Wessex Archaeology

Aggregate Dredging Licence Application Area 228

Archaeological Assessment

Ref: 78670.02

December 2011

AGGREGATE DREDGING LICENCE APPLICATION

AREA 228
ARCHAEOLOGICAL ASSESSMENT

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Archaeological Assessment
Area 228

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AGGREGATE DREDGING LICENCE APPLICATION

Archaeological Assessment
Area 228

Report ref.: 78670.03

Summary

Wessex Archaeology (WA) was commissioned by Volker Dredging Limited (VDL) to undertake an Environmental Impact Assessment in relation to marine heritage and in preparation for a licensing application for aggregate extraction from Area 228. Licence Area 228 is located 12km east of Great Yarmouth. The proposal is for dredging permission allowing a maximum extraction of 22,500,000 tonnes of sand and gravel aggregate over a 15 year period, with a maximum single year off-take of 3 million tonnes. The final application tonnage will be dependent upon the outcome of a full resource survey undertaken in 2011.

To provide archaeological context for the assessment, a Marine Study Area (MSA) was created within Area 228 contextualised by a 1km buffer around the Licence Area; for the purpose of collating data and to consider the overall potential for archaeological remains, and to view the site in a broader archaeological context.

A variety of sources have been consulted, including: the National Monuments Record; the UK Hydrographic Office; the Ministry of Defence; the Shipwreck Index of the British Isles; the records of salvage droits held by the Receiver of Wreck for the relevant area; finds discovered through the English Heritage/British Marine Aggregate Producers Association (BMAPA) Protocol; the East Coast Regional Environmental Characterisation (EC REC) (Limpenny *et al*. 2011) and; the Anglian Offshore Dredging Association Marine Aggregate Regional Environmental Assessment (AODA MAREA) (Wessex Archaeology 2010a).

Historical and archaeological data were combined with seabed and sub-bottom geophysical survey datasets and geotechnical core logs to allow an assessment of the archaeological potential in three broad temporal categories relating to the sequence of inundation for the application area. These are defined as follows:

- Lower, Middle and Early Upper Palaeolithic remains, either as derived artefacts or as possible *in situ* remains;
- Late Upper Palaeolithic and/or Mesolithic artefacts *in situ* and derived;
- Wrecks and related material, from prehistoric to modern times.
    - It should be noted that aircraft crash sites are included in this assessment as wreck as a matter of course. Any remains of crashed military aircraft are automatically protected under the Protection of Military Remains Act (PMRA) 1986.

Following a Stage 1 geotechnical assessment it is clear that the sequences contained within the 25 vibrocores, whilst in some cases difficult to ascribe with confidence to particular units/formations, are in many aspects similar to sediments recorded in and studied in adjacent dredging areas.

The prehistoric archaeological potential of the sediments is discussed in **Section 12** