BC		Mesolithic		c. 5,500 BC	-10m
					c. 6000 BC	-17m
					c. 6300 BC	
					c. 6,700 BC	-20m
					c. 9,000 BP c. 7,000 BC	-25m
	7,500 BC		Early Mesolithic		c. 9,500 BP c. 7,500 BC	-30m
1	10,000 BP/ 8,000 BC	Devensian			c. 10,000 BP c. 8,000 BC	-35m
			Late Upper Palaeolithic		c. 11,000 BP c. 9,000 BC	-40m
						-50m
2	12,000 BP/ 10,000 BC				c. 12,000 BP c. 10,000 BC	-60m
					c. 13,500 BP c. 11,500 BC	
	16,000 BP/ 14,000 BC					

Oxygen Isotope Stage	Age in years BP/BC	British Conventional Chronology	Archaeological Period	Climate	Sea-Level Age	Relative Sea-Level
2	18,000 – 25,000	Devensian	Early Upper Palaeolithic	Mainly cold	c. 18,000 BP c. 16,000BC	-120m
3	25,000 – 50,000				c. 40,000 BP c. 38,000BC	-50m
4	50,000 – 70,000		Middle Palaeolithic			
5a-d	70,000 – 110,000					
5e	110,000 – 130,000	Ipswichian		Warm	c. 122,000 BP	+8m
6	130,000 – 186,000	Wolstonian		Cold	c. 128,000 BP	-100
7	186,000 – 245,000			Warm	c. 186,000 BP	High?
8	245,000 – 303,000		Lower Palaeolithic	Cold	c. 250,000 BP	Low?
9	303,000 – 339,000			Warm	c. 300,000 BP	High?
10	339,000 – 380,000			Cold	c. 339,000 BP	
11	380,000 – 423,000	Hoxnian		Warm	c. 380,000 BP	High?
12	423,000 – 478,000	Anglian		Cold	c. 425,000 BP	-120m+?
13	478,000	Cromerian		Variable	c. 480,000 BP	Varying
17 or 19?	700,000 BP				c. 700,000 BP	

Table 4.1: Relative Sea-Level Changes (after Wymer (1999), Shennan et al. (2000), Wenban-Smith (2002), Coles (1998), Jelgersma (1979), Parfitt et al. (2005) and the work of the Land-Ocean Evolution Perspective Study (LOEPS).

4.2.4. The PSA and ECRSA would have been at least partially ice-free and above sea-level during some of the colder periods of the Lower and Middle Palaeolithic (c.700, 000 to 50,000 BP), and potentially habitable for humans. This would also have been the case between the end of the last cold period of the Devensian Glaciation (known as the Loch Lomond Stadial 13,000 to 11,500 BP) and the Mesolithic.

4.2.5. The discovery of lithic implements from Pakefield in Suffolk dated to c.700,000 BP has revealed evidence of occupation on what is described as a floodplain that extended off the east coast of Britain. This provides evidence for a previously unknown warm period during the Cromerian (700,000 to 478,000 BP) (Parfitt *et al*. 2005: 1008). It is proposed that climate during the Cromerian period alternated between cold and warm phases; at least six distinct temperate phases have been recognized, between approximately 780,000 and 450,000 BP (Preece 2000: 26). At times during this period the study areas may have been exposed and therefore possibly suitable for occupation by hominin populations.

4.2.6. The most extensive ice cover of Britain occurred during the Anglian glacial phase (c.478,000 to 423,000 BP), when the ice sheet is believed to have extended almost as far south as the Thames (Wymer 1999: 17). The study areas would have been completely covered by ice during the

glacial maximum. However there would have been a period as the ice retreated when the PSA and ECRSA were exposed, before the rapid rise of sea-level associated with the Hoxnian stage immediately thereafter would have covered the area.

4.2.7. The full extent of Wolstonian ice cover (c.380,000 to 130,000) is unknown, but it is considered likely that at its maximum the ice sheet may have reached as far south as the Wash, covering the study areas (May 1976: 17-18).

4.2.8. The advance of the later Devensian ice (c.110,000 to 10,000 BP) is also likely to have reached past the southern limit of the present-day Wash (Brew 1997: 137). The intervening warm period of the Ipswichian (c.110, 000 to 130,000 BP) is predicted to have had sea-levels eight metres higher than today, completely inundating the PSA and ECRSA.

4.2.9. The speed and effect of the last marine transgression upon the area is difficult to quantify. A model developed by Shennan *et al*. (2000: 291) suggests that the study areas would have been most recently inundated around 6,000 BP. Sea-level curves for the Fenlands indicate a relative sea-level of nine metres below its current position at around 7,000 BP (ibid. 2000: 292). It is possible, however, that portions of Race Bank, at 2.3m below modern Chart Datum could have survived as dry land into the Bronze Age. Reconstructions of the postulated changes in sea-level in relation to the study areas toward the end of the Devensian are illustrated in **Figure 4**.

Periods of Potential Human Occupation

4.2.10. The Lower and Middle Palaeolithic landscape of Britain is difficult to reconstruct, but it is possible to make some generalisations based on existing evidence.

4.2.11. The temperate phases of the Cromerian period resulted in alternating climatic conditions which would have had a significant impact on the landscape of Norfolk, Lincolnshire and the North Sea Basin.

4.2.12. This Cromerian landscape would have extended across the whole of the southern North Sea. The woodland and wildlife would have made the area an attractive habitat for hominin occupation. Some of the earliest hominin sites in Britain have been found at Happisburgh in Norfolk and Pakefield in Suffolk, on the North Sea coast. This suggests the potential for evidence of hominin occupation in the PSA and ECRSA may date back at least as far as these discoveries.

4.2.13. Fossil evidence from the West Runton Freshwater Bed on the North Norfolk coast indicates a temperate climate and palaeobotanical material points to a habitat of woodland and grass (Stuart and Lister 2001: 1678). The Cromer Bed sediments, south of the study areas in Norfolk have revealed that large grazing mammals such as mammoth, elephant and giant deer would have been present in the landscape at this time (Wymer 1999: 129).

4.2.14. The Anglian glaciation (c.423,000 BP) brought ice cover and a periglacial climate to Britain. Although for a time, at the end of the period, the study areas may have been exposed, harsh conditions are likely to have precluded hominin occupation. While the Hoxnian stage was to be warmer, a sea-level higher than today is probable, inundating the study areas.

4.2.15. The Wolstonian (c.380,000 to 130,000 BP) period appears to have comprised a number of warm and cold periods. There have been no substantial studies of this period specifically dealing with the southern North Sea, but evidence from other parts of Britain has revealed some details of interglacials during the Wolstonian, such as the Purfleet interglacial (320,000 to 290,000 BP / OIS 9), when Schevre (2001: 1698) believes Britain to have been inhabited by Neanderthals, and the Aveley interglacial (180,000 to 230,000 BP / Oxygen Isotope Stage (OIS) 7).

4.2.16. It has been postulated that early human populations were absent from Britain during the Ipswichian and later (130,000-50,000 BP) (Wymer 1999:33). It is implied that these populations retreated to the continent or gradually perished during the cold extremes at the end of the Wolstonian glaciation (186,000–130,000 BP). Though the subsequent warming during the Ipswichian interglacial would have presented a favourable climate for habitation it is suggested that the corresponding rise in sea-level presented a barrier to re-colonisation from the Continent.

4.2.17. There is little evidence to suggest when re-colonisation occurred, but it is thought to have happened during the Devensian at approximately 50,000 BP when sea-levels would have fallen enough to expose the North Sea as dry land and allow human population movement (Wymer 1999:34). The Devensian ice sheet reached as far south as the Wash, therefore the PSA and ECRSA are likely to have been covered by ice or in very close proximity to the southern limits of the ice sheet at this time. Archaeological evidence from South Wales, however, has indicated the ability of Devensian human populations to exist within several kilometres of ice sheets (Woodcock 2000: 404). Therefore if the study areas were at the limits of ice sheet coverage, there is potential for the PSA and ECRSA to have been inhabited in this period or soon after the beginning of glacial retreat.

4.2.18. As the Devensian glacial ice sheets began to retreat around 13,000 BP, the North Sea Basin would once again have been exposed. The immediate post-glacial landscape was colonised by grasses, sedges and herbs and increasingly mild temperatures provided a suitable environment for initial birch, willow, poplar, hazel and pine vegetation (Fryer *et al*. 2005: 10). Late Upper Palaeolithic (c.16, 000 to 11,000 BP) evidence from Titchwell, just to the south of the study areas, confirms human occupation of the region in this period (Wymer & Robins 1994).

4.2.19. At the transition into the Mesolithic (c.11,000 BP) the southern North Sea would have been an area of low-lying fresh and brackish-water wetlands and lagoons, supporting animals such as deer and aurochs (Murphy 2005: 6). As sea-level rose it eventually inundated the study areas in the Mesolithic period around 6,000 BP.

Known and Potential Archaeology

4.2.20. Three major glaciations have reworked the landscape of the study areas since the earliest known Lower Palaeolithic occupation of Britain during the Cromerian. It can be assumed that there was no human occupation of the ice sheets, but glacial maxima would not have been achieved quickly and occupation may well have taken place near the advancing and retreating fringes of the ice sheets in all periods (Wymer 1999: 18).

4.2.21. Material remains from the earliest periods of the human occupation in Britain are relatively rare. It is useful therefore to refer to evidence from across Britain as a whole and the wider environmental context, as discussed above, to establish the potential for the presence of early prehistoric archaeological remains within the study areas.

4.2.22. The most easily identifiable features of the prehistoric landsurfaces described above are the buried remains of former river systems or ‘palaeochannels’. These systems incised new valleys into the landsurfaces exposed by the lower sea-level, and often cut through previous layers, removing and redepositing sediments.

4.2.23. These river valleys are likely to have been attractive environments to prehistoric humans, and human activity would have tended to concentrate around the food and other resources they offered. They would also have provided easy pathways for communication and with the aid of simple watercraft would have served as transport routes.

4.2.24. The seismic survey has produced evidence for seven potential palaeochannels within the PSA (**Figure 2**), the shallowest margins of some of which lie less than one metre below the modern seabed. Two of these palaeochannels (**7173** and **7177**) are unlikely to be affected by the wind farm construction and are not considered any further. Five of the channels; **7172** (**Figure 6**), **7174**, **7175**, **7176** and **7178** (**Figure 7**), are likely to be directly affected by construction activities and are described in more detail below.

4.2.25. Channels **7172** and **7174** appear to be filled with fine-grained stratified sediments, which have the potential to contain post-Devensian archaeological and palaeoenvironmental material. Channel **7172** was observed on seven data lines and lies between 6.6m and 21.2m below the seabed. It lies in the north-western section of the PSA at the location of the proposed substation. Channel **7174** was observed on five data lines and lies between 2m and 19.8m below the seabed in the eastern section of the PSA. Both channels are relatively shallow and too far apart to be related. Despite the extensive reworking of the

landscape, some deposits from pre-glacial periods may survive *in situ* in the North Sea (Hosfield & Chambers 2004) and palaeochannels provide the greatest chance for survival to occur.

4.2.26. The alternating temperate phases of the Cromerian period would have presented favourable conditions for hominin occupation of the study areas, and evidence for hominin remains from this period has been found in Norfolk and Suffolk. However, marine transgressions and regressions associated with the three major glaciations and the intervening warm interglacial periods are likely to have moved archaeological material from this period from its original site of deposition to other locations. Therefore it is considered that potential archaeology from this period is more likely to exist as derived archaeological material rather than *in situ* deposits.

4.2.27. The opportunity for early human occupation of Britain would next have presented itself at the beginning and end of the Hoxnian interglacial. Hand-axes from this period have been found in Lynford and Little Cressington in Norfolk (Wymer 2005a: 13) and a flint flake with trimmed edge interpreted as part of the Clactonian industry (c.400, 000 BP), was found in Hunstanton in 1951. It is very likely however that the PSA and ECRSA would have been inundated for most of this period.

4.2.28. The Middle Palaeolithic (c.245,000 to 50,000 BP) period is marked by a significant absence of finds in Britain despite evidence that the Wolstonian included a number of warm phases suitable for occupation. Wymer has suggested that Britain may have been uninhabited at this time (1999: 33). Norfolk however contains a rare site at Lynford Quarry in Mundford (approximately 50 miles south of the PSA and ECRSA) where a number of *in situ* flint artefacts have been recovered dating to the later Middle Palaeolithic period c.65,000 to 32,000 BP and attributed to Neanderthal inhabitants (Wymer 2005a: 13).

4.2.29. Human occupation of Britain increased in the Upper Palaeolithic (c.50,000 to 11,000 BP). *In situ* worked flint from Titchwell, directly south of the PSA and ECRSA, has been attributed to the late Upper Palaeolithic tradition of tool making and may date to just after the glacial maximum (c.13,000 to 12,000 BP). Wymer & Robins (1994: 35-36) believe the extent of such human occupation in Britain, so soon after the Devensian glaciation, to have been very limited.

4.2.30. As a post-Devensian *in situ* site within peat deposits Titchwell suggests some potential for similar sites elsewhere on the Norfolk coast. However, the nature and effect of marine transgression on this area of coastline may have varied substantially due to local conditions. There is currently no evidence for the presence of likely peat deposits in the offshore study areas. However, WA recorded blocks of peat washing ashore on the beaches near Hunstanton (WA 2006a).

4.2.31. During the early Mesolithic, Norfolk would have formed the western edge of a great plain extending over what is now the North Sea. No

Mesolithic finds are known within the PSA or ECRSA but human artefacts including flints, spear-heads and mammal remains have been dredged from locations on Dogger Bank in the North Sea (Department of Trade and Industry 2002: 33). A bone tool and flints have been found on shore to the south west of the study areas and Mesolithic microliths and distinctive long blades have been found elsewhere in Norfolk and suggest occupation by small groups of hunter-gatherers during this period (Wymer 2005b: 15).

4.2.32. While the PSA and ECRSA are likely to have been entirely inundated by 6,000 BP there is the potential for them to contain early Mesolithic *in situ* and derived material. After this date any archaeological material in the PSA or ECRSA will be of a marine nature only.

4.3. MARINE ARCHAEOLOGY

Known Wrecks and Geophysical Anomalies within the PSA

4.3.1. A full list of all known wrecks drawn from documentary sources, and geophysical anomalies identified in the geophysical assessment, within the PSA is presented in **Appendix II** and displayed in **Figure 2**.

4.3.2. **Table 4.3** lists the geophysical anomalies (177) identified within the PSA according to the geophysical survey methods by which they were identified. There are also four wrecks (two 'live' and two 'dead') known from UKHO records within the PSA. No evidence of the 'dead' wrecks was found in the geophysical data and they are not included in **Table 4.3** or the discussions below. However, it was possible to link the two 'live' sites to anomalies observed in the geophysical data and described below.

4.3.3. Archaeological Exclusion Zones will be the principle means to preserve *in situ* the sites, features or deposits of potential or known archaeological interest discussed below. The Archaeological Exclusion Zones referred to in the following sections are based on information available at the time of the compilation of the desk-based assessments and review of marine geophysical data, and will be described in detail in the Written Scheme of Investigation.

Dataset	Number of sites located	Sites that require further investigation	Sites with recommended construction exclusion zones
UKHO only	2	2	-
Seismic	7	5	-
Sidescan sonar	146	135	11
Magnetometer	16	16	-
Sidescan sonar and magnetometer	8	5	3
Total	179	163	14

Table 4.2: Means of site location (PSA)

4.3.4. 163 of the 177 identified anomalies have geophysical traces that are not clear enough to give an indication of what they are. These anomalies require further archaeological investigation to confirm or deny their anthropogenic origin. Of these, 16 are magnetic anomalies with a small, or medium sized amplitude for which there is no corresponding sidescan data, probably because the site or material is buried within the seabed. There are a further 140 anomalies recorded by sidescan or by a combination of sidescan and magnetometry which are insufficiently clear to identify their form.

4.3.5. Of the 177 anomalies it is recommended that 14 are subject to construction exclusion zones. A combination of attributes which are suggestive of an anthropogenic origin for each of these anomalies, such as obvious height, structure and high magnetic amplitude, are amongst the reasons why construction exclusion zones have been applied to these sites. These sites are discussed individually below.

4.3.6. Site **7007** (**Plate 1**) may represent a wooden wreck site. It comprises an elongated oval patch of dark reflectors. No height was observed, although the anomaly covers a substantial area of seabed measuring 25.6 metres by 8.3 metres and is distinct from the sandy and rippled seafloor at this location. A confidence rating of medium has been applied to this feature. The site lies within the wind farm's footprint, approximately 800 metres inside the eastern limit of the northern section of the proposed development area.

4.3.7. Site **7013** is an area of four distinct dark reflectors covering an area of seabed measuring 41 metres by 20 metres, and lies 450 metres outside of the wind farm's footprint near the northern edge of the PSA. The anomaly has been given a high confidence rating.

4.3.8. Site **7017** may represent a possible wreck or area of debris. It is comprised of a large structured anomaly disturbing the sea floor. Four smaller dark reflectors lie within a 50 metre radius of it. The site is situated inside the wind farm's footprint, near the centre of the northern section of the PSA. The site was given a high confidence rating.

4.3.9. Site **7043** (Plate 2) may be an area of debris, revealed within an area of sandwaves. It is comprised of two large objects and a dark reflector with an associated magnetic anomaly 35 metres to the south-west. Considered together these objects make up a possible debris field which covers an area of seabed measuring 52 metres by 15.3 metres. The site lies within the wind farm's footprint, approximately 400 metres from the eastern limit of the northern section of the proposed development area and was given a high confidence rating.

4.3.10. Site **7049** (**Plate 3**) has been interpreted as a potential wreck. It is a site formed by angular dark reflectors and covers an area on the seabed measuring 21 metres by 7.5 metres and lies less than 100 metres outside of the wind farm's footprint on the eastern side of the PSA and was given a high confidence rating.

4.3.11. Site **7050** consists of two dark reflectors forming an elongated wreck-shaped site which covers an area measuring 11.5 metres by 3 metres. The site lies less than 300m inside the wind farm's footprint near the north-western edge of the PSA. A high confidence rating was applied to this site.

4.3.12. Sites **7065** (**Plate 4**) and **7066** have been interpreted as small wrecks. They lie approximately three kilometres apart on the eastern limit of the wind farm's footprint. Both anomalies were given a confidence rating of high.

4.3.13. Site **7074** (**Plate 5**) is a wreck, reported by the UKHO as being an unknown 'live' wreck and measuring 41.9 metres by 15 metres with a height of 2.7 metres. From the sidescan image the site appears to be a steel wreck, and this identification is supported by its association with a magnetic anomaly that occurs within 25 metres of the wreck. As a result the site was given a high confidence rating. The UKHO record describes the extent of the wreck as 62x19 metres. This difference may indicate that the wreck has been partially buried since the collection of the UKHO survey data. The difference in measurements could also be the result of differing survey methodologies and interpretation of data. The site lies near but inside the south-eastern edge of the wind farm footprint and within the limits of palaeochannel **7174**.

4.3.14. Site **7099** has been interpreted as a small wreck. It measures 30.5 metres by 13.8 metres and is upstanding to a height of 0.6 metres. This anomaly was given a high anomaly rating. The site lies near the south-eastern edge of the wind farm footprint and within 300 metres of the identified limits of palaeochannel **7174**.

4.3.15. Site **7116** has been interpreted as a seafloor disturbance. It covers an area measuring 53 metres by 9.5 metres and is thought to be a potential wreck with two associated objects which may be debris. Due to its slightly indistinct nature this site was given a confidence rating of medium. The site lies within the wind farm's footprint, near the centre of the PSA.

4.3.16. Site **7131** comprises isolated debris with some associated seabed disturbance. There is a large magnetometer hit within 130 metres of the site but no direct association has been identified between the two. The site is upstanding to a height of 3.6m and was also observed on bathymetric data. A high confidence rating was applied to this site. It lies on the north-western edge of the wind farm's footprint.

4.3.17. Site **7150** is a bright reflector measuring 16.9 metres by 7.7 metres. It may indicate a buried structure and lies near the south-eastern edge of the wind farm's footprint. A high confidence rating was applied to this site.

4.3.18. Site **7151** is interpreted as being the site of a partially buried wreck. The site is associated with a magnetic anomaly with an amplitude of

104.5nT. This site is recorded by the UKHO as an unknown 'live' wreck. As such, a high confidence rating was applied to this site.

Known Wrecks and Geophysical Anomalies within the ECRSA

4.3.19. All known wrecks identified within the ECRSA are listed in an additional table in **Appendix II** and displayed in **Figure 2**.

4.3.20. **Table 4.3** lists the geophysical anomalies (14) identified within the ECRSA according to the geophysical survey methods by which they were identified. There are also two 'live' wrecks known from UKHO records within the ECRSA. Although no conclusive evidence of either was seen in the geophysical data, two of the geophysical anomalies described below may be associated with these sites.

Dataset	Number of sites located	Sites that require further investigation	Sites with recommended construction exclusion zones
UKHO only	2	2	-
Seismic	-	-	-
Sidescan sonar	9	6	3
Magnetometer	2	2	-
Sidescan sonar and magnetometer	3	1	2
Total	**16**	**11**	**5**

Table 4.3: Means of site location (ECRSA)

4.3.21. Nine of the 14 identified anomalies have geophysical traces that are not clear enough to give an indication of what they are. These anomalies require further archaeological investigation to confirm or deny their anthropogenic origin. Of these there are two magnetic anomalies with a small, or medium sized amplitude for which there is no corresponding sidescan data, probably because the site or material is buried within the seabed. A further seven anomalies are recorded by sidescan, one of which is also recorded in the magnetometer data. These anomalies are also insufficiently clear to identify.

4.3.22. Of the 14 anomalies it is recommended that five are subject to construction exclusion zones. A combination of attributes which are suggestive of an anthropogenic origin for each of these anomalies, such as obvious height, structure and high magnetic amplitude, are amongst the reasons why construction exclusion zones have been applied to these sites. These sites are discussed individually below.

4.3.23. Site **7185** is an anomalous dark reflector situated in the buffer of the most easterly of the three cable routes which make up the ECRSA. It measures 8.2 metres by 9 metres and has a distinct oblong shape. A medium confidence rating was applied to this site.

4.3.24. Site **7187** (**Plate 6**) is interpreted as being a small wreck or portion of a wreck, measuring 15.7 metres by 7 metres with an upstanding height of 0.6 metres. The site is situated on the western limit of the ECRSA, on the edge of the buffer surrounding the most westerly of the three cable paths. A high confidence rating was applied to this anomaly.

4.3.25. Site **7188** is interpreted as being a possible wreck in an area of coarse sediment. It is associated with a magnetic anomaly with an amplitude of 5.1nT. A medium confidence rating was applied to this site. Site **7188** is situated in the buffer around the easternmost of the three cable routes.

4.3.26. Site **7189** may be possible wreck debris with a magnetic amplitude of 18.9nT. This anomaly has been observed on bathymetric data as an oval mound measuring 20 metres by 15 metres with an upstanding height of 1.2 metres. The anomaly is at a position given for an unknown 'live' obstruction by the UKHO. As such, this anomaly was given a high confidence rating.

4.3.27. Site **7194** may be debris associated with a wreck recorded as an unknown 'live' obstruction by the UKHO. It has been observed on the bathymetric data as a low circular mound measuring 8 metres by 8 metres with an upstanding height of 0.4 metres. A medium confidence rating was applied to this site.

Documented Losses

4.3.28. In addition to the four known sites recorded by the UKHO there are records of vessels lost in the area for which the exact position and extent of survival (if any) is not known. These documented losses are listed by the NMR which has assigned them to points known as Named Locations, two of which exist within the PSA. Named Locations represent losses within a broader area and therefore any losses recorded at these two Named Locations do not necessarily lie within the PSA. Given the proximity of the two study areas, losses attributed to Named Locations within the PSA could potentially lie within the ECRSA, or outside of both.

4.3.29. The NMR records 118 documented losses at the two Named Locations in the PSA (**Appendix III**). The earliest recorded loss is that of the English cargo vessel *Ipswich* in 1763 (**NMR1371004**) one of only six vessels documented to be lost before 1800. The latest year of loss is 1945. Only one of the vessels (**NMR1383893**) is detailed as being lost as a result of military action during either of the two World Wars. However, as already stated, five military aircraft are reported as lost in the area during World War II (**NMR1325173**, **NMR1323066**, **NMR1354038**, **NMR1354212** and **NMR1354383**).

4.3.30. The temporal distribution of the losses shown in **Table 4.3** below is not thought to be indicative of an absence of maritime losses during earlier periods, nor is it thought to be a comprehensive catalogue of all losses during the periods shown.

Date of Loss	No. of wrecks	No. of Aircraft
1763 – 1800	6	-
1801 – 1850	32	-
1850 – 1913	55	-
1914 – 1918	4	-
1919 – 1938	2	-
1939 – 1945	13	5
Unknown	1	-
Total	**113**	**5**

Table 4.3: Wrecks and Aircraft classified by date of loss

4.3.31. The number of documented losses are generally limited in that they are dependent on a.) the reporting and recording of a loss, and b.) the survival of the record of that loss. Records of maritime casualties were not systematically kept until the 18th century, and even then the records cannot be considered comprehensive. The distance of the study areas from the shore may also have influenced the number of recorded losses for the area as vessels may easily have foundered without record that far offshore. As the known sites and recorded sites in the study areas may not be representative of the true number of sites that survive there, the potential for as yet unrecorded and unknown archaeological material representing the past maritime use of the study areas is considered here in addition to the recorded losses.

4.3.32. Estimates of the true number of maritime casualties around the UK coast vary substantially and cannot be considered wholly reliable. 'Best guesses' vary between 100,000 and 500,000 losses, which suggests an average of 8 to 40 wrecks for every mile of coastline. While this equation is overly simple it is useful as an illustration of the potential for wreck densities per mile of the UK coast. Based on these numbers the sea off the 27km of coast adjacent to the PSA and ECRSA could potentially contain between 144 and 720 wrecks.

4.3.33. The sandbanks of Race Bank and nearby Docking Shoal are and were navigational and shipping hazards and are surrounded by busy historical shipping routes. Since Roman times water depth over Race Bank has been approximately 2.5m to 9.3m below CD. During storms this depth is likely to be decreased further in wave troughs and as the size of ocean-going vessels has increased, Race Bank and other sandbanks are likely to have been potential hazards to vessels since at least the 18th century, particularly during bad weather.

Maritime Activity and Potential Archaeology

4.3.34. Mesolithic people are known to have favoured waterways and used boats to navigate them. The gradual inundation of the study areas during the Mesolithic means human exploitation of the coastal region is highly likely. While this implies potential for finds of this date within the PSA and ECRSA, the survival of wooden artefacts of this age would be extremely unusual.

4.3.35. During the Neolithic the sea-level would still have been several metres below its current level and the coastline would have been at least 500

metres seaward of today's position. The Neolithic inhabitants of Norfolk and Lincolnshire made use of water transport to exploit the resources of the area, using vessels such as log boats which are well attested from this period (McGrail 2004: 173).

4.3.36. The possible use of this area as a focus for vessels engaged in seafaring across the southern North Sea is speculative, however a sea-faring tradition is known to have existed in the Irish Sea in this time. Neolithic links across the Irish Sea are shown by artefacts such as handaxes produced in Ireland and found in Britain, and *vice versa*. Axes made from porcellanite, a stone only found in Antrim and on Rathlin Island off Northern Ireland have been found in Scotland, England and Wales. Artefacts made from British sourced stones have also been found in Ireland (Breen and Forsythe 2004:32-33).

4.3.37. The ties Bronze Age people had to the coast are well attested in Norfolk from discoveries such as 'Seahenge' to the south west of the study areas. Vessels from the Bronze Age have been discovered to the north in the Humber Estuary, Lincolnshire. The Bronze Age Brigg raft and Ferriby boats are believed to have been restricted to tidal waters, and possibly used as cargo ferries on the Humber (McGrail 2004: 184-188). However the possibility of coastal maritime traffic, engaged in voyages across the southern North Sea, is high.

4.3.38. Sea-level is likely to have reached a similar level to its present position at the end of the Iron Age. From this period on, maritime activity within the study areas is likely to be closely linked to activity within the Wash, as any traffic heading to the Wash from the east must pass through the passage flanked by Docking Shoal and Race Bank, or travel further out to sea to pass north of Race Bank. It has been suggested by Hutcheson (2005: 26) that the high concentration of Iron Age gold torcs found in the north and west of Norfolk implies that people living in this area were able to obtain gold by controlling the trade in the Wash, much of which will have passed through the PSA and ECRSA.

4.3.39. During the Iron Age period human occupation to the south of the study areas is known at Hunstanton and coastal activity in this area would have included small scale industrial processes such as salt extraction and fishing.

4.3.40. During the Roman period maritime activity in the area can be inferred from the construction of shore forts, such as the fort at Brancaster to the south of the study areas which was built in the 3rd century AD. Originally believed to have been built as a military base and depot controlling and safeguarding trade routes and merchant shipping it later became part of the string of coastal defences guarding the *Litus Saxonicum* or 'Saxon Shore' against the 'barbarian' raiders (Gurney 2002: 5).

4.3.41. The seafaring abilities of the people who settled Britain from the continent in the post-Roman period (from 410 AD), including the Angles (who lent their name to the modern region of East Anglia), are clearly

evident from the well known Saxon period boat burials at Sutton Hoo and Snape (Carver 1990: 117). Viking activity is recorded in East Anglia from the 9th century and is likely to have started with periods of overwintering followed by gradual settlement. Although the precise location of Viking landings is not known, evidence of Viking activity, in the form of Trefoil brooches and weights, has been found in rivers accessible from the north coast of Norfolk at Blakeney and Wells-next-the-Sea (Pestall 2005: 36).

4.3.42. Shipping and seaborne trade in medieval Norfolk was dominated by the ports of Great Yarmouth and King's Lynn (known as Bishop's Lynn until the mid 16th century but commonly referred to as Lynn) (Rutledge 2005: 78). Lynn supported an extensive foreign trade in various periods exporting corn, wool, cloth and herring. Vessels travelling from Lynn to the Rhineland, France and Germany are all likely to have passed through the PSA and ECRSA (ibid: 78).

4.3.43. In the 13th century the port of Lynn collected the fourth highest duties of any south or east coast port including London but by the 15th century Bishop's Lynn was in decline (ibid: 78). Some trade and fishing from local ports including Blakeney continued into the post-medieval period.

4.3.44. In the post-medieval period a successful fishing industry survived on the north Norfolk coast south of the study areas at Thornham and Brancaster and parts of the PSA and ECRSA are likely to have been fished during this time. A chart from the 19th century however records areas of Docking Shoal as drying out at low tide (Chart: 'From Cromer to Trusthorpe' 1843) and the Shoal is noted as a hazard in the 1858 Pilot for the region (UKHO: 104). Both of these factors are likely to have limited the use of the area during this period.

4.3.45. In addition to the potential for shipwrecks within the PSA and ECRSA, there is potential for stray finds of items lost or thrown overboard from vessels crossing the area. Such material may indicate past sailing routes and its presence, although likely, is difficult to predict.

4.3.46. In summary, the known and potential archaeology within the PSA and ECRSA can be summarised as:

- 193 known wrecks and geophysical anomalies;
- 118 documented losses, the precise location of which is unknown;
- Unknown and undocumented losses from various periods possibly dating back to the Mesolithic;
- Stray finds of shipborne debris from various periods.

4.4. IMPORTANCE OF THE KNOWN SITES AND ANOMALIES

4.4.1. Of the known wrecks within the study areas four (**7074**, **7151**, **7189**, and **7194**) have additional information associated with them, being 'live' wrecks reported to the UKHO. However, although the UKHO

information details the date on which the obstructions were first reported, there is no indication of the date of loss and therefore the identity of the vessel concerned. The archaeological importance of these sites can thus not be assessed with any degree of certainty.

4.4.2. Construction exclusion zones have been recommended around 19 sites with clear archaeological potential.

4.4.3. The remaining 174 anomalies have geophysical traces that are not clear enough to give an indication of what they are. These anomalies require further archaeological investigation (see **Section 5.8** below) to confirm or deny their anthropogenic origin and therefore their importance is currently unquantifiable.

4.5. IMPORTANCE OF ANY UNKNOWN SITES

4.5.1. Any further wreck sites that come to light during the course of development will have to be assessed for importance on a site by site basis. A level of importance from 'negligible' to 'international importance' is possible for any site.

4.5.2. Although no submerged prehistoric archaeological remains are currently known within the study areas, were any to be discovered during the course of the development they are likely to be of national or international importance. This assessment is based on the relative paucity of such sites within the British and European archaeological record.

4.5.3. The importance of any isolated or chance finds of submerged prehistoric material is more problematic. Such finds are likely to have a high level of importance, particularly if found in primary context. However, where such material is derived or in secondary context (i.e. not found in its original depositional context), the area of seabed from which it comes may not necessarily be important.

5. IMPACT ASSESSMENT

5.1. DEVELOPMENT OVERVIEW

5.1.1. The following information has been taken from the 2007 AMEC report *Race Bank – Rochdale Envelope*.

5.1.2. A range of turbine sizes are under consideration for the Race Bank OWF. These arrays comprise either 3MW or 6MW wind turbines. The actual number of turbines required to meet the installed capacity of 500 MW will vary according to the size of the turbine finally selected. Based on 3 MW and 6 MW turbines, the number of installed machines would be 166 to 83 respectively.

5.1.3. The number of turbines that can be sited within the proposed site boundary, not taking into account constraints posed by potentially

difficult ground conditions, is greater than the number actually required to meet the target installed capacity of 500 MW. To ensure that the maximum number of potential turbine positions were examined, every potential site of turbine installation was assessed for impact on the historic environment. The maximum range of turbine locations based on an envelope of 3 MW to 6 MW can be seen in **Table 5.1**.

Turbine rating	Maximum number of turbines
3MW	206
6MW	88

Table 5.1: Maximum number of turbine

Foundation option 1: Monopile

5.1.4. The monopile is the most common wind turbine foundation option used in the UK and consists of a single steel pipe driven into the seabed. The monopile diameter and depth of penetration into the ground (embedded length) will depend on the size of the wind turbine finally selected. The minimum and maximum dimensions are represented by the 3 MW and 6 MW foundations. Foundations constructed to support a 3 MW turbine would have a maximum diameter of 4.5 m and embedded length of up to 37 m while those required for a 6 MW turbine would have a maximum diameter of 6 m and embedded length of up to 42 m.

5.1.5. Installation of the monopiles is achieved by either driving them directly into the seabed, where minimum preparation of the seabed is required, or by drilling a hole in the seabed which is larger than the diameter of the pile, into which the pile is inserted and grouted in place. A combination of drilling and driving is also a possibility if a pile hits refusal prior to its desired penetration depth being achieved. Where drilling is required spoil must be disposed of.

5.1.6. Installation of the monopile foundation will require appropriate transport and handling vessels. The installation vessel ('Jack-up') would most likely have six to eight legs which would be lowered onto the seabed, once in position, and the vessel raised out of the water to create a stable working platform. These 'jack-up' legs will make an impact on the sea floor, as will any anchors from associated vessels.

5.1.7. Survey results predict the possibility of scour around monopiles in this area. The scour is predicted to have a maximum depth of 1.3 times the pile diameter and a maximum diameter of four times that of the pile.

5.1.8. Upon decommissioning it may be necessary to remove the piles. In most instances this involves a degree of excavation around the pile to allow pile removal to a specified depth below the seabed.

Foundation option 2: Gravity Base

5.1.9. The gravity base foundation relies on spread weight to stabilise the turbine and consists of a cellular steel or concrete structure loaded with a ballast of rock. Depending on the rating of turbine the diameter of the base will vary between 21m and 29m. Of the considered foundations the gravity base will cover the largest area of the seabed. The gravity

base is by far the heaviest of the foundation options and will exert a large amount of pressure on the seabed, although the exact ground pressure is unknown.

5.1.10. The bases may be floated out to site and installed using a barge. The multiple anchors from these vessels will have an impact on the seabed.

5.1.11. An even, level seabed is required for installation of the gravity base. This is likely to require seabed preparation of the foundation area to a depth of 2m - 3m and to a diameter slightly larger than the base itself.

5.1.12. Scour may occur around the base and therefore scour protection may be necessary. The preparation of the seabed will generate spoil that will need to be disposed of.

Foundation option 3: Jacket Structure

5.1.13. A jacket foundation would be comprised of steel members in a pyramid shape placed on the seabed. It may consist of three or four sides and each corner of the jacket foundation would be secured to the seabed using driven piles or suction caissons. The vertical legs of the jacket may be up to 15m apart and secured in position with piles of up to 30 m in length and 3.75m in diameter.

5.1.14. It is likely that a crane barge would be used to install the jacket structure foundation. The anchors deployed by such a vessel will have an impact upon the seabed. Localised excavation no greater than that specified for the gravity base foundation may be necessary to prepare the seabed for the installation operation. This will generate spoil that will need to be disposed of at a suitable location.

5.1.15. Scour may occur around the base. This however will be less than that of the monopile due to the reduced size of the piles.

5.1.16. Upon decommissioning it may be necessary to remove the piles. As with the monopile foundation, a degree of excavation may be required in order to achieve removal of the pile below the level of the surrounding seabed.

Submarine cables

5.1.17. Burial of both export and inter-array submarine cables associated with the wind farm is necessary to protect them from damage from anchors, fishing gear, etc. Burial will also protect the environment and safeguard fishing and other vessels. Clearance of seabed debris may be necessary before cable laying. This consists of detecting and removing obstructions by towing a snagging device. Where required grappling or grabbing may also be employed to remove obstructions.

5.1.18. Three techniques are generally employed to bury the cables; ploughing, jetting and cutting. It is necessary to cut an incision in the seabed within which the cables are buried. This is immediately back-filled to minimise

disturbance to the seabed. If required, scour protection methods will be investigated after construction.

5.1.19. The exact depth to which the inter-turbine cables at Race Bank will be buried has not yet been determined. However, a review of burial depths adopted during construction of other recent wind farms, suggests that burial depths of up to 3m are possible.

5.2. IDENTIFICATION OF EFFECTS

5.2.1. The Rochdale Envelope worst case scenario approach has been applied to the identification of effects. A review of the two turbine and associated inter-turbine cable options in relation to the 19 sites subject to construction exclusion zones was undertaken.

5.2.2. The worst case scenario for the known archaeology is likely to be the 3MW turbine option (**Figure 8**). In the PSA, the inter-turbine cable array falls within the construction exclusion zones surrounding four of the sites (**7043**, **7050**, **7074** and **7099**), one of which is also within 100m of a proposed turbine location. In this configuration the inter-turbine cable array would also directly impact a further two of the sites, as it crosses the location of sites **7017** and **7151**. An alternative inter-turbine cable layout would not necessarily mitigate the risk posed to site **7017** as it it situated within 30 m of a proposed wind turbine location and within the construction zone based on the 3 MW turbine layout.

5.2.3. The potential impact on archaeology is considered worst for the 3MW layout for gravity foundations as this layout and foundation option has the largest number of turbines, covers the largest area of the seabed and therefore has the greatest potential impact upon archaeology.

5.2.4. In addition to the potential impact on known sites and anomalies, the 3MW turbine option would impact the palaeochannels detected through seismic survey. Some of these channels contain fine-grained stratified sediments, which may have the potential to contain post-Devensian archaeological material.

5.2.5. Under this configuration, turbines would be installed within the identifiable limits of channels **7172**, **7174**, **7175**, **7176** and **7178**, and channel **7172** would also be impacted by the construction of one of the two substations. The shallowest margins of channels **7174**, **7175** and **7178** have been observed to range in depth between 0.5m and 3.5m and their channels may therefore also be impacted upon during the laying of the inter-turbine cables.

5.2.6. The impact of the 6MW turbine option is lower (**Figure 9**). The inter-turbine cable would directly impact two sites, crossing the location of site **7151** and coming within two metres of site **7017**. Inter-turbine cables come within 15m of site **7007** and site **7150** lies within 50m of a cable and the proposed location of a turbine, within the construction exclusion zone.

5.2.7. The 6MW turbine option is also likely to have less impact on the palaeochannels in the PSA. Proposed turbine locations in this configuration would impact on channels **7172** and **7174**. The shallower limits of channels **7174** and **7175** are also close enough to the seabed to be affected by the laying of inter-turbine cables.

5.2.8. None of the sites in the ECRSA are located within 100m of the export cable footprints. The routes of the export cables are the same for both the 3MW and 6MW turbine options.

5.2.9. The archaeological potential of the area, in the form of wrecks, aircraft and prehistoric landsurfaces, is considered to be high. The existence of palaeochannels in the PSA further adds to the potential archaeological sensitivity of the area, suggesting the presence of a submerged palaeolandscape within which archaeological material may be preserved.

5.3. CONSTRUCTION EFFECTS

5.3.1. The construction effects can be summarised as follows:

- Potential damage to prehistoric land surfaces by turbine foundations;
- Potential damage and destruction of shipwrecks and aircraft by turbine foundations;
- Potential damage to prehistoric land surfaces from pre-construction dredging;
- Potential damage and destruction of shipwrecks and aircraft from pre-construction dredging;
- Potential damage to prehistoric land surfaces from ploughing/jetting and cutting;
- Potential damage and destruction of shipwrecks and aircraft from ploughing/jetting and cutting;
- Potential damage to shipwrecks, aircraft and prehistoric land surfaces by jack up vessel legs and other vessel moorings.

5.4. OPERATIONAL EFFECTS

5.4.1. The operational effects can be summarised as follows:

- Potential damage to prehistoric land surfaces from scouring;
- Potential destruction of shipwrecks and aircraft from scouring.

5.5. DECOMMISSIONING EFFECTS

5.5.1. The decommissioning effects can be summarised as follows:

- Potential damage to prehistoric land surfaces from excavation of piles;
- Potential destruction of shipwrecks and aircraft from excavation of piles.

- Potential damage to shipwrecks, aircraft and prehistoric land surfaces by jack up vessel legs and other vessel moorings.

5.6. EVALUATION OF EFFECTS

5.6.1. When evaluating the effects the Rochdale Envelope worst case scenario approach has been applied. This presents the worst case scenario identified effects, in a situation where mitigation measures are not in place.

5.6.2. The effects on unknown wrecks, aircraft and prehistoric land surfaces during construction: from the ground preparation, installation of turbine foundations, ploughing and from jack up legs will be localised. Similarly the effects during operation; from scouring around piles, and during decommissioning: from the excavation of piles will be localised. Where direct disturbance of archaeological deposits cannot be avoided during the construction of the wind farm impacts will be permanent and negative. The residual impact of changes in scour and sedimentation associated with the construction, operation and decommissioning of the wind farm may also be negative where wrecks, aircraft and/or prehistoric deposits are exposed to erosion. In some circumstances, the residual impact may be positive if increased sedimentation leads to burial of an archaeological site or feature, resulting in increased protection.

5.6.3. Known wrecks will be subject to exclusion zones and will not be directly impacted, therefore effects will be minimised on these sites.

5.6.4. The significance of the effects is described using the significance levels: ‘Not Significant’, ‘Minor’, ‘Moderate’ and ‘Major’. To assess the significance of effects upon the archaeology within the PSA and ECRSA the importance of the site and the scale of the impact need to be known.

5.6.5. In the PSA, the only two wreck sites for which any supplementary information is available are **7074** and **7151**. Both sites were observed on the geophysical survey results and are listed as ‘live’ wrecks by the UKHO. Apart from the date on which each wreck was first reported there is little information on these two wrecks, therefore their archaeological importance cannot be stated with any degree of certainty. The remaining 177 PSA sites are also of unknown importance and therefore a significance of effect cannot be applied.

5.6.6. In the ECRSA, the only two sites for which any supplementary information is available are **7189** and **7194**. Both sites were observed on the geophysical survey results and are listed as ‘live’ wrecks by the UKHO. Apart from the date on which each wreck was first reported there is little information on these two wrecks, therefore their archaeological importance cannot be stated with any degree of certainty. The remaining 12 ECRSA sites are also of unknown importance and therefore a significance of effect cannot be applied.

5.7. CUMULATIVE IMPACTS

5.7.1. The Race Bank OWF is part of the Great Wash region of offshore energy developments which includes six other developments (http://www.britishwindenergy.co.uk/ukwed/offshore.asp). Of these, the developments in close proximity to Race Bank OWF which are likely to occur within the timeframe of the Race Bank project and which are considered for this cumulative impact assessment are:

- Inner Dowsing Offshore Wind Farm (Round 1);
- Lincs Offshore Wind Farm and associated Wash Cable Route Corridor (Round 2);
- Lynn Offshore Wind Farm (Round 1);
- Docking Shoal Offshore Wind Farm and associated Wash Cable Route Corridor (Round 2);
- Sheringham Shoal Offshore Wind Farm (Round 2);
- Humber Gateway Offshore Wind Farm (Round 2).

5.7.2. Offshore renewable energy projects which are proposed, but which may not occur within the lifetime of the Race Bank project, or not at all are:

- Dudgeon East Offshore Wind Farm (Round 2);
- Triton Knoll Offshore Wind Farm (Round 2);
- Westermost Rough Offshore Wind Farm (Round 2).

5.7.3. Another seabed development in the vicinity of the Race Bank OWF is the Area 481 Aggregate Extraction Area.

5.7.4. All of the above developments have been subject to archaeological assessments that have identified all known wrecks, and assessed geophysical data as part of an attempt to identify unknown losses. These assessments have also assessed the potential for the presence of submerged prehistoric archaeology.

5.7.5. With respect to wrecks, in all cases the means of mitigating against damage to the known sites will be through the implementation of exclusion zones. This approach will have the effect of minimising the direct impacts from construction and dredging. It will also be used to protect geophysical anomalies that may represent currently unknown shipwrecks, aircraft or other features of anthropogenic origin. As a result the cumulative direct impact on known sites from turbine, installation, cable laying, anchoring and dredging, resulting from the above schemes, is negligible.

5.7.6. The effect on known sites of indirect impacts from, for example, scour and changes to sedimentation patterns are more difficult to quantify. Localised, scheme specific studies have, for the most part, indicated

little change in sedimentation from wind farm construction, but the impact resulting from multiple schemes remains relatively under-researched. It should be noted that changes to sedimentation may serve to both cover up, and therefore protect, or uncover and destabilise sites. However, the possibility of impact remains.

5.7.7. This has been addressed by the generally adopted principle that further geophysical studies, undertaken during the working life of the schemes, will be archaeologically assessed. Thus any, currently known or unknown sites that may be exposed if scour or sedimentation changes occur, should be identified. Should this occur then the general archaeological principals of evaluation to a level suitable to identify importance and the significance of the effect, followed by remedial mitigation, can be applied.

5.7.8. With respect to submerged prehistoric archaeology, none of the archaeological assessments have identified any known sites or former land surfaces within the development areas. For aggregate extraction areas the need to keep recovered gravel free from contaminants, including peat, helps to protect submerged prehistoric deposits. However, in the case of wind farms turbine installation may pose a threat to as yet unconfirmed prehistoric archaeology, although other activities such as cable laying and anchoring are unlikely to penetrate the seabed to a depth sufficient to cause concern.

5.7.9. In view of the potential for cumulative impact from turbine installation it is appropriate to look at the worst case scenario for the scale of this effect. In order to do this the total surface area of the turbine foundations has been compared with the overall footprint of the schemes listed above as follows:

Name	Scheme area (m^2)	No. of turbines	Turbine foundation area (m^2)	Total turbine area (m^2)	% of OWF area subject to turbine impact
Lynn OWF	9,996,905	27	19.6	530	0.005
Inner Dowsing OWF	9,994,894	27	19.6	530	0.005
Docking Shoal OWF	74,969,130	166	380.1	63102	0.08
Humber OWF	35,043,023	43	1256.6	54,034	0.15
Lincs OWF	34,933,773	83	380.1	31551	0.09
Sheringham OWF	34,971,171	108	706.9	76341	0.22

Table 5.2 Scheme footprints

5.7.10. This assessment shows that the percentage of the seabed that is subject to permanent negative impact from turbine foundations is very small. Therefore the cumulative impact upon any submerged prehistoric deposits that may survive off the Lincolnshire and Norfolk coastline, from the construction of offshore wind farms is likely to be small. Notwithstanding this, there is still some potential for impact, which is addressed by means of mitigation that offsets the negative impact through compensatory works i.e. archaeological assessments of vibrocore and seismic data that serves to increase the archaeological knowledge base of this largely under-researched heritage asset.

5.8. MITIGATION AND MONITORING

5.8.1. The following measures are designed to mitigate the impact of the development upon known sites, and to establish the presence of unknown sites within the current wind farm area and cable route corridor. Should the scheme change subsequent to the compiling of this report, full archaeological assessment will be necessary for any areas not already covered by this assessment.

5.8.2. Archaeological best practice favours *in situ* preservation of archaeological material and avoidance of archaeological remains. Where this is not possible the effects of the scheme can be offset with compensatory measures.

5.8.3. A Written Scheme of Investigation (WSI) is recommended to set out procedures for dealing with any features that appear to be of archaeological importance which are discovered in the course of construction. The WSI would ensure compliance with the relevant legislation. The WSI should be finalised once the final scheme details are available.

5.8.4. As laid out in the COWRIE Guidance Note (WA 2006b: 43) the objectives of a WSI are to:

- Set out the respective responsibilities of the developer, main contractors, and archaeological contractors/consultants, to include contact details and formal lines of communication between the parties and with archaeological curators;
- Ensure that any further geophysical and geotechnical investigations associated with the project are subject to archaeological input, review, recording and sampling;
- Provide for archaeological involvement in any diver and/or ROV obstruction surveys conducted for the scheme;
- Establish the exact position and extent of archaeological exclusion zones, and methodologies for their monitoring, modification and/or removal;
- Propose measures for mitigating effects upon any archaeological material encountered during the operation and decommissioning of the scheme;
- Establish the reporting, publication, conservation and archiving requirements for the archaeological works undertaken in the course of the scheme.

5.8.5. In view of their archaeological potential it is proposed that construction exclusion zones are placed around the 14 sites in the PSA described in **4.3.5** – **4.3.17** above.

Sites in the PSA proposed to have construction exclusion zones	**7007**
	7013
	7017

	7043
	7049
	7050
	7065
	7066
	7074
	7099
	7116
	7131
	7150
	7151

Table 5.3: Sites in the PSA proposed to have construction exclusion zones

5.8.6. A construction exclusion zone is defined as an area where any construction that would impact upon or disturb the seabed is prohibited. Two of the sites with recommended construction exclusion zones lie outside the footprint of the wind farm but within the 500m buffer zone which forms the PSA. For precautionary reasons **7013** and **7049**, to the north of the wind farm footprint, are recommended to have construction exclusion zones although they are unlikely to be impacted upon.

5.8.7. In the ECRSA, the five sites recommended to have construction exclusion zones do not lie in the path of the export cable itself, but are within its 500m buffer. For precautionary reasons **7185, 7187, 7188, 7189** and **7194**, are recommended to have construction exclusion zones although they are unlikely to be impacted upon.

Sites in the ECRSA proposed to have construction exclusion zones	**7185**
	7187
	7188
	7189
	7194

Table 5.4: Sites in the ECRSA proposed to have construction exclusion zones

5.8.8. It is proposed that construction exclusion zones are marked on the scheme masterplans, including contract documents.

5.8.9. While the depth and extent of the archaeology in the area of the proposed wind farm is unknown, the larger the overall area of seabed covered by turbine foundations i.e. the larger the number of turbines and the greater the size of the foundations, the greater the potential impact upon the archaeology. Some impact upon submerged landscapes in the area is inevitable. However, the risk to archaeology increases proportionately from the 6MW to the 3MW layout. The jacket structure can be said to be slightly more favourable than that of the gravity base foundation with the monopile having the least impact upon the seabed.

5.8.10. Due to the number of options, a review of each of the 172 anomalies requiring further investigation in relation to the options was not undertaken. However, within each option there are anomalies that lie close to the area of impact. Small provisional construction exclusion zones are proposed for each anomaly. Once scheme details have been

confirmed, any anomalies along the line of construction may be investigated and construction exclusion zones or scheme plans altered as necessary.

5.8.11. Due to the specification of the geophysical survey not all sites may have been detected and therefore some wrecks of archaeological importance may exist undetected within the PSA and ECRSA. If any further sidescan sonar or magnetometer survey is to take place where the line spacing is equal to, or less than, the range setting for the sidescan sonar it is recommended that the data be archaeologically assessed.

5.8.12. To further determine the potential for the presence of buried land surfaces, and associated sites and to offset scheme damage, it is proposed that any further marine geotechnical surveys (vibrocores or boreholes) are subject to assessment by a suitably qualified archaeologist. To offset any damage to palaeochannels **7172**, **7174**, **7175**, **7176** and **7178** caused by piling and cable laying it would be appropriate to conduct an archaeological borehole assessment. Where practicable, provision should be made for the complete recovery of cores containing pre-inundation prehistoric material and/or organic deposits, and for the analysis of a suitable number of core samples. This would be best accomplished within the five stage geotechnical assessment process used by WA.

5.8.13. Notwithstanding these precautions, features of archaeological interest may be encountered in the course of construction. In such instances the following should be complied with:

- The Merchant Shipping Act 1995 in respect of reporting and ownership of the wreck including notification of the Receiver of Wreck;
- The JNAPC Code of Practice for Seabed Developers;
- The Protocol for Finds of Archaeological Interest (BMAPA/EH 2005).

Table 5.5 Environmental Assessment Matrix

Environmental Effect	Description of Features Affected (Receptors)	Type of Effect	Geographical Extent/Policy Importance (or sensitivity)	Magnitude/ duration/ frequency of effect	Probability of Effect Occurring	Significance Level	Mitigation measures and Rationale	Significance Level After Mitigation and Geographical Extent
Construction								
Installation of turbine foundations	Prehistoric land surfaces	P	I	Uncertain until scheme plans are finalised (worst case High)	Uncertain	Major	Use of fewer turbines: 6MW layout with monopile base. Archaeological investigation of any vibrocores and geophysics conducted.	Offset by compensatory works (minor)
Installation of turbine foundations	Known wrecks and aircraft	P	Varies by site	Varies by site (worst case High)	Varies by site	Varies by site	Exclusion zone	Minor
Installation of turbine foundations	Unknown wrecks and aircraft	P	Varies by site	Varies by site (worst case High)	Varies by site	Varies by site	Protocol for reporting finds, followed by avoidance or remedial mitigation (excavation)	Moderate or minor
Dredging in advance of foundations and cable laying	Prehistoric land surfaces	P	I	Uncertain until scheme plans are finalised (worst case High)	Uncertain	Major	Use of fewer turbines: 6MW layout with monopile base. Archaeological investigation of any vibrocores and geophysics conducted.	Offset by compensatory works (minor)
Dredging in advance of foundations and cable laying	Known wrecks and aircraft	P	Varies by site	Varies by site (worst case High)	Varies by site	Varies by site	Exclusion zone	Minor
Dredging in advance of	Unknown wrecks and aircraft	P	Varies by site	Varies by site (worst case	Varies by site	Varies by site	Protocol for reporting finds, followed by	Moderate or minor

Environmental Effect	Description of Features Affected (Receptors)	Type of Effect	Geographical Extent/Policy Importance (or sensitivity)	Magnitude/ duration/ frequency of effect	Probability of Effect Occurring	Significance Level	Mitigation measures and Rationale	Significance Level After Mitigation and Geographical Extent
foundations and cable laying				High)			avoidance or remedial mitigation (excavation)	
Ploughing, jetting and cutting in advance of cable laying	Prehistoric land surfaces	P	I	Uncertain until scheme plans are finalised (worst case High)	Uncertain	Major	Use of fewer turbines: 6MW layout with monopile base. Archaeological investigation of any vibrocores and geophysics conducted.	Offset by compensatory works (minor)
Ploughing, jetting and cutting in advance of cable laying	Known wrecks and aircraft	P	Varies by site	Varies by site (worst case High)	Varies by site	Varies by site	Exclusion zone	Minor
Ploughing, jetting and cutting in advance of cable laying	Unknown wrecks and aircraft	P	Varies by site	Varies by site (worst case High)	Varies by site	Varies by site	Protocol for reporting finds, followed by avoidance or remedial mitigation (excavation)	Moderate or minor
Deployment of jack up spuds and/or vessel anchors	Prehistoric land surfaces	P	I	Uncertain until scheme plans are finalised (worst case High)	Uncertain	Major	Use of fewer turbines: 6MW layout with monopile base. Archaeological investigation of any vibrocores and geophysics conducted.	Offset by compensatory works (minor)
Deployment of jack up spuds and/or vessel anchors	Known wrecks and aircraft	P	Varies by site	Varies by site (worst case High)	Varies by site	Varies by site	Exclusion zone	Minor
Deployment of jack up spuds and/or	Unknown wrecks and aircraft	P	Varies by site	Varies by site (worst case	Varies by site	Varies by site	Protocol for reporting finds, followed by	Moderate or minor

Environmental Effect	Description of Features Affected (Receptors)	Type of Effect	Geographical Extent/Policy Importance (or sensitivity)	Magnitude/ duration/ frequency of effect	Probability of Effect Occurring	Significance Level	Mitigation measures and Rationale	Significance Level After Mitigation and Geographical Extent
vessel anchors				High)			avoidance or remedial mitigation (excavation)	
Operation								
Scouring around turbine foundations	Prehistoric land surfaces	P	I	Uncertain until scheme plans are finalised (worst case High)	Uncertain	Major	Use of fewer turbines: 6MW layout with monopile base. Archaeological investigation of any vibrocores and geophysics conducted.	Offset by compensatory works (minor)
Scouring around turbine foundations	Known wrecks and aircraft	P	Varies by site	Varies by site (worst case High)	Varies by site	Varies by site	Exclusion zone	Minor
Scouring around turbine foundations	Unknown wrecks and aircraft	P	Varies by site	Varies by site (worst case High)	Varies by site	Varies by site	Protocol for reporting finds, followed by avoidance or remedial mitigation (excavation)	Moderate or minor
Decommissioning								
Excavation of turbine foundations	Prehistoric land surfaces	P	I	Uncertain until scheme plans are finalised (worst case High)	Uncertain	Major	Use of fewer turbines: 6MW layout with monopile base. Archaeological investigation of any vibrocores and geophysics conducted.	Offset by compensatory works (minor)
Excavation of turbine foundations	Known wrecks and aircraft	P	Varies by site	Varies by site (worst case High)	Varies by site	Varies by site	Exclusion zone	Minor

Environmental Effect	Description of Features Affected (Receptors)	Type of Effect	Geographical Extent/Policy Importance (or sensitivity)	Magnitude/ duration/ frequency of effect	Probability of Effect Occurring	Significance Level	Mitigation measures and Rationale	Significance Level After Mitigation and Geographical Extent
Excavation of turbine foundations	Unknown wrecks and aircraft	P	Varies by site	Varies by site (worst case High)	Varies by site	Varies by site	Protocol for reporting finds, followed by avoidance or remedial mitigation (excavation)	Moderate or minor
Deployment of vessel anchors	Prehistoric land surfaces	P	I	Uncertain (worst case High)	Uncertain	Major	Archaeological investigation of any vibrocores and geophysics conducted.	Offset by compensatory works (minor)
Deployment of vessel anchors	Known wrecks and aircraft	P	I	Varies by site (worst case High)	Varies by site	Varies by site	Exclusion zone	Minor
Deployment of vessel anchors	Unknown wrecks and aircraft	P	I	Varies by site (worst case High)	Varies by site	Varies by site	Exclusion zone	Moderate or minor

Key: P – Permanent
I - Important

6. ABBREVIATIONS AND GLOSSARY

BGS	British Geological Survey
CD	Chart Datum
ECRSA	Extended Cable Route Study Area
DCMS	Department of Culture Media and Sport
DoE	Department of the Environment
DTI	Department of Trade and Industry
EH	English Heritage
IFA	Institute of Field Archaeologists
MSA	Merchant Shipping Act
NMR	National monuments Record
NHER	Norfolk Historic environment record
nT	NanoTesla
OWF	Offshore Wind Farm
PPG	Planning Policy Guidance
PMRA	Protection of Military Remains Act
PWA	Protection of Wrecks Act
RBSA	Race Bank Study Area
RCHME	Royal Commission on the Historical Monuments of England
UKHO	United Kingdom Hydrographic Office
WA	Wessex Archaeology
WSI	Written Scheme of Investigation

Anomaly: An object or feature on the seabed, identified from geophysical data which differs from the surrounding environment and which may be anthropogenic, or humanly derived

Archaeology: The study of the development of the human species and its environment through their material remains.

Artefact: Any object or part of an object which has been made, used or modified in some way by human beings. Common examples include tools, utensils, art, food remains, and other products of human activity.

Bronze Age: The period in history after the Stone Age characterized by the development of bronze and its use, especially for weapons and tools. In the UK the Bronze Age dates to 2400-700 BC and is divided into three phases – Early (2400-1500 BC), Middle (1500-1100 BC) and Late (1100-700 BC).

Curator: A person or organisation responsible for the conservation and management of archaeological evidence by virtue of official or statutory duty, including for example County, District or Council archaeological officers, and the national bodies, English Heritage, Historic Scotland, Cadw (Wales), and Department of Environment, Northern Ireland.

Derelict: A vessel abandoned in open water by its crew without any hope or intention of returning

Flotsam: The part of the wreckage of a ship and its cargo found floating on the water

Hominin: During the Lower and Middle Palaeolithic, the archaeological record relates to a number of different species which are the precursors to, or direct ancestors of modern humans and Neanderthal species.

Iron Age: A cultural stage characterized by the first use of iron as the main metal. In the UK the Iron Age dates to the period between c. 700BC and 43AD.

Isostatic: The equilibrium in the earth's crust such that the forces tending to elevate landmasses balance the forces tending to depress landmasses

Jetsam: Goods cast overboard deliberately, to lighten a vessel or improve its stability in an emergency, which sink where jettisoned or are washed ashore

Lagan: Goods (or wreckage) on the sea bed that is attached to a buoy so that it can be recovered

Lithic: Composed of stone. ‘Lithic implement’ are tools made by humans from flaked or ground stone

Medieval: The period between the Dark Ages and the Renaissance (11th – 14th centuries AD).

Mesolithic: A transitional period of the Stone Age intermediate between the Palaeolithic and the Neolithic periods, characterized by adaptation to a hunting, collecting, and fishing economy based on the use of forest, lakeside, and seashore environments.

Mitigation: The process of avoiding, reducing or remedying adverse effects on the environment.

Palaeolithic: The earliest of three subdivisions of the Stone Age, preceding the Mesolithic and Neolithic. It lasted several million years, from the first appearance of stone tools to the Mesolithic microlith-using hunter-gatherers of the most recent postglacial period (± 8,500 years BC), and is normally divided into Lower, Middle and Upper phases.

Post-medieval: The term used to describe the period covering the last 500 years, or since the end of the 14th century. In other areas it may be known as Historical Archaeology.

Prehistoric: The period prior to written records for any given area which is revealed by archaeological methods and interpreted with the help of anthropological and historical analogies.

Roman: Refers to the period between AD 43 and AD 410 when parts of the UK were under Roman control.

Site: A location where human activities once took place and left some form of material evidence.

Wreck: A vessel in a state of ruin from disaster at sea, on rocks, etc.

7. REFERENCES

7.1. PUBLISHED SOURCES

AMEC, 2006, Race Bank – Rochdale Envelope. Unpublished report

Breen, C. and Forsythe, W. 2004, *Boats and Shipwrecks of Ireland*, Tempus Publishing, Gloucestershire.

Brew, D.S., 1997, 'The Quaternary history of the subtidal central Wash, eastern England.' *Journal of Quaternary Science* 12 (2) 131-141

Brew, D.S., Holt, T., Pye, K., and Newsham, R., 2000, 'Holocene sedimentary evolution and palaeocoastlines of the Fenland embayment, eastern England' in Shennan, I and Andrews, J. E. (eds.)

Holocene Land–Ocean Interaction and Environmental Change around the North Sea, Geological Society Special Publication no.166

British Geographical Survey (BGS), 1991, *East Anglia Sheet 52° N-00°* 1:250 000 Series Quaternary Geology. BGS, NERC

Carver, M.O.H., 1990, 'Pre-viking traffic in the North Sea' in McGrail, S. *Maritime Celts, Frisians and Saxons* CBA Research Report No 71.

Coles, B.J., 1998, Doggerland: a Speculative Survey, *Proceedings of the Prehistoric Society* 64, pp. 45-81

Department of Culture Media and Sport (DCMS), 2004, Protecting the marine historic environment: making the system work better, DCMS

Department of the Environment (DoE), 1990, *Planning Policy Guidance: Archaeology and Planning* (PPG 16), HMSO

Department of Trade and Industry (DTI), 2002, The scope of Strategic Environmental Assessment of North Sea areas SEA3 and SEA2 in regard to prehistoric archaeological remains. DTI

EEC, 1985, EIA Directive 85/337/EEC, Official Journal No. L175, 05/07/1985: pp.40-48, Council of the European Community

English Heritage, 1996, Englands Coastal Heritage: *A Statement on the Management of Coastal Archaeology*, English Heritage

English Heritage, 1996, Englands Coastal Heritage: *A Statement on the Management of Coastal Archaeology*, English Heritage

English Heritage, 1998, Identifying and Protecting Palaeolithic Remains; archaeological guidance for planning authorities and developers, English Heritage

English Heritage, 2002a, Military Aircraft Crash Sites: archaeological guidance on their significance and future management, English Heritage

English Heritage, 2002b, Taking to the Water: English Heritage's Initial Policy for the Management of Maritime Archaeology in England, English Heritage

English Heritage, 2003, Conservation Bulletin: The Archaeology of Conflict, English Heritage

European Union, Council Directive 97/11/EC of 3rd March amending Directive 85/337/EEC, Official Journal No. L073, 14/03/1997: 005, Council of the European Union.

European Union, Council Directive 2003/35/EC of the European Parliament and of the Council providing for public participation in respect of the

drawing up of certain plans and programmes relating to the environment and amending with regard to public participation and access to justice Council Directives 85/337/EEC and 96/61/EC, Official Journal No. L 156, Council of the European Union

Fryer, V., Murphy, P. and Wiltshire, P., 2005, 'Coastal Change and Human Response', in Ashwin, T. and Davison, A., 2005, *An Historical Atlas of Norfolk*, Phillimore and Co. Ltd.

Gurney, D., 2002, Outposts of the Roman Empire. A Guide to Norfolk's Roman Forts at Burgh Castle, Caister-on-Sea and Brancaster, Norfolk Archaeological Trust

Hosfield, R.T. and Chambers, J.C., 2004, *The Archaeological Potential of Secondary Contexts*. English Heritage Project Report (Project No. 3361), English Heritage Archive Report, London.

Hutcheson, N., 2005, 'The End of Prehistory: Gold, Silver, Boudica and the Romans' in Ashwin, T. and Davison, A., 2005, *An Historical Atlas of Norfolk*, Phillimore and Co. Ltd.

Institute of Field Archaeologists, 2001, Standard and Guidance for Archaeological Desk-based Assessments, IFA

Jelgersma, S., 1979, 'Sea level changes in the North Sea basin' in Oele, E., Schuttenhelm, R.T.E and Wiggers, A.J. (eds), *The Quaternary History of the North Sea*, Uppsala, p.233-48.

Joint Nautical Archaeology Policy Committee, 2006, *Code of Practice for Seabed Development,* JNAPC

May, J., 1976, *Prehistoric Lincolnshire*, History of Lincolnshire, Volume 1

McGrail, S., 2004, Boats of the World: From the Stone Age to Medieval Times, Oxford University Press

Ministry of Defence (MoD), November 2001, Public Consultation on Military Maritime Graves and the Protection of Military Remains Act 1986, MoD

Murphy, P., 2005, 'Coastal Change and Human Response', in Ashwin, T. and Davison, A., 2005, *An Historical Atlas of Norfolk*, Phillimore and Co. Ltd.

Parfitt, S.,Barendregt, R.W., Breda, M., Candy, I.,Collins, M.J., Coope, G.R., Durbidge, P., Field, M.H., Lee, J.R., Lister, A.M., Mutch, R., Penkman, K.E.H., Preece, R.C., Rose, J., Stringer, C.B., Symmons, R., Whittaker, J.E., Wymer, J.J. and Stuart, A.J., 2005, The earliest humans in Northern Europe: artefacts from the Cromer Forest-bed Formation at Pakefield, Suffolk, UK.' *Nature*, 438, 1008 – 1012

Pestall, T., 2005, 'Viking Settlement in Norfolk', *An Historical Atlas of Norfolk*, Phillimore and Co. Ltd.

Preece, R.C. and Parfitt, S.A., 2000, 'The Cromer Forest-bed Formation: new thoughts on an old problem' in Lewis, S.G., Whiteman, C.A. and Preece, R.C. (eds.) *The Quaternary of Norfolk and Suffolk: Field Guide*, Quaternary Reasearch Association, London.

Rutledge, E., 2005, 'Medieval and Later Ports, Trade and Fishing, up to 1600', in *An Historical Atlas of Lincolnshire*, Phillimore and Co. Ltd.

Schreve, D.C., 2001, 'Differentiation of the British late Middle Pleistocene interglacials: the evidence from mammalian biostratigraphy', *Quaternary Science Reviews*, 20, pp.1693-1705

Shennan, I. Lambeck, K., Horton, B., Innes, J., Lloyd, J., McArthur, J. and Rutherford, M. 2000, 'Holocene isostasy and relative sea level changes on the east coast of England' in Shennan, I and Andrews, J. E. (eds.) *Holocene Land–Ocean Interaction and Environmental Change around the North Sea*, Geological Society Special Publication no.166

Stuart, A.J. and Lister, A.M., 2001, 'The mammalian faunas of Pakefield/Kessingland and Corton, Suffolk, UK: evidence for a new temperate episode in the British early Middle Pleistocene', *Quaternary Science Reviews*, 20, pp. 1677-1692

United Kingdom Hydrographic Office, 1858, *NP54. North Sea Pilot Part III*

Wenban-Smith, F., 2002, Palaeolithic and Mesolithic Archaeology on the Sea-bed, Marine Aggregate Dredging and the Historic Environment. Wessex Archaeology, Salisbury

Woodcock, N.J., 2000, 'The Quarternary', in N. R. Woodcock and R. Strachan (ed.), *The Geological History of Britain and Ireland*, Blackwell Science.

Wymer, J.J., Robins, P.A., 1994, 'A long blade flint industry beneath boreal peat at Tichwell, Norfolk', *Norfolk Archaeology*, Volume XLII Part 1, pp. 13-37

Wymer, J., 1999, *The Lower Palaeolithic Occupatrion of Britain*, Volume 1.Wessex Archaeology and English Heritage, Salisbury

Wymer, J., 2005a, 'Coastal Change and Human Response', in Ashwin, T. and Davison, A., 2005, *An Historical Atlas of Norfolk*, Phillimore and Co. Ltd.

Wymer, J., 2005b, 'Occupation Beofre the Last Glaciation: The Palaeolithic Period', in Ashwin, T. and Davison, A., 2005, *An Historical Atlas of Norfolk*, Phillimore and Co. Ltd.

7.2. WESSEX ARCHAEOLOGY REPORTS

Wessex Archaeology, 2002a, Lynn and Inner Dowsing Offshore Wind Farms: Maritime Archaeological Assessment, unpublished report ref: 51145.02

Wessex Archaeology, 2002b, Lynn and Inner Dowsing Offshore Wind Farms: Terrestrial Archaeological Assessment, unpublished report ref: 51145.04

Wessex Archaeology, 2006a, Wash Cable Route Corridor Archaeological Desk-based Assessment, unpublished report ref: 62550.01

Wessex Archaeology, 2006b, Historic Environment Guidance Note for the Offshore Renewable Energy Sector, Cowrie Ltd.

Wessex Archaeology, 2006c, Race Bank and Docking Shoal Offshore Wind Farms Archaeological Desk-based Assessment, unpublished report ref: 62550.02

Wessex Archaeology, 2006d, Lincs Offshore Wind Farm Archaeological Desk-based Assessment, unpublished report ref: 59100.05

Wessex Archaeology, 2006e, Docking Shoal Offshore Wind Farms and Wash Cable Route Corridor Geophysical Data Audit and Review, unpublished report ref: 62550.04

Wessex Archaeology, 2007, Docking Shoal Offshore Wind Farm Archaeological Assessment, unpublished report ref.: 62550.05.

7.3. DOCUMENTARY RECORDS

Reference	Date	Title	Seen	Copy
OCB1455	1843-1874	England East Coast Sheet IV from Cromer to Trusthorpe	Y	N

APPENDIX I: STUDY AREA CO-ORDINATES

PRINCIPAL STUDY AREA

Point	UTM Easting	UTM Northing
1	359550.51891	5898360.25143
2	359517.81735	5898359.18089
3	359485.11578	5898360.25143
4	359452.55425	5898363.45846
5	359420.27219	5898368.78826
6	359388.40782	5898376.21798
7	359357.09762	5898385.71583
8	359326.47563	5898397.24113
9	359296.67300	5898410.74452
10	359268.26435	5898425.91043
11	352286.96368	5902446.96581
12	352286.51668	5902447.22358
13	352258.73156	5902464.50148
14	352232.13597	5902483.55961
15	352206.84377	5902504.31638
16	352182.96329	5902526.68289
17	352160.59678	5902550.56337
18	352139.84001	5902575.85557
19	352120.78187	5902602.45116
20	352103.50398	5902630.23628
21	352088.08031	5902659.09194
22	352074.57692	5902688.89457
23	352063.05162	5902719.51655
24	352053.55376	5902750.82675
25	352046.12404	5902782.69112
26	352044.56003	5902790.91298
27	351315.52692	5906806.13273
28	349513.54307	5907822.53940
29	349509.18587	5907825.02597
30	349481.40075	5907842.30386
31	349454.80516	5907861.36200
32	349429.51296	5907882.11876
33	349405.63248	5907904.48528
34	349383.26597	5907928.36576
35	349362.50920	5907953.65796
36	349343.45107	5907980.25355
37	349326.17317	5908008.03867
38	349310.74950	5908036.89432
39	349297.24611	5908066.69696
40	349285.72081	5908097.31894
41	349276.22296	5908128.62914
42	349268.79323	5908160.49351
43	349263.46344	5908192.77557
44	349260.25641	5908225.33711
45	349259.18587	5908258.03867
46	349260.13804	5908288.88115
47	349484.52741	5911919.62103

Point	UTM Easting	UTM Northing
48	349484.64578	5911921.48011
49	349487.85281	5911954.04164
50	349493.18261	5911986.32370
51	349500.61234	5912018.18807
52	349510.11018	5912049.49828
53	349521.63548	5912080.12026
54	349535.13888	5912109.92289
55	349550.56254	5912138.77854
56	349567.84044	5912166.56366
57	349586.89858	5912193.15926
58	349607.65534	5912218.45145
59	349630.02185	5912242.33194
60	349653.90234	5912264.69845
61	349679.19453	5912285.45521
62	349705.79013	5912304.51335
63	349733.57525	5912321.79125
64	349762.43090	5912337.21491
65	349792.23353	5912350.71831
66	349822.85551	5912362.24361
67	349854.16572	5912371.74145
68	349886.03008	5912379.17118
69	349918.31214	5912384.50098
70	349950.87368	5912387.70801
71	349983.01367	5912388.77823
72	354854.14066	5912394.24920
73	354854.70223	5912394.24951
74	354887.40379	5912393.17897
75	354919.96533	5912389.97194
76	354952.24739	5912384.64215
77	354984.11175	5912377.21242
78	355015.42196	5912367.71458
79	355046.04394	5912356.18928
80	355075.84657	5912342.68588
81	355104.70223	5912327.26221
82	355132.48734	5912309.98432
83	355159.08294	5912290.92618
84	355184.37514	5912270.16941
85	355208.25562	5912247.80290
86	355230.62213	5912223.92242
87	355251.37890	5912198.63022
88	355270.43703	5912172.03462
89	355287.71493	5912144.24951
90	355303.13860	5912115.39386
91	355316.64199	5912085.59123
92	355328.16729	5912054.96924
93	355337.66514	5912023.65903
94	355342.43597	5912004.32130
95	356402.90762	5907305.31688
96	362395.19288	5903842.88069
97	362422.82690	5903825.69006
98	362449.42250	5903806.63193

Point	UTM Easting	UTM Northing
99	362474.71469	5903785.87516
100	362498.59517	5903763.50864
101	362520.96169	5903739.62816
102	362541.71846	5903714.33597
103	362560.77659	5903687.74037
104	362578.05449	5903659.95526
105	362593.47815	5903631.09960
106	362606.98155	5903601.29697
107	362618.50685	5903570.67498
108	362628.00470	5903539.36478
109	362635.43443	5903507.50041
110	362640.76421	5903475.21835
111	362643.97125	5903442.65682
112	362645.04178	5903409.95526
113	362643.97125	5903377.25369
114	362640.76421	5903344.69216
115	362635.43443	5903312.41010
116	362628.00470	5903280.54573
117	362618.50685	5903249.23553
118	362606.98155	5903218.61354
119	362593.47815	5903188.81091
120	362578.06134	5903159.96713
121	362578.05449	5903159.95525
122	359950.83690	5898609.19277
123	359950.83005	5898609.18090
124	359933.55215	5898581.39577
125	359914.49402	5898554.80018
126	359893.73725	5898529.50799
127	359871.37074	5898505.62750
128	359847.49025	5898483.26099
129	359822.19806	5898462.50422
130	359795.60246	5898443.44609
131	359767.81735	5898426.16819
132	359738.96169	5898410.74452
133	359709.15906	5898397.24113
134	359678.53708	5898385.71583
135	359647.22687	5898376.21798
136	359615.36250	5898368.78826
137	359583.08045	5898363.45846
Projection: WGS 84 UTM Zone 31N		

EXTENDED CABLE ROUTE STUDY AREA

Point	UTM Easting	UTM Northing
1	351519.50041	5905682.72918
2	348472.16401	5902296.92294
3	345942.02196	5898778.74333
4	345932.88397	5898766.08402
5	351071.75507	5906943.63193
6	351315.52692	5906806.13273

Point	UTM Easting	UTM Northing
7	348005.28498	5898089.02515
8	347664.42997	5898433.38310
9	351666.87399	5904871.05503
10	351904.50828	5903562.26144
11	348290.60662	5899219.52435
12	355367.39038	5900672.71672
13	356739.31430	5899882.52269
14	349825.84862	5901438.87115
Projection WGS 84: UTM Zone 31N		

APPENDIX II: KNOWN WRECKS AND GEOPHYSICAL ANOMALIES

KNOWN WRECKS AND GEOPHYSICAL ANOMALIES IN THE PSA

WA ID	Name	UTM Easting	UTM Northing	Description	Sources	External References
7000	Dark reflector	353330.78	5912289.89	Isolated anomaly (5.2 x 3.6 x 0m).	6001	
7001	Dark reflector and seabed disturbance	353663.75	5911482.40	Elongated area of seafloor disturbance (21 x 8.6m) and dark reflector within it (3.7 x 3.7 x 0.3m). Total area of the dark reflector and disturbance covers 21 x 8.6 x 0.3m.	6002	
7002	Seafloor disturbance	353917.03	5911098.38	Elongated area of darker seafloor (16.2 x 3.6m) and an object within it (1.3 x 0.9 x 0.8m). Total area of the disturbance covers 17 x 6m.	6003	
7003	Dark reflector	354509.94	5910640.35	Elongated area of seafloor disturbance (8.6 x 2.2m) and small shadow indicating an additional standing object (too small to measure).	6005	
7004	Debris	354825.00	5909925.27	Two elongated dark reflectors 10m apart with height or scour (12.1 x 2.2 x 0.6m and 8.1 x 1.6m). The debris covers an area of 12.1 x 12.2m.	6006	
7005	Seafloor disturbance	354689.61	5910006.55	Two broad dark reflectors covering an area of 24.7 x 19.8m in sandy rippled seafloor.	6007	
7006	Dark reflector	353865.26	5910523.46	Isolated anomaly (4.8 x 2.9 x 0m)	6008	
7007	Seafloor disturbance	354519.93	5910101.63	Possible wreck site. Elongated oval patch of dark reflectors distinct from surrounding sandy and rippled seafloor covering and area of 25.6 x 8.3m. No height was observed.	6009	
7008	Debris	353667.65	5910881.51	Two associated small objects with height alongside other smaller dark reflectors (2.6 x 1.5 x 0.7m and 2.1 x 0.9 x 0.6m). The area covered by this debris covers 25 x 15m.	6010	
7009	Dark reflector	352550.60	5911644.57	Isolated anomaly (4.7 x 1.9 x 0m).	6011	

WA ID	Name	UTM Easting	UTM Northing	Description	Sources	External References
7010	Debris	353544.87	5911004.24	Isolated dark reflector exhibiting height (9 x 4.9 x 0.5m).	6012	
7011	Debris	353611.46	5911099.40	Debris (4.1 x 1 x 0.3m) situated 100m east of anomaly 7010.	6013	
7012	Dark reflector	355477.15	5909866.46	Isolated object (6.4 x 2.8m) in an area of sandy and rippled seafloor.	6014	
7013	Dark reflectors	355851.82	5909635.67	Area with four distinct dark reflectors (3.6 x 2.9m; 10.4 x 3.6m; 6.4 x 3.8m; 5.7 x 1.4m). These anomalies cover an area of 41 x 20m.	6015	
7014	Dark reflector	352565.91	5911236.28	Dark reflector (3.2 x 2.3 x 0m).	6016	
7015	Dark reflector	352601.54	5911283.25	Dark reflector (4.4 x 1.6 x 0m).	6017	
7016	Dark reflector	352593.88	5911303.24	Dark reflector (2.5 x 1.6 x 0m).	6018	
7017	Debris	353270.56	5910726.42	Area of debris (81 x 70m): Large structured anomaly (9.5 x 9.4m) disturbing the sandy and rippled seafloor and four smaller dark reflectors, also interpreted as debris, present within 50m radius (4.8 x 2.8m; 3.7 x 1.2m; 10.9 x 3.1 x 0.5m; 14.2 x 6.3 x 0.5m).	6019	
7018	Dark reflectors	353349.75	5910661.50	Three objects (2.7 x 2.1; 1.4 x 0.5; 4.2 x 1.6m) situated on a sandy and rippled seafloor covering an area of 27 x 16m.	6020	
7019	Dark reflector	354321.86	5910038.56	Angular and isolated object (6.4 x 4.2 x 0m).	6021	
7020	Debris	353325.57	5910568.07	Anomaly (3.6 x 0.8 x 0.4) situated on a sandy and rippled seafloor.	6022	
7021	Dark reflector	353234.56	5910644.71	Anomaly (2.5 x 2.2 x 0m) situated on a sandy and rippled seafloor.	6023	
7022	Dark reflector	352288.32	5911086.79	Isolated anomaly (2.9 x 2 x 0m) in a sandy and rippled seafloor.	6024	
7023	Dark reflector	354614.80	5909553.22	Isolated object (3.5 x 1.8 x 0m).	6025	
7024	Dark reflector	353042.46	5910587.07	Isolated object (3.9 x 1.7 x 0m).	6026	
7025	Dark reflector	352873.94	5910567.93	Object measuring 7.2 x 1.8 x 0m.	6027	
7026	Dark reflector	352883.77	5910640.54	Object measuring 3.8 x 2.8 x 0m.	6028	

WA ID	Name	UTM Easting	UTM Northing	Description	Sources	External References
7027	Dark reflector	352762.64	5910639.05	Object measuring 3.8 x 2.9 x 0m.	6029	
7028	Dark reflector	352744.60	5910674.76	Patch of dark reflectors (possibly natural) covering an area of 30.4 x 6.4m.	6030	
7029	Dark reflector	352684.07	5910787.11	Object measuring 4 x 2.7 x 0m.	6031	
7030	Dark reflector	352663.64	5910792.23	Strong dark reflector (6 x 2.5 x 0m).	6032	
7031	Dark reflector	352626.87	5910798.75	Elongated dark reflector (10.4 x 3.8m) with a bright reflector in the middle	6033	
7032	Debris	352566.09	5910788.33	Dark reflector, probable debris, with point of height (5.6 x 1.6 x 0.3).	6034	
7033	Dark reflector	352549.39	5910772.52	Object measuring 1.2 x 1.0m.	6035	
7034	Dark reflector	352571.02	5910851.37	Angular object (2.8 x 1.6 x 0m) alongside anomaly 7035.	6036	
7035	Dark reflector	352570.10	5910866.48	Elongated object (3.4 x 0.9 x 0m) alongside anomaly 7034.	6037	
7036	Dark reflector	352613.38	5910865.18	Elongated object (5 x 0.5 x 0m).	6038	
7037	Dark reflector	352621.11	5910859.49	Elongated object (2.2 x 0.6 x 0m).	6039	
7038	Dark reflector	352625.61	5910863.33	Round object (1 x 0.5 x 0m).	6040	
7039	Dark reflector	352154.43	5910990.08	Angular object (2.7 x 1.9 x 0m).	6041	
7040	Debris	352010.04	5910966.55	Dark reflector with a point of height (5.5 x 1.2 x 0.4m).	6042	
7041	Seafloor disturbance	351168.67	5911362.95	Two objects with height (2.8 x 1.7 x 0.6m; 3.1 x 1.4 x 0.5m) creating a distinct area of disturbed seafloor (28.8 x 13.3m)	6043	
7042	Dark reflector	352901.55	5910203.24	Isolated object measuring 4.2 x 2.1 x 0m.	6044	
7043	Debris	355358.47	5908043.70	Area of sandwaves revealing mainly two large objects (5.6 x 2.4 x 0.2m and 5.2 x 1m), a dark reflector (2.3 x 1.3m) and a magnetic anomaly 35m southwest (22.3 nT). The debris field covers an area of 52 x 15.3m.	6046	
7044	Bright reflector	355287.58	5908011.19	Angular object measuring 2.8 x 2.4m. Unknown whether anomaly is anthropogenic or natural.	6047	

WA ID	Name	UTM Easting	UTM Northing	Description	Sources	External References
7045	Debris	361579.21	5903899.97	Area with three distinct objects (2.8 x 2.3 x 0.5m; 2.9 x 1.2; 2.5 x 0.7m). Area of debris covers 36 x 4.5m.	6048	
7046	Dark reflector	361676.57	5903849.96	Isolated object measuring 2.7 x 1.8m.	6049	
7047	Dark reflectors	353909.59	5908712.60	A series of dark reflectors arranged in a linear manner (2.5 x 2.1m; 4.6 x 1.4m; 18.3 x 0.2m). Area of dark reflectors covering an area of 23.5 x 13m.	6050	
7048	Dark reflectors	351648.20	5910137.29	Four objects creating an area of seafloor disturbance measuring 61 x 24m. One is linear and angular (8.8 x 1.3m), another has height or scour (3 x 1 x 0.5m); the other two measure 11.7 x 2.6 and 11.3 x 3.7m	6051	
7049	Wreck	357482.27	5906277.47	Site formed by angular dark reflectors, interpreted as a possible wreck measuring 21 x 7.5m	6052	
7050	Dark reflector	350225.84	5910904.97	Two objects probably forming on single site (3.9 x 1.7m and 5.9 x 1.5m). Elongated wreck shaped site measuring 11.5 x 3.0m.	6053	
7051	Debris	350341.54	5910875.71	Two objects near a possible wreck site (7050) and lying in an area of darker seafloor measuring 13 x 2m. One object with height or scour (2.7 x 0.6 x 0.4), the other measures 2.1 x 1.4m	6054	
7052	Dark reflector	350292.55	5911002.20	Two adjacent objects measuring 4.4 x 1.2m and 2.5 x 2.3m, covering a total area of 19 x 3.5m.	6055	
7053	Dark reflectors	350666.64	5910760.20	Patch of multiple objects lying in a sandy rippled seafloor covering an area of 110 x 43m. Largest object is 8.1 x 8m and smallest measures 2.6 x 1.6m	6056	
7054	Dark reflector	350725.62	5910576.87	Object (6.2 x 4.6 x 0m) situated between sandwaves.	6057	
7055	Dark reflector	353983.46	5908632.06	Isolated object (2.4 x 4 x 0m).	6058	

WA ID	Name	UTM Easting	UTM Northing	Description	Sources	External References
7056	Debris	360715.18	5904085.22	Debris with large scour measuring 4.3 x 3.1m.	6059	
7057	Debris	360260.72	5904341.51	Isolated object (3.2 x 0.6 x 0.5m).	6060	
7058	Dark reflectors	360075.65	5904586.75	Two objects lying 17m apart, between sandwaves, and measuring 9.8 x 5.9m and 3.7 x 2.6m. Total area covered: 17.2 x 5.9m.	6061	
7059	Dark reflector	360021.58	5904503.28	Object (8.1 x 2.9 x 0m) lying between sandwaves.	6062	
7060	Dark reflector	357669.58	5906141.60	Isolated object (11.4 x 1.5 x 0m).	6063	
7061	Debris	350335.09	5910726.91	Two objects with a point of height (2.2 x 0.7 x 0.3m and 5.3 x 2.5 x 0.4m) covering an area of 12 x 3.2m. Objects detected in an area of sandwaves.	6064	
7062	Debris	350030.45	5910907.68	Isolated object (3.4 x 0.7 x 0.4m) with height and scour.	6065	
7063	Debris	349663.04	5911114.67	Isolated object with height measuring 4.1 x 1.1 x 0.4m.	6066	
7064	Seafloor disturbance	350036.76	5910785.53	Possible patch of debris covering an area of 40.8 x 13.6 x 0m.	6069	
7065	Wreck	356090.20	5906903.25	Possible small wreck measuring 12.4 x 6.2 x 1.1m.	6070	
7066	Wreck	358375.90	5905425.50	Possible small wreck measuring 16.1 x 12.6 x 1.4m.	6071	
7067	Debris	358515.61	5905346.15	Small isolated object (2.3 x 1 x 0.3m).	6072	
7068	Debris	359931.50	5904353.66	Isolated object (3.0 x 1.1 x 0.4m).	6073	
7069	Seafloor disturbance	359183.18	5904783.38	Isolated object measuring 14.5 x 7.3 x 0m.	6074	
7070	Dark reflectors	359226.62	5904697.58	Two dark reflectors covering an area of 8.4 x 9.2m. Individual objects measures 8.4m x 1.5m and 2.1 x 0.8m.	6075	
7071	Dark reflector	358435.28	5905331.35	Isolated object (2.4 x 1.5 x 0m) in an area of large sand waves seems to create a long scour.	6076	

WA ID	Name	UTM Easting	UTM Northing	Description	Sources	External References
7072	Dark reflector	356998.50	5906131.50	Three pieces of linear debris covering an area of 12.3 x 0.2m.	6077	
7073	Debris	353909.98	5908077.42	Isolated object (3.4 x 1.4 x 0.6m).	6079	
7074	Wreck	359388.02	5904410.59	Wreck measuring 41.9 x 15 x 2.7m situated 24.6m northeast of an UKHO wreck loss with debris (2.9 x 0.8 x 0.3m) and associated magnetic anomaly (88.5nT).This wreck was reported b the UKHO as an unknown live wreck reportedly measuring 62 x 19 x 1.8m which was first reported in 1963.	6081	UKHO 8619
7075	Bright reflector	353800.64	5908058.60	Possibly debris measuring 3.1 x 2.2 x 0m.	6089	
7076	Dark reflector	354041.66	5907983.87	Object measuring 4 x 2.5 x 0m.	6090	
7077	Dark reflector	355891.05	5906830.54	Object measuring 11.7 x 2.4 x 0m.	6091	
7078	Dark reflector	355954.42	5906759.93	Two objects (3.5 x 0.6m and 10.8 x 2.3m) covering an area of 14.2 x 10.8m.	6092	
7079	Seafloor disturbance	355998.64	5906678.68	Dark reflector (19.3 x 4.3 x 0m).	6093	
7080	Dark reflector	356208.97	5906482.34	Isolated elongated dark reflector (8.6 x 1.6 x 0m).	6094	
7081	Dark reflector	356391.41	5906461.18	Isolated elongated dark reflector (4.7 x 1.4 x 0m).	6095	
7082	Seafloor disturbance	356539.84	5906365.96	Darker area of seafloor and linear dark reflectors covering an area of 15.8 x 14.3m.	6096	
7083	Debris	357135.75	5905924.19	Two elongated dark reflectors possibly associated lie 13m apart (13 x 6.2m). They measure 5.9 x 0.7 x 0.1m and 6.2 x 1.3m.	6097	
7084	Dark reflector	358124.51	5905411.64	Two linear dark reflectors parallel to each other and covering 11 x 6.2m. They measure 6.2 x 0.8m and 6.1 x 0.7m	6098	
7085	Debris	359793.44	5904050.51	Isolated angular object with a point of height (8.8 x 2.2 x 0.5m).	6099	

WA ID	Name	UTM Easting	UTM Northing	Description	Sources	External References
7086	Dark reflector	359663.25	5904152.66	Object measuring 7.4 x 1.2 x 0m. Similar object 74m west (7087).	6100	
7087	Dark reflector	359588.51	5904153.07	Object measuring 3.7 x 2.8 x 0m. Similar object 74m east (7086).	6101	
7088	Dark reflector	357061.29	5905976.39	Linear reflector (7.8 x 0.7 x 0.4m).	6102	
7089	Seafloor disturbance	356596.28	5906195.02	Patch of darker seafloor (26.9 x 10.8m) and some objects with no height (an object measures 7.5 x 1.7m). Total area: 21.5 x 26.9m.	6103	
7090	Dark reflector	354492.74	5907577.35	Isolated linear object, possible debris (10.3 x 1.6 x 0m).	6104	
7091	Dark reflectors	351259.56	5909356.83	Large angular object and five other dark reflectors covering an area of 27 x 25m (largest measuring 7.2 x 6m and the smallest 1.1 x 1.1m).	6111	
7092	Dark reflectors	351992.10	5908894.59	Area of dispersed debris (114 x 25m). Five objects have been noted, the largest (7.4 x 6.3m) is an angular object party buried under a large sand wave. The dimensions of the remainder are approximately 2.5 x 2m.	6112	
7093	Debris	356471.51	5906011.13	Area formed by at least 8 objects classified as debris, dark reflectors and linear bright reflectors covering an area of 134.5 x 31.3m. The largest object measures 6.3 x 0.9 x 0.4m, a linear object measures 20.9 x 1.3m and the smallest measures 1.3 x 1.2m.	6113	
7094	Dark reflector	356896.15	5905889.50	Linear object (20 x 0.8 x 0m).	6114	
7095	Dark reflector	356473.92	5906126.24	Isolated object (3.7 x 2.4 x 0m).	6115	
7096	Debris	356656.14	5906004.84	Isolated object (3.1 x 0.4 x 0.3m).	6116	
7097	Bright reflector	352942.34	5908378.54	Isolated object (13.9 x 5.3 x 0m).	6117	
7098	Dark reflector	358123.29	5905100.88	Isolated object (7.9 x 5.3 x 0m).	6118	
7099	Wreck	358771.98	5904642.63	Small upstanding wreck (30.5 x 13.8 x 0.6m).	6119	
7100	Dark reflector	358729.45	5904717.83	Isolated object (4.9 x 1.3 x 0m).	6120	
7101	Dark reflector	360110.59	5903809.99	Isolated object (4.1 x 1.6 x 0m).	6121	

WA ID	Name	UTM Easting	UTM Northing	Description	Sources	External References
7102	Dark reflectors	360368.38	5903642.92	Area (97.1 x 10m) with three dark reflectors measuring 5.6 x 2.8m, 3.8 x 2m and 3.1 x 1.9m	6122	
7103	Dark reflector	360463.14	5903428.24	Isolated object (3.4 x 2.1 x 0m).	6123	
7104	Debris	358033.78	5904873.10	Isolated object (1.3 x 0.8 x 0.2m).	6124	
7105	Dark reflector	357637.92	5905107.58	Isolated object (4.6 x 2.3 x 0m).	6125	
7106	Dark reflector	356619.29	5905800.48	Isolated object (4.4 x 3.4 x 0m).	6126	
7107	Dark reflectors	355872.69	5906229.34	Group of two separate dark reflectors covering an area of 37.5 x 3.8m and measuring 3.8 x 3.5m and 2.8 x 2.3m.	6127	
7108	Dark reflector	355432.10	5906679.98	Isolated object (7.5 x 1.7 x 0m).	6128	
7109	Debris	355085.04	5906916.84	Isolated object (2.9 x 1 x 0.5m).	6129	
7110	Seafloor disturbance	352452.15	5908585.47	Area showing linear and angular dark reflectors covering 9.7 x 6.8m.	6130	
7111	Seafloor disturbance	352441.26	5908490.58	Area showing linear and angular dark reflectors covering 26.5 x 24.3m.	6131	
7112	Dark reflector	349792.59	5910171.40	Isolated object (3 x 1.2 x 0m).	6132	
7113	Dark reflector	352401.77	5908459.30	Isolated object (4.7 x 1.2 x 0m).	6139	
7114	Dark reflector	350067.68	5909812.77	Isolated object (2.8 x 1.3 x 0m).	6140	
7115	Dark reflector	353257.00	5907776.00	Area of mobile sediments (55 x 14.8m) where five objects have been detected (9.5 x 1.9m; 6.1 x 1m and 5.4 x 1.1m; 2.5 x 1 x 0m; 4.3 x 0.9 x 0.6m)	6141	
7116	Seafloor disturbance	355080.37	5906634.38	Possible wreck measuring 25 x 2.7 x 0.7m and two pieces of potential debris (1.6 x 0.6 x 0.4m and 3.1 x 1 x 0.5m). Entire area covers 53 x 9.5m.	6143	
7117	Debris	355396.08	5906445.36	Dark reflector with a point of height (6.7 x 2.5 x 0.4m).	6144	
7118	Magnetic Anomaly	354780.91	5909995.00	Anomaly with magnetic amplitude of 34.7nT	6145	
7119	Magnetic Anomaly	355165.97	5908865.00	Anomaly with magnetic amplitude of 8.0nT	6146	

WA ID	Name	UTM Easting	UTM Northing	Description	Sources	External References
7120	Magnetic Anomaly	353625.72	5909545.00	Anomaly with magnetic amplitude of 6.9nT	6147	
7121	Magnetic Anomaly	349520.09	5911890.00	Anomaly with magnetic amplitude of 7.4nT	6148	
7122	Magnetic Anomaly	358491.50	5905820.00	Anomaly with magnetic amplitude of 6.1nT	6149	
7123	Magnetic Anomaly	350360.22	5910605.00	Anomaly with magnetic amplitude of 11.6nT	6150	
7124	Magnetic Anomaly	359191.59	5904490.00	Anomaly with magnetic amplitude of 4.8nT	6151	
7125	Magnetic Anomaly	350480.23	5910050.00	Anomaly with magnetic amplitude of 14.2nT	6152	
7126	Dark reflector	349404.3	5910221.13	Isolated object (2.4 x 0.3 x 0m).	6175	
7127	Dark reflector	349564.17	5910015.03	Small dark reflector (1.2 x 1 x 0m).	6176	
7128	Dark reflector	349567.7	5909974	Oblong structure (3.7 x 3.0 x 0m).	6177	
7129	Dark reflector	358754.07	5904112.12	Isolated object (3.2 x 0.6 x 0m).	6178	
7130	Dark reflector	352032.39	5908282.84	Small isolated object (2.5 x 1.5 x 0m).	6179	
7131	Debris	349935.81	5909540.66	Isolated debris with associated seabed disturbance (4.1 x 1.4 x 3.6m). Large magnetometer hit 130m away, but no direct association identified. Feature also observed on the bathymetric data.	6180	
7132	Dark reflector	360970.3	5902487.02	Small isolated object (2 x 0.7 x 0.8m).	6181	
7133	Possible debris	361048.7	5902249.94	Small isolated object (0.6 x 0.4 x 0.3m).	6182	
7134	Debris	360335.6	5902669.53	Possible debris. Isolated (3.6 x 1.1 x 0.7m).	6183	
7135	Debris	358290.69	5903980.03	Small isolated dark reflector, possible debris (2.5 x 0.8 x 0.5m).	6184	
7136	Dark reflectors	361099.85	5902047.69	Two small dark reflectors, possible debris (2 x 0.9 x 0.5m)	6185	

WA ID	Name	UTM Easting	UTM Northing	Description	Sources	External References
7137	Dark reflector	350246.14	5909084.84	Small isolated object (1.7 x 0.4 x 0m), magnetic anomaly (7170) situated approximately 100m northeast, although no direct association established	6186	
7138	Dark reflectors	353708.97	5906703.97	Two associated dark reflectors showing some structure feature situated on the crest of a sandwave, probable debris. Debris covers an area of 5.1 x 3.6m	6187	
7139	Debris	357386.37	5904334.84	Two closely associated anomalies, probable debris measuring 3.7 x 0.9 x 0.2m.	6188	
7140	Dark reflector	360142.46	5902526.28	Isolated, possible debris (1.7 x 0.1 x 0.3m).	6189	
7141	Dark reflectors	360313.76	5902285.62	Numerous small dark reflectors with height (5.5 x 1.0 x 0.4m).	6191	
7142	Debris	349462.4	5909078.7	Four associated items of debris (3.9 x 0.3m; 5.8 x 2.5m; 3.1 x 1.6m; 4.5 x 2.8m) covering an area of 41.6 x 14.6m.	6192	
7143	Dark reflector	360320.72	5902087.91	Small object exhibiting height (2.3 x 0.7 x 0.6m).	6193	
7144	Dark reflector	360389.04	5902120.75	Small object exhibiting height (2.9 x 1.2 x 0.2m).	6194	
7145	Dark reflector	360849.45	5901561.62	Isolated anomaly (2.5 x 0.4 x 0.5m).	6196	
7146	Dark reflectors	360965.73	5901468.6	Two adjacent dark reflectors, both exhibiting height (4.3 x 0.8 x 0.5m). Possible debris.	6197	
7147	Dark reflectors	360830.96	5900901.07	Two adjacent dark reflectors. Some disturbance around the area (7.7 x 1 x 0.8m).	6199	
7148	Dark reflector	352500.45	5906140.21	Small isolated object (1.5 x 0.6 x 0.3m).	6200	
7149	Dark reflector	352028.86	5906233.2	Small isolated object (2.8 x 0.8 x 0m).	6201	
7150	Bright reflector	360363.8	5900708.87	Possible buried structure (16.9 x 7.7 x 0m).	6204	
7151	Wreck	354692.09	5904123.84	Possibly partly buried wreck measuring 25.7 x 7.4 x 0.5m. Anomaly with magnetic amplitude of 104.5nT. Reported by UKHO as unknown live wreck measuring 33 x 12 x 1.3m which was first reported in 1993.	6206	UKHO 9168

WA ID	Name	UTM Easting	UTM Northing	Description	Sources	External References
7152	Seabed disturbance	355073.3	5903615.5	Possible partially buried wreck/structure (74.0 x 30.9 x 0m). Associated cable/scarring.	6207	
7153	Debris	353002.71	5903870.17	Isolated anomaly, probable debris (3.6 x 0.1 x 0.4m).	6210	
7154	Dark reflectors	359736.3	5899308.2	Cluster of numerous dark reflectors (14.1 x 7.6 x 0.5m), possible debris and area of seabed disturbance (10.9 x 17m). Dark reflectors and seabed disturbance cover a total area of 26.8 x 17.0m.	6211	
7155	Debris	351978.74	5904041.74	Isolated debris (8.3 x 0.1 x 0.3m) on edge of sandwave.	6212	
7156	Dark reflector	358589.32	5898897.29	Small isolated dark reflector (3.9 x 0.1 x 0.3m).	6214	
7157	Dark reflector	354552.46	5901706.18	Isolated anomaly (4.1 x 0.1 x 0m).	6215	
7158	Debris	355049.47	5902064.05	Possible debris with associated seabed depression (0.9 x 2.8 x 0.8m).	6216	
7159	Debris	358467.84	5899906.22	Isolated anomaly, possible debris (2.8 x 1.1 x 1.1m).	6217	
7160	Debris	359136.21	5899419.24	Large anomaly showing height, probable debris (12.6 x 4.9 x 1.4m).	6218	
7161	Debris	360730.81	5901659.92	Elongated patch of debris (3.8 x 0.5 x 0.5m)	6223	
7162	Magnetic Anomaly	355284.27	5903150.00	Anomaly with magnetic amplitude of 7.3nT	6224	
7163	Magnetic Anomaly	354979.34	5903330.00	Anomaly with magnetic amplitude of 5.1nT	6225	
7164	Magnetic Anomaly	353014.81	5904295.00	Anomaly with magnetic amplitude of 32.0nT	6226	
7165	Magnetic Anomaly	350935.31	5907400.00	Anomaly with magnetic amplitude of 12.8nT	6227	
7166	Magnetic Anomaly	350555.41	5908685.00	Anomaly with magnetic amplitude of 36.7nT	6228	
7169	Magnetic Anomaly	361392.81	5902055.00	Anomaly with magnetic amplitude of 6.2nT	6231	

WA ID	Name	UTM Easting	UTM Northing	Description	Sources	External References
7170	Magnetic Anomaly	350330.45	5909135.00	Anomaly with magnetic amplitude of 12.5nT	6232	
7171	Magnetic Anomaly	350020.52	5909455.00	Anomaly with magnetic amplitude of 2350.7nT	6233	
7172	Channel	351464.20	5907363.00	Broad shallow channel (2274 x 665m) observed between 6.6 and 21.2m sub-seabed. Maximum infill of 14.6m.Channel observed on 7 data lines. Sediment infill is observed as stratified sediments.	6234	
7173	Channel	355450.00	5910469.00	Complex channel (557 x 356m) observed between 8.0 and 20.6m sub-seabed, with a maximum infill of 12.6m. The channel was observed on 3 data lines.	6235	
7174	Channel	359190.00	5904320.00	Shallow channel (660 x 750m) observed 2.0 to 19.8m sub-seabed with a maximum infill of 17.8m. However, general infill depth is approximately 13m. Channel appears infilled with fine-grained sediments. Channel observed on 5 data lines.	6236	
7175	Channel	359944.70	5902360.00	Shallow channel (750 x 660m) observed 0.5 to 11.3m sub-seabed with a maximum infill of 10.8m. Channel appears infilled with coarse-grained sediments. Channel observed on 4 data lines.	6237	
7176	Channel	357288.00	5900429.00	Irregular shaped channel observed between 4.6 - 12.4m sub-seabed with a general infill of 7.8m. The channel was observed on three adjacent survey lines. A maximum length of 380m and a maximum width of 360m was observed.	6238	
7177	Channel	356511.00	5901216.00	Small channel feature (245 x 200m) observed between 5.7 and 11.0m sub-seabed. Maximum sediment infill observed at 4.8m.	6239	

WA ID	Name	UTM Easting	UTM Northing	Description	Sources	External References
7178	Channel	357264.00	5901499.00	Main channel to the south splits into two meandering channels, the eastern channel is traced further north than the western channel. The channel was observed between 3.5 and 11.2m sub-seabed. A maximum infill of 6.1m was observed in the eastern channel. The channel was observed on ten survey lines. A maximum length of 1340m and a maximum width of 835m was observed.	6240	
7179	Jane and Elizabeth	361371	5903526	UKHO dead wreck reported to be a British ketch (51 tonnes) sunk in 1885. No evidence of this wreck was observed on any geophysical data	6241	UKHO 8618
7180	Unknown wreck	352602	5910127	UKHO dead wreck first reported in 1921. No evidence of this wreck was observed on any geophysical data	6242	UKHO 8634
7181	Dark reflector	348678	5902457	Linear anomaly (10.4 x 1.7 x 0m) with magnetic amplitude of 8.7nT	6171	

KNOWN WRECKS AND GEOPHYSICAL ANOMALIES IN THE ECRSA

WA ID	Name	UTM Easting	UTM Northing	Description	Sources	External References
7182	Magnetic Anomaly	349176	5902440	Anomaly with magnetic amplitude of 16646.4nT	6172	
7183	Magnetic Anomaly	349836	5902160	Anomaly with magnetic amplitude of 1669.3nT	6173	
7184	Dark reflector	350890	5902755	Isolated anomaly (2.7 x 2.4 x 0m).	6244	
7185	Dark reflector	348725	5903108	Anomalous distinct dark reflector measuring 8.2 x 9.0 x 0m	6246	
7186	Dark reflector	349383	5901807	Linear dark reflector measuring 11.2 x 0.3 x 0.2m	6249	
7187	Wreck	355174	5899925	Small wreck showing some height measuring 15.7 x 7.0 x 0.6m	6251	

WA ID	Name	UTM Easting	UTM Northing	Description	Sources	External References
7188	Wreck	353114	5899264	Possible wreck (27.6 x 7.7 x 1.1m) in area of coarse sediment with magnetic anomaly of 5.1nT	6255	
7189	Debris	349537	5899294	Possibly wreck debris with magnetic amplitude of 18.9nT. Observed on the bathymetric data as an oval mound (20 x 15 x 1.2m). This anomaly is noted as a 'live' obstruction by the UKHO (UKHO 8610)	6259	UKHO 8610
7190	Dark reflector	349176	5898618	Small dark reflector	6260	
7191	Bright reflector	349033	5898658	Small dark reflector	6261	
7192	Dark reflector	348897	5899969	Possible debris	6262	
7193	Dark reflector	348831	5899898	Possible debris	6263	
7194	Debris	349274	5898744	Debris associated with the UKHO recorded wreck. Observed on the bathymetric data as an low circular mound (8 x 8 x 0.4m). This anomaly is noted as a 'live' obstruction by the UKHO (UKHO 9172)	6264	UKHO 9172

APPENDIX III: DOCUMENTED LOSSES

NMR ID	Name	Description	Date Lost	UTM Easting	UTM Northing
1371004	*Ipswich*	English cargo vessel	1763	360942	5911585
1325827	*Juffrouw Anna Maria*	Dutch craft	1783	360942	5904005
1326992	*Mayflower*	Wreck of English craft which foundered near the Dudgeon Light; a wooden sailing vessel.	1785	360942	5904005
1390162	*Boscawen*	Wreck of British cargo vessel which foundered off the "Floating Light", presumed to be the Dudgeon Light vessel, following a collision en route from Newcastle-upon-Tyne to London with coal; a wooden sailing vessel.	1788	360942	5904005
1336463	*Neptune*	English cargo vessel	1794	360942	5904005
1337829	*Latona*	Craft	1797	360942	5904005
1339283	*Fanny*	Craft	1803	360942	5904005
1339844	*Swift*	Wreck of English craft which stranded on or near the Dudgeon shoal; a wooden sailing vessel.	1805	360942	5904005
1397062	*Thomas And Hannah*	Wreck of English sloop which foundered near the Dudgeon Light vessel on her passage from Newcastle-upon-Tyne; a wooden sailing vessel.	1805	360942	5904005
1340411	*Jane And Sarah*	Wreck of English cargo vessel which foundered off the Dudgeon Light during a gale, while on her passage with coal; a wooden sailing vessel.	1806	360942	5904005
1399020	Unknown	Wreck of French lugger which foundered 9 miles off the Dudgeon light vessel after a collision with one of her intended victims; a wooden sailing vessel.	1808	360942	5904005
1399932	*Unity*	Wreck of English cargo vessel which foundered off the Dudgeon light vessel, on her passage with coal; a wooden sailing vessel.	1810	360942	5904005
1342883	*Iris*	British craft	1813	360942	5904005
1343382	Unknown	Craft	1814	360942	5904005

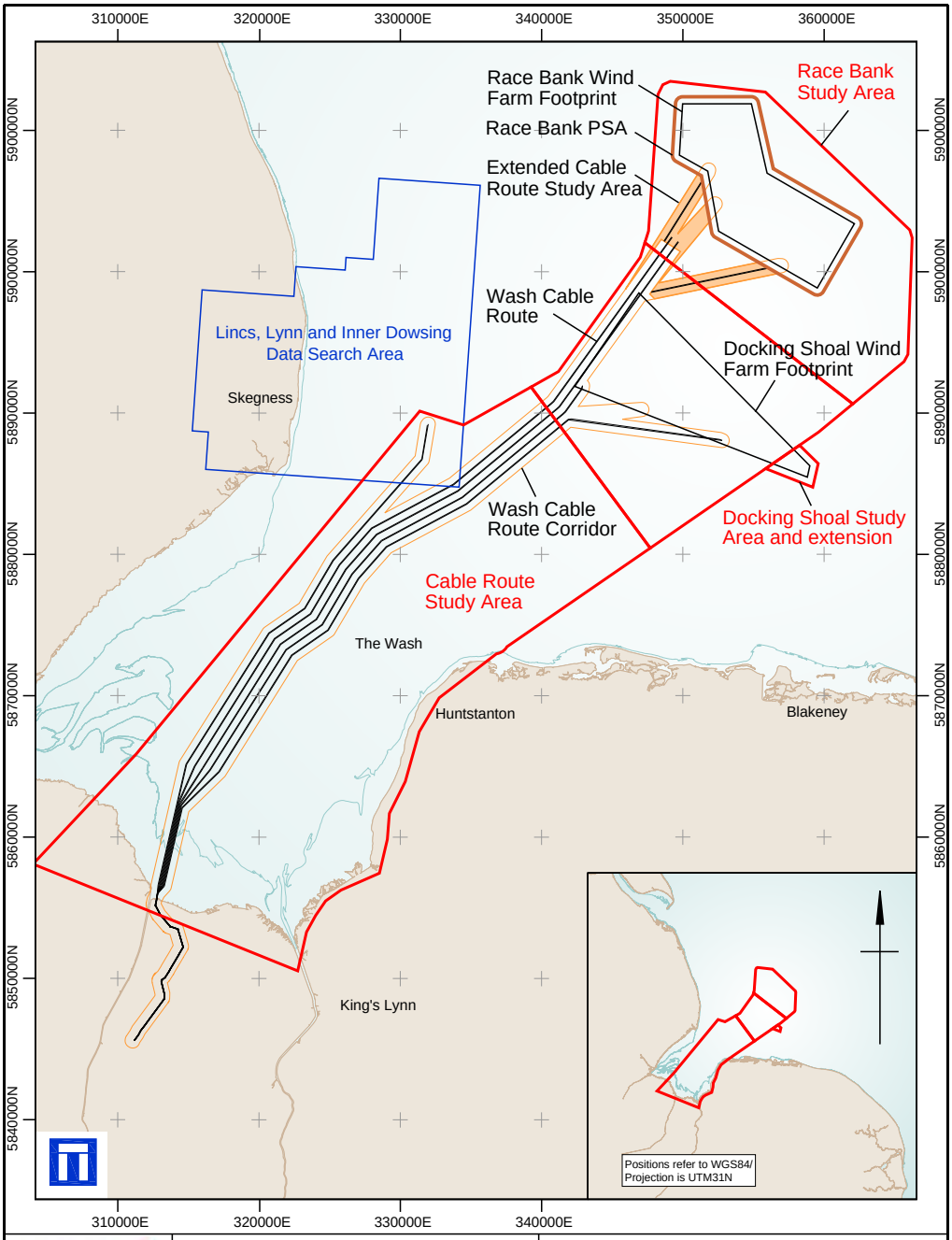
NMR ID	Name	Description	Date Lost	UTM Easting	UTM Northing
1197003	*New Bradford*	Wreck of English cargo vessel which exploded and foundered off the Dudgeon after catching fire en route from London to Kingston-upon-Hull. Laden with gunpowder and rum, she was a wooden sailing vessel.	1817	360942	5904005
1403344	*Fly*	Wreck of British schooner which foundered 12 miles from the Dudgeon light vessel, after a collision. En route from Great Yarmouth to Leith with barley, she was a wooden sailing vessel.	1817	360942	5904005
1347609	*John*	Wreck of British brig which was abandoned to founder approximately 8 miles SW of the Dudgeon light vessel en route from Shields to London; a wooden sailing vessel.	1820	360942	5904005
1347961	*Mold*	Wreck of British craft which foundered 4 or 5 miles east of the Dudgeon after springing a leak. En route from Shields to London, she was a wooden sailing vessel.	1821	360942	5904005
1351292	Unknown	Cargo vessel	1823	355610	5911585
1352101	*Fortune*	Wreck of Scottish brig which foundered near the Dudgeon Light Vessel following a collision. En route from St. David's to London, she was a wooden sailing vessel.	1824	360942	5904005
1406603	Unknown	Wreck of brig which foundered 8 miles NNW of the Dudgeon Light Vessel. Thought to have been on her passage south, she was a wooden sailing vessel.	1824	360942	5904005
1358933	*Dandy*	Wreck of British craft which foundered off the Dudgeon shoal following a collision with a wreck. En route from Dundee to London, she was a wooden sailing vessel.	1825	360942	5904005
1237062	*Hero*	Wreck of English craft which foundered 10 miles north of the Dudgeon light vessel, or "Float", after a collision; a wooden sailing vessel.	1827	360942	5904005
1309100	Unknown	Wreck of Scottish sloop which foundered near the Dudgeon Shoal after a collision. Laden with an unspecified cargo, she was a wooden sailing craft.	1830	360942	5904005

NMR ID	Name	Description	Date Lost	UTM Easting	UTM Northing
1309103	*Maria*	Wreck of English brig which foundered near the Dudgeon Shoal following a collision, en route from King's Lynn to London and Portsmouth. Laden with a cargo variously described as corn or coal, she was a wooden sailing vessel.	1830	360942	5904005
1237934	*Atlas*	British craft	1832	360942	5904005
1237947	*Lowther*	British packet	1832	360942	5904005
1237951	*Harriet*	British cargo vessel	1832	360942	5904005
1358854	*Robert And Sarah*	Wreck of British craft which foundered after grounding on the Dudgeon shoal during a "heavy gale". On her passage from Sunderland, she was a wooden sailing vessel.	1832	360942	5904005
1407182	*Success*	Wreck of British craft which foundered off the Dudgeon Shoal. En route from Newcastle-upon-Tyne to Great Yarmouth, she was a wooden sailing vessel.	1832	360942	5904005
1237957	*Haddow House*	British cargo vessel	1833	360942	5904005
1238005	*Ely*	Wreck of English brig which foundered after grounding on the Race Bank; a wooden sailing vessel.	1833	360942	5904005
1238084	*Robert*	British craft	1833	360942	5904005
1350391	Unknown	Craft	1833	360942	5904005
1432710	*Resolution*	Wreck of English craft which was abandoned to founder off the Dudgeon, after springing a leak; a wooden sailing vessel.	1833	360942	5904005
1350281	*Sarah*	English brig	1836	360942	5904005
928933	*Thomas And Mary*	British cargo vessel	1841	360942	5904005
1435472	Unknown	Wreck of craft which was burnt, presumed foundered, 5 miles SE of the Dudgeon Light Vessel. Constructed of wood, she was a sailing vessel.	1841	360942	5904005
1238955	Unknown	Schooner	1851	360942	5904005
1337295	*Venus*	British schooner	1851	360942	5904005
927811	*Rival*	English sloop	1852	360942	5904005
927812	Unknown	English billyboy	1852	360942	5904005
1235561	*Rambler*	English sloop	1852	360942	5904005

NMR ID	Name	Description	Date Lost	UTM Easting	UTM Northing
1240029	*Pattison*	English brig	1852	360942	5904005
1341772	*Industry*	British craft	1853	360942	5904005
1245421	*Borneo*	British barque	1854	360942	5904005
1245444	*Josephine*	English barque	1854	360942	5904005
1341774	*Happy Return*	English lugger	1854	360942	5904005
1341797	*Jessie*	British brig	1858	360942	5904005
1341812	*Devon*	English brig	1858	360942	5904005
1341817	*Devonian*	English snow	1859	360942	5904005
1341837	*Four Brothers*	British ketch	1859	360942	5904005
1341860	*George*	British cargo vessel	1865	360942	5904005
1350022	*Olive*	English smack	1865	355610	5911585
1432571	Unknown	Wreck of schooner or barque which foundered between the Dudgeon Shoal and the Outer Dowsing; a wooden sailing vessel.	1866	360942	5904005
1341889	*J And S Martin*	British schooner	1868	360942	5904005
1341961	*Test*	British ketch	1869	360942	5904005
1341964	*Mira*	Canadian barque	1870	360942	5904005
1341998	*Venus*	English brig	1871	360942	5904005
1350987	*Leonie*	French cargo vessel	1871	355610	5911585
1342072	*Place*	British dandy	1872	360942	5904005
928010	*Thetis*	English brig	1873	360942	5904005
1350993	*Ann*	English brigantine	1873	355610	5911585
1342098	*Alert*	English cutter	1874	360942	5904005
928012	*Deborah*	English schooner	1875	360942	5904005
1342101	*Sarah Jane*	English brigantine	1876	360942	5904005
1342107	*Tweed*	English schooner	1876	360942	5904005
1351097	*Don Colino*	Channel island schooner	1877	355610	5911585
1351111	*Kron Prinz Ernst August*	German schooner	1878	355610	5911585
1347343	*Reprisal*	English ketch	1879	360942	5904005
1351150	*Dora*	English smack	1880	355610	5911585

NMR ID	Name	Description	Date Lost	UTM Easting	UTM Northing
1377823	*Tabor*	Wreck of English collier presumed to have foundered off the Dudgeon while en route from the Tyne for London with coal. This steam vessel was built in 1871.	1881	360942	5904005
1351202	*Wonderful*	English ketch	1883	355610	5911585
1347800	*Hastings*	English cargo vessel	1888	360942	5904005
1347838	*Maglona*	English cargo vessel	1889	360942	5904005
1370547	*William And Susannah*	An English dandy which collided with another vessel and foundered 14 miles east of New Sand light vessel in 1889.	1889	355610	5911585
1351281	*Richard And Frances*	English sloop	1890	360942	5904005
1348394	*Claremont*	English cargo vessel	1891	360942	5904005
1370602	*Sarah*	An English schooner which foundered 18 miles south east of Spurn Head in 1891; wind conditions were west north west force 10. She departed from King's Lynn for Stockton on Tees with a cargo of wheat. The wooden sailing vessel was built in 1861.	1891	355610	5911585
1348470	*Wave*	English keel	1893	360942	5904005
942997	*Hero*	English cargo vessel	1894	360942	5904005
1351864	*Francis*	English ketch	1894	360942	5904005
943005	*Pacifique*	French barque	1895	360942	5904005
928324	*Juanita*	English brig	1897	360942	5904005
1348708	*Obedient*	English cargo vessel	1898	360942	5904005
1351917	*Glencairn*	English brig	1898	360942	5904005
1351919	*Dudgeon Lightship*	English lightship	1898	360942	5904005
928726	*Dudgeon Lightship*	English light vessel	1902	360942	5904005
943046	*Wave*	English schooner	1904	360942	5904005
1302213	*Seagull*	British lugger	1904	355610	5911585
927539	*Silver Spray*	English ketch	1909	360942	5904005
1302268	*Anaconda*	English dandy	1910	360942	5904005
1225550	*Gertrude*	English cargo vessel	1912	360942	5904005
929012	*Scots Greys*	Scottish fishing drifter	1913	360942	5904005
1302304	*Torquay*	Norwegian cargo vessel	1914	355610	5911585
1302307	*Bogatyr*	Danish cargo vessel	1916	360942	5904005

NMR ID	Name	Description	Date Lost	UTM Easting	UTM Northing
1374948	*Lavinia Westoll*	Wreck of English cargo vessel which foundered about 30 miles south east of Spurn Head light vessel after detonating a mine, in a snow storm. This steel steam vessel was en route from Almeria to Middlesbrough with iron ore.	1916	360942	5904005
1352096	*Polzella*	British cargo vessel	1928	355610	5911585
929142	*Borce*	French cargo vessel	1936	360942	5904005
1323066	Blenheim Mk Iv R3765	British bomber	1940	355610	5911585
1325173	Spitfire Mk I L1051	British fighter	1940	360942	5904005
1349570	*Giorgio Ohlsen*	Italian cargo vessel	1940	360942	5904005
1349572	*Baron Ailsa*	Scottish cargo vessel	1940	360942	5904005
1349574	*Burgos*	Norwegian cargo vessel	1940	360942	5904005
1383893	*Chevychase*	Wreck of an English cargo vessel which foundered on the Dudgeon Shoal after detonating a mine. This steel steam vessel, built in 1926, was en route from Blyth to London with coal.	1940	360942	5904005
1349633	*Herport*	English cargo vessel	1941	360942	5904005
1349644	*Ambrose Flemming*	English cargo vessel	1941	360942	5904005
1349673	*Brynmill*	English cargo vessel	1941	360942	5904005
1349692	*Empire Newcomen*	British cargo vessel	1941	360942	5904005
1349703	*Fireglow*	English cargo vessel	1941	360942	5904005
1352164	*Schieland*	Dutch cargo vessel	1941	360942	5904005
1352183	*Cormarsh*	English cargo vessel	1941	360942	5904005
1354038	Hampden Mk I X3021	British bomber	1941	355610	5911585
1352224	*Chatwood*	English cargo vessel	1942	360942	5904005
1354212	Wellington Mk Iv Z1285	British heavy bomber	1942	355610	5911585
1354383	Whitley Mk Vii Z6960	British heavy bomber	1942	355610	5911585
1352230	*Hms Dalemoor*	English cargo vessel	1945	355610	5911585
1370570	*H Smethurst*	An English dandy which burnt and foundered 22 miles east of Spurn Head. The wind conditions were NNE force 5. She departed from Grimsby on a fishing and return trip. The wooden sailing vessel was built in 1865.	Unknown	355610	5911585



1:500,000 at A5 plot size

0 2 4 km 0 1 2 nm

RACE BANK OFFSHORE WIND FARM

Race Bank OWF & Adjacent Wind Farm Areas

Drg No	Rev
6217 - 530 - WA- 001	A

FIGURE 1

350000E

360000E

5910000N

5900000N

Legend

- Palaeochannels
- Sites subject to exclusion zones
- 100m exclusion zones
- Anomalies requiring further investigation
- Race Bank Wind Farm footprint
- Principal Study Area
- Extended Cable Routes
- Extended Cable Route Study Area

Wash Cable Route Corridor

Admiralty Chart 108 (dated 2000)
Positions refer to WGS84 / Projection is UTM31N

amec

centrica energy

1:60,000 at A3 plot size

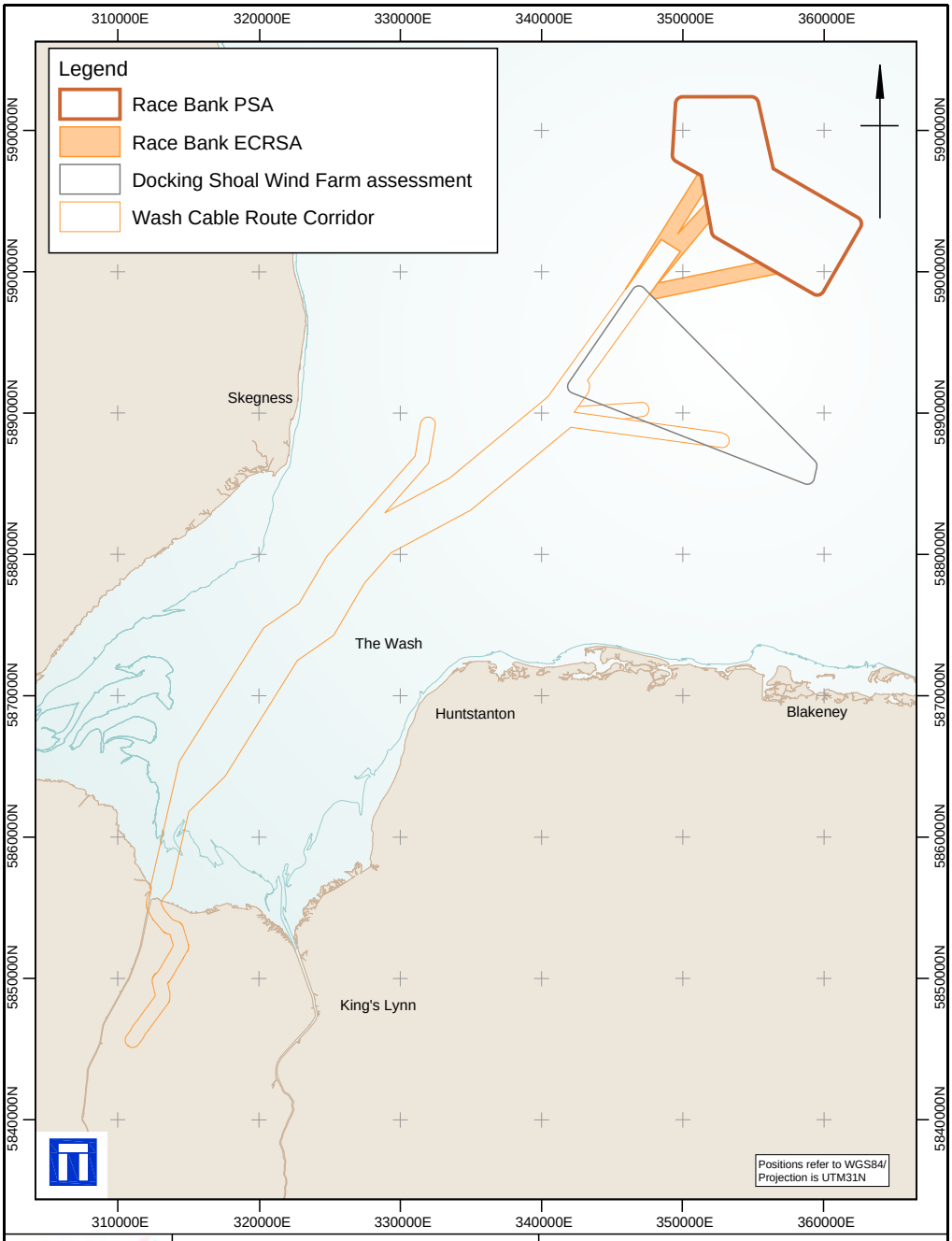
0 1 km 0 1 nm

RACE BANK OFFSHORE WIND FARM

Known Maritime Sites in the PSA and ECRSA

Drg No	Rev
6217 - 530 - WA- 002	A

FIGURE 2



1:500,000 at A5 plot size

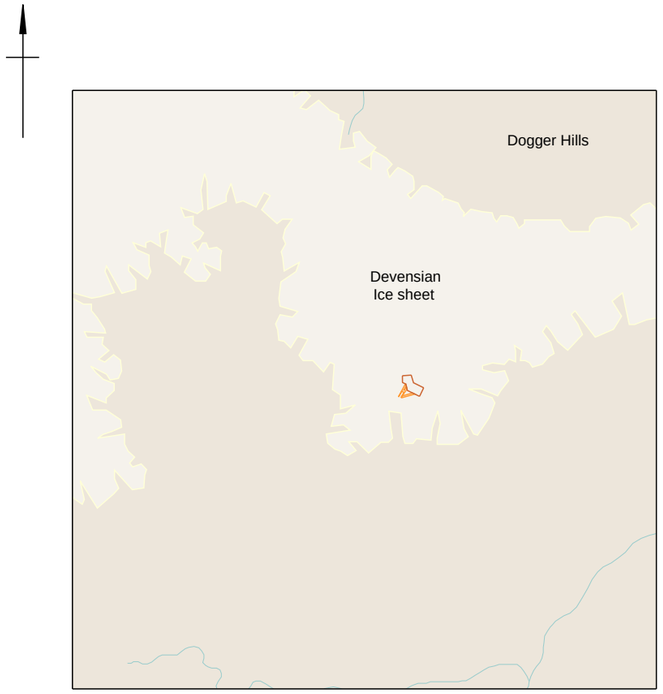
0 2 4 km 0 1 2 nm

RACE BANK OFFSHORE WIND FARM

ECRSA: Areas of Extended Cable Route Not Covered by Previous Assessments

Drg No	Rev
6217 - 530 - WA- 003	A

FIGURE 3



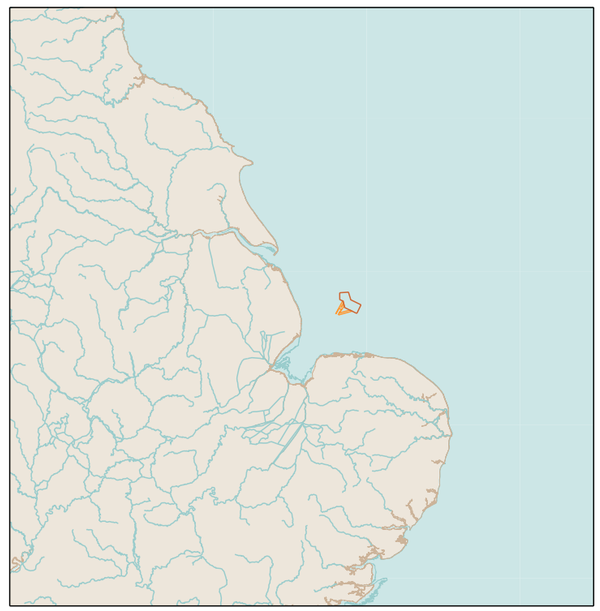
18,000BP

16,000BP

13,000BP

10,000BP

5,000BC



Current coastline

Legend

- Principal Study Area
- Extended Cable Route Study Area

1:4,000,000 at A3 plot size

0 100 km 0 10 20nm

After Coles, 1998

RACE BANK OFFSHORE WIND FARM

Post-Devensian Sea Level Changes

Drg No	Rev
6217 - 530 - WA- 004	A

FIGURE 04

350000E

360000E

5910000N

5900000N

Legend

- Sandwave coverage
- Race Bank Wind Farm footprint
- Principal Study Area
- Extended Cable Routes
- Extended Cable Route Study Area

NORTH RIDGE

RACE BANK

DUDGEON SHOAL

Admiralty Chart 108 (dated 2000)
Positions refer to WGS84 / Projection is UTM31N

amec

centrica energy

1:60,000 at A3 plot size

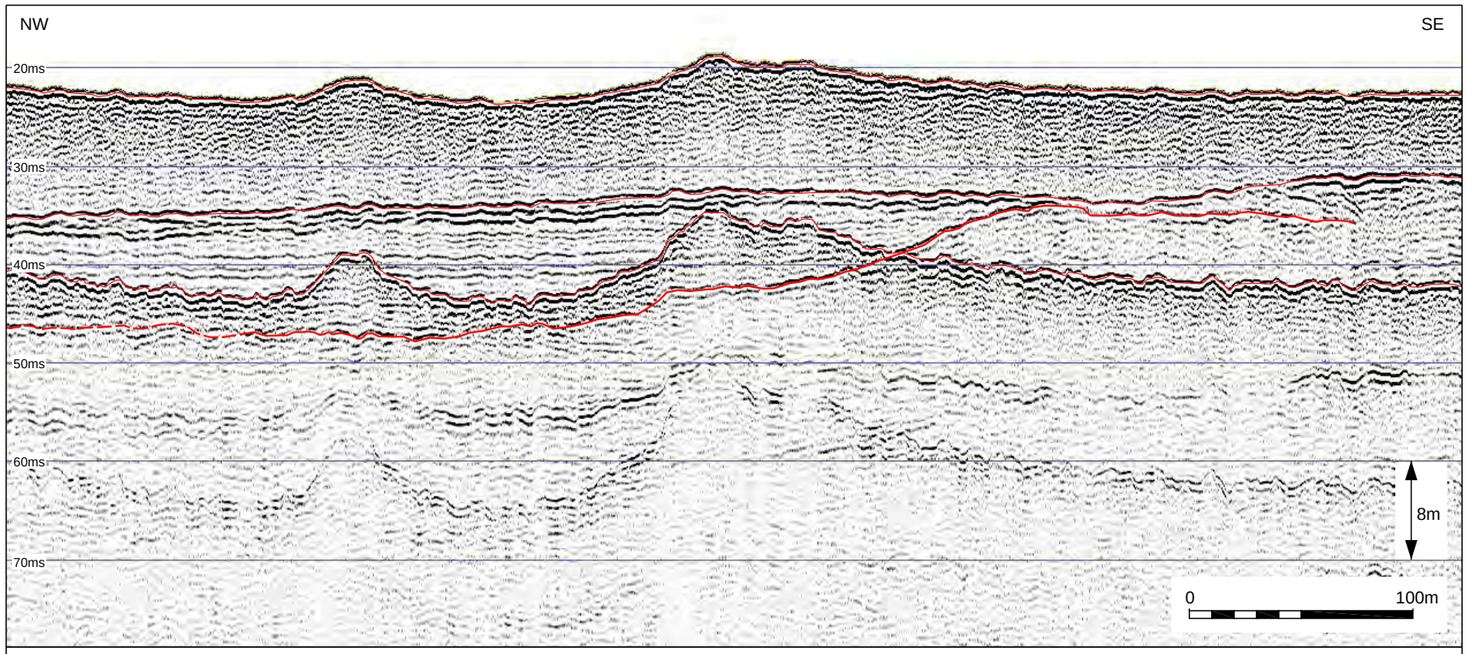
0 1 km 0 1 nm

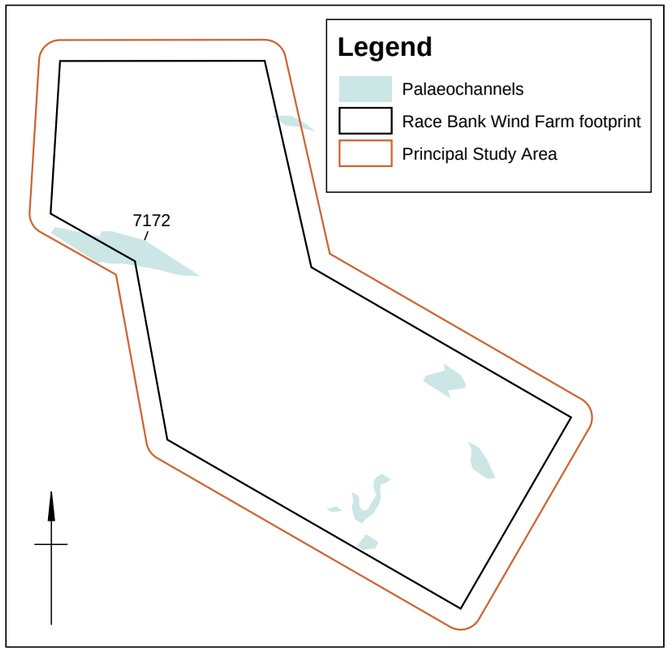
RACE BANK OFFSHORE WIND FARM

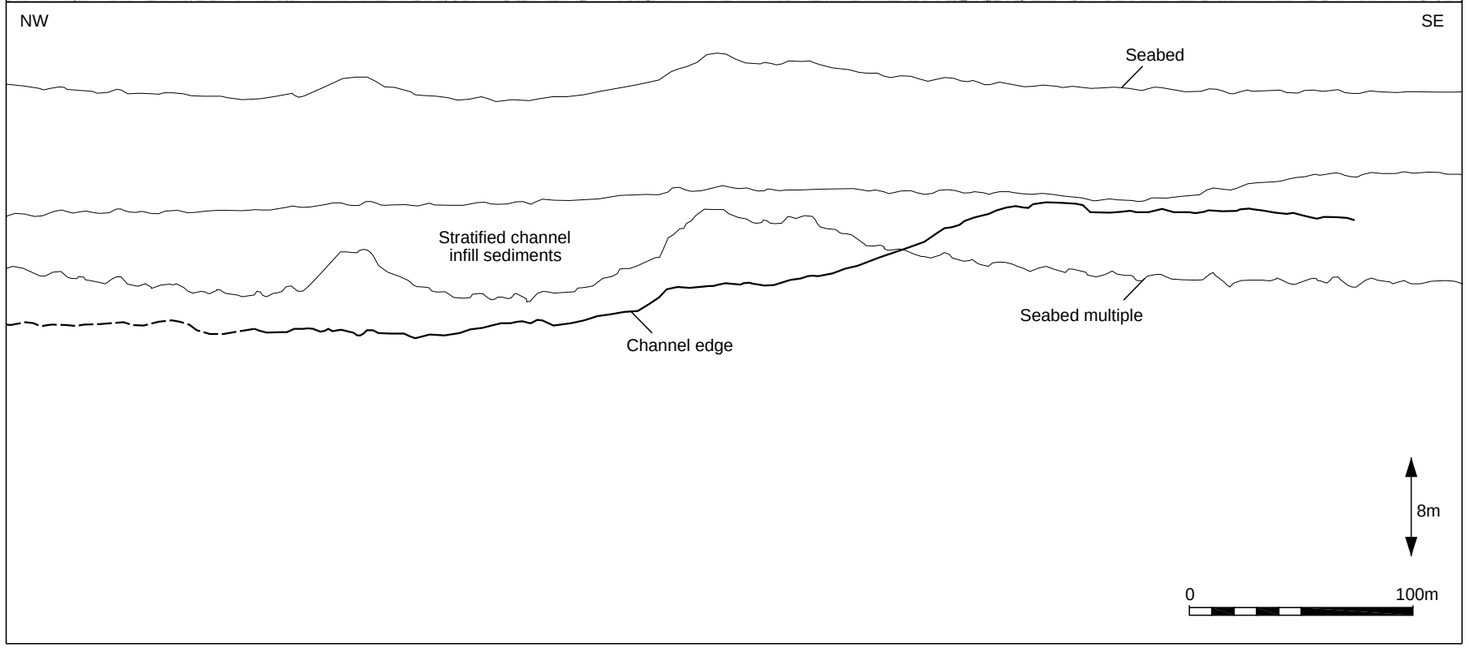
Sandwave Coverage in the PSA and ECRSA

Drg No	Rev
6217 - 530 - WA- 005	A

FIGURE 5







Sub-bottom profiler data example illustrating stratified channel infill sediments (WA 7172)

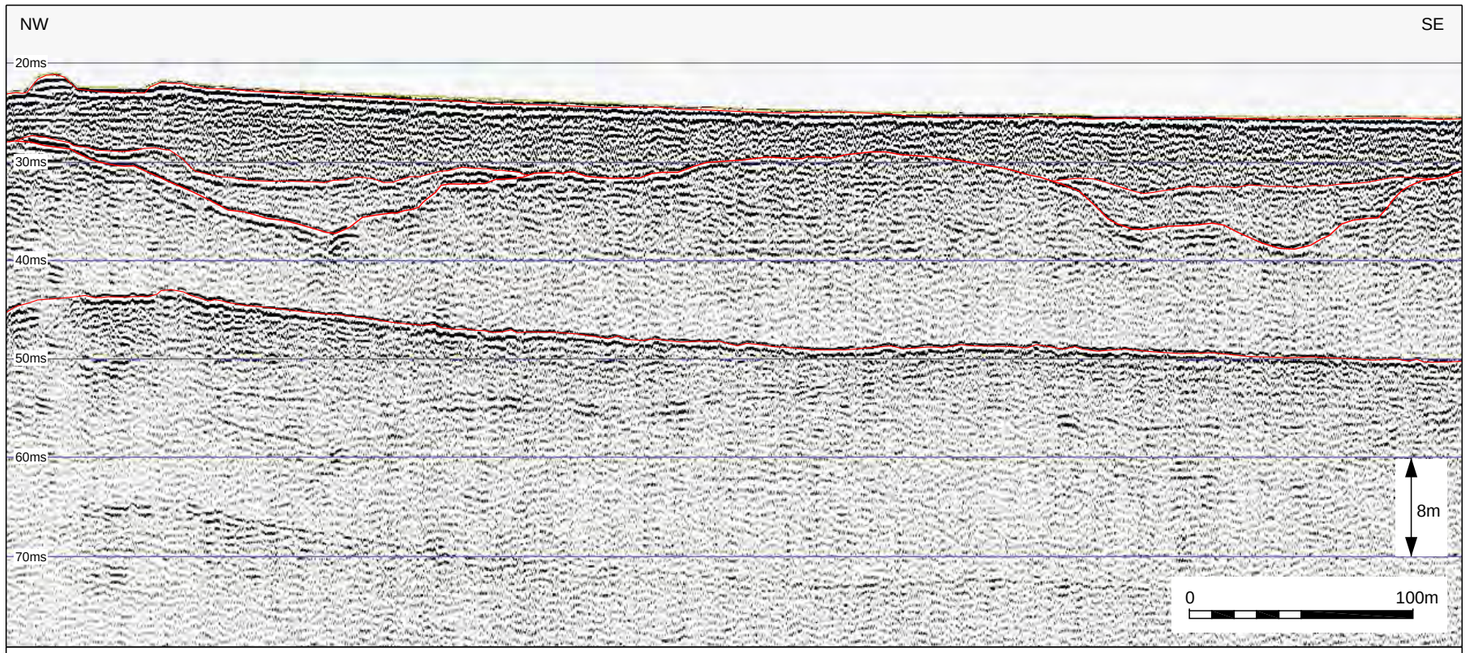
Projection is UTM31N

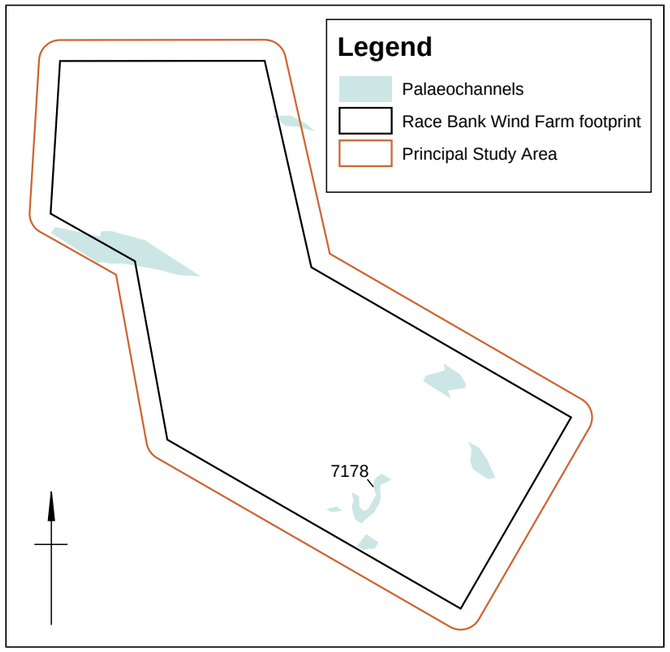
1:500 vertical scale at A3 plot size

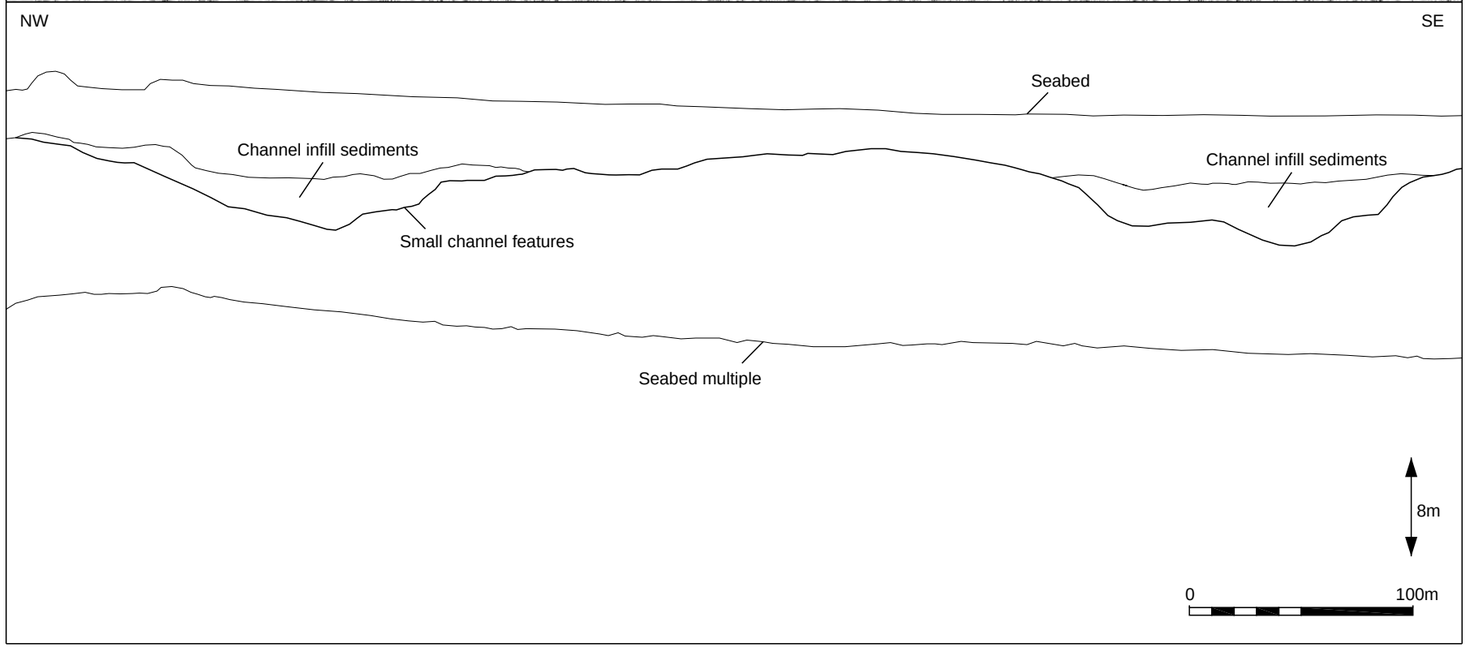
RACE BANK OFFSHORE WIND FARM
Sub-bottom Profiler Data Example (WA7172)

Drg No	Rev
6217 - 530 - WA - 006	A

FIGURE 6







Sub-bottom profiler data example illustrating small channel features (WA 7178)

Projection is UTM31N

1:500 vertical scale at A3 plot size

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Sub-bottom Profiler Data Example (WA7178)

Drg No	Rev
6217 - 530 - WA- 007	A

FIGURE 7

350000E

360000E

5910000N

5900000N

Legend

- Palaeochannels
- Sites subject to exclusion zones
- 100m exclusion zones
- Anomalies requiring further investigation
- Race Bank Wind Farm footprint
- Principal Study Area
- 3MW turbine option
- Substations
- Inter-turbine cables combination option

NORTH RIDGE

RACE BANK

DUDGEON SHOAL

N Docking

F.l.G.5s 13-Bell

N Race

Obstn

Admiralty Chart 108 (dated 2000)
Positions refer to WGS84 / Projection is UTM31N

amec

centrica energy

1:60,000 at A3 plot size

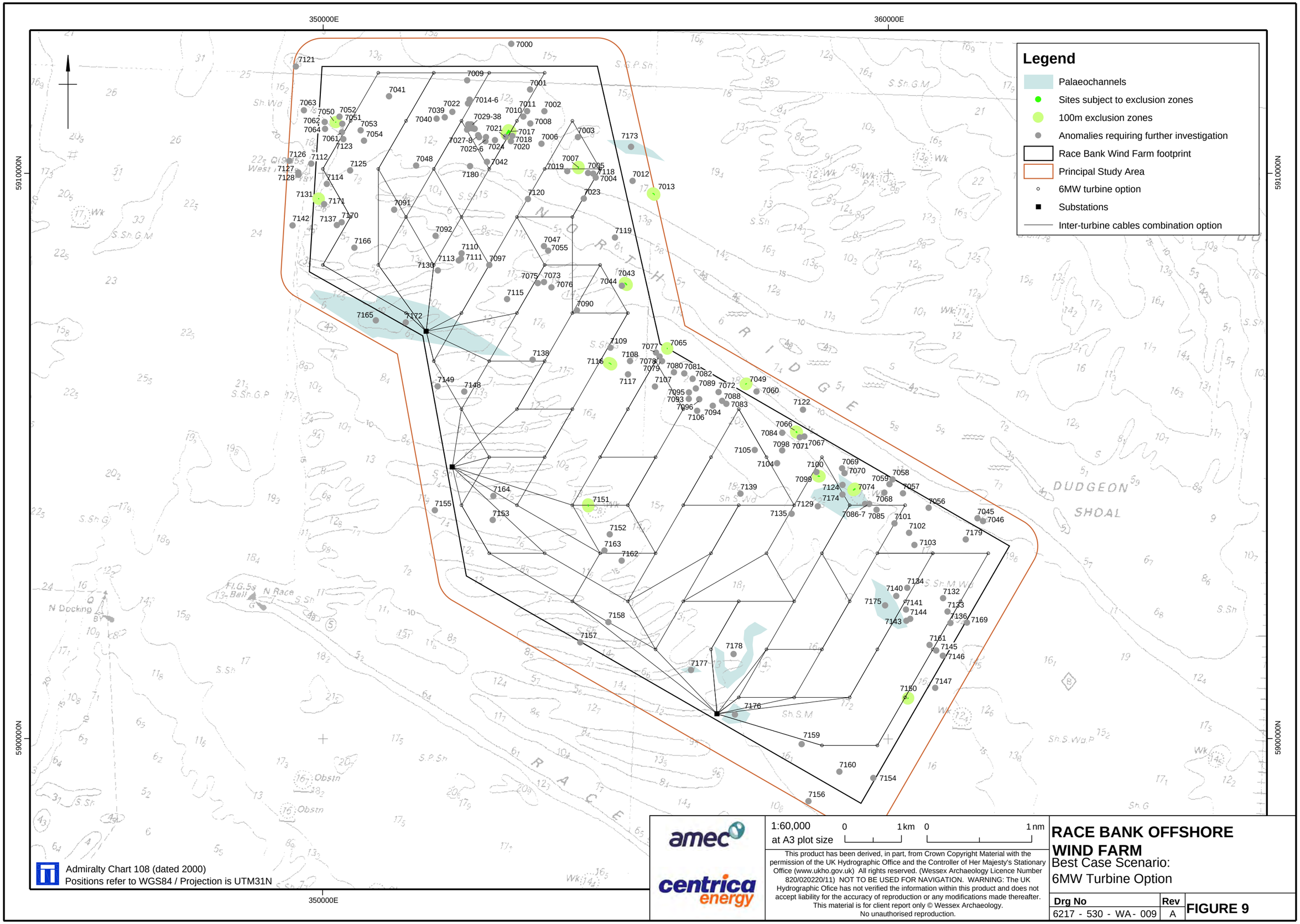
0 1 km 0 1 nm

RACE BANK OFFSHORE WIND FARM

Worst Case Scenario:
3MW Turbine Option

Drg No	Rev
6217 - 530 - WA- 008	A

FIGURE 8



amec

centrica energy

1:60,000 at A3 plot size

0 1 km 0 1 nm

RACE BANK OFFSHORE WIND FARM

Best Case Scenario:
6MW Turbine Option

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6217 - 530 - WA- 009	A

FIGURE 9

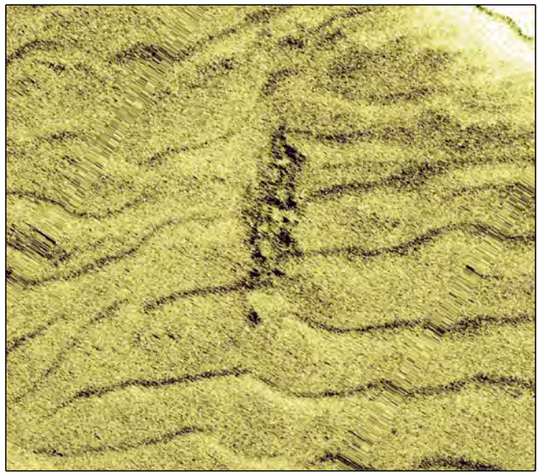
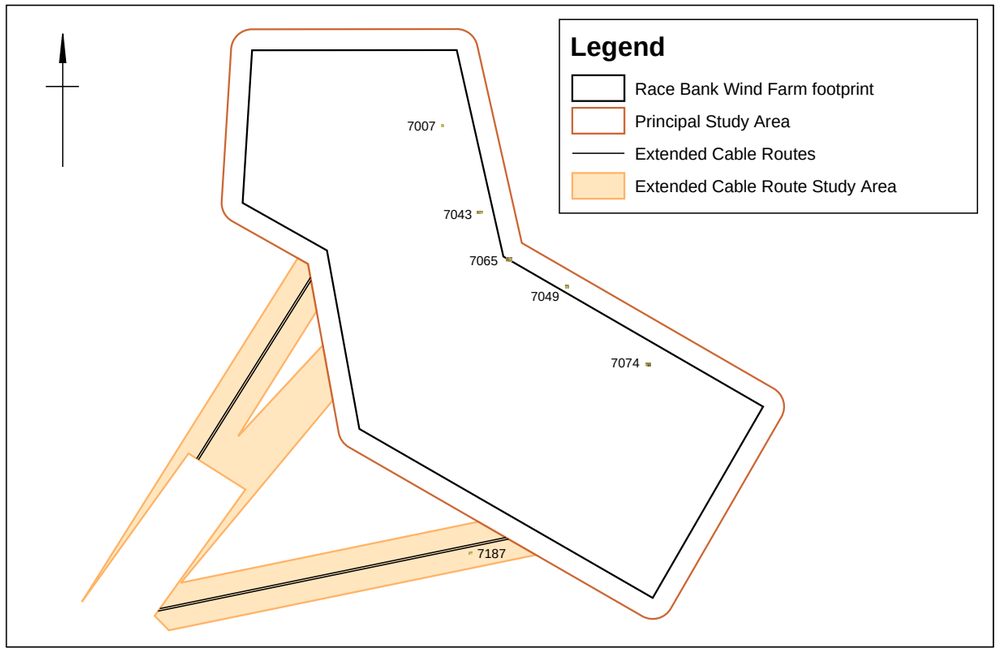


Plate 1. Site 7007: Probable wreck site measuring 25.6 x 8.3m situated in an area of sandwaves



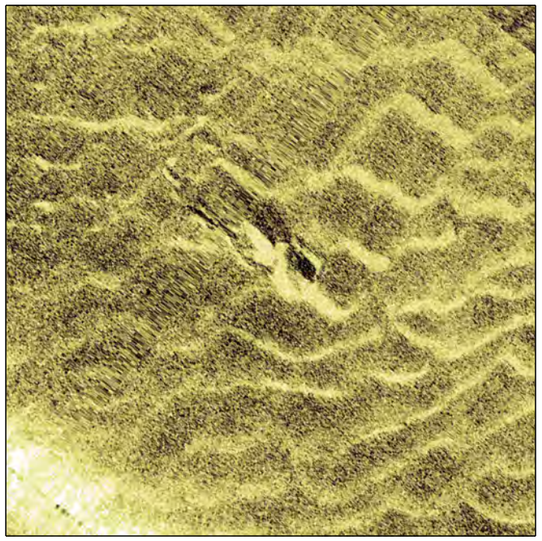


Plate 2. Site 7043: Debris or possible wreck site covering an area of 52 x 15m. The anomaly has a maximum height of 0.6m

Plate 3. Site 7049: Site formed by angular dark reflectors, interpreted as a possible wreck measuring 21 x 7.5m

Projection is UTM31N

1:750 at A3 plot size

0 10m

RACE BANK OFFSHORE WIND FARM

Sidescan Sonar Data Examples of Sites that have Exclusion Zones

Drg No	Rev	
6217 - 530 - WA - 005	A	**PLATES 1-3**

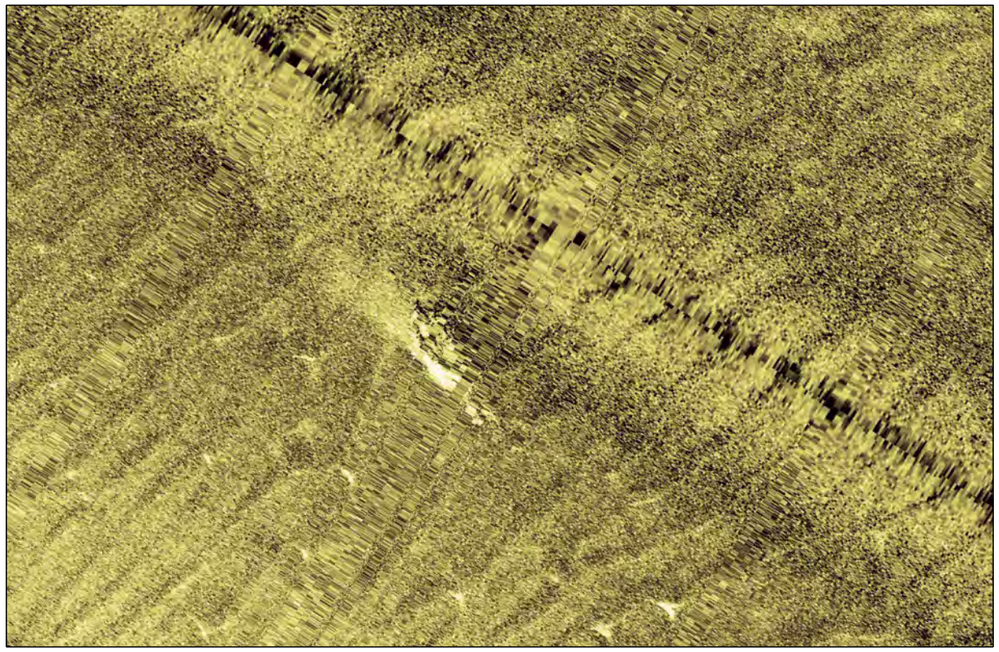


Plate 4. Site 7065: Possible small wreck site measuring 12.4 x 6.2 x 1.1m

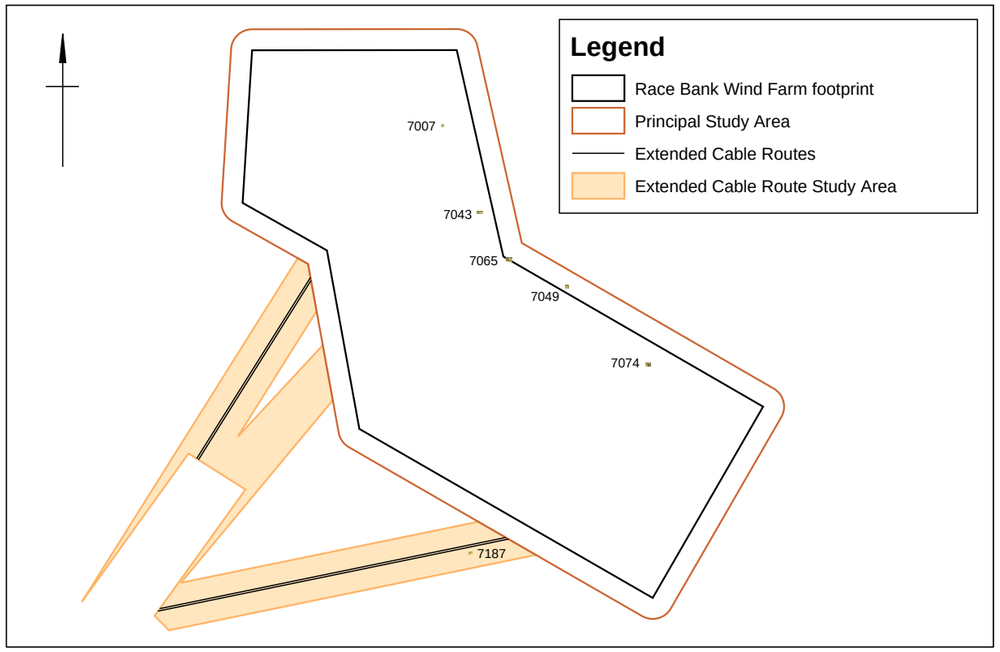


Plate 5. Site 7074: Wreck (41.9 x 15 x 2.7m) observed with obvious structure and associated debris

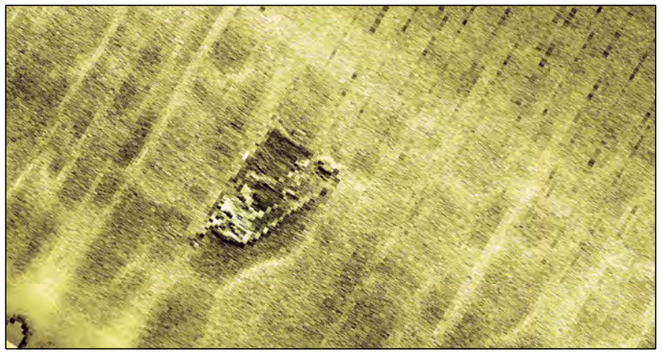


Plate 6. Site 7187: Small wreck showing some height (15.7 x 7.0 x 0.6m) situated in an area of sand waves

Projection is UTM31N

Plate 4&6 1:750, Plate 5 1:500 at A3 plot size

0 10m Plate 4&6

0 10m Plate 5

RACE BANK OFFSHORE WIND FARM

Sidescan Sonar Data Examples of Sites that have Exclusion Zones

Drg No	Rev	
6217 - 530 - WA- 010	A	**PLATES 4-6**

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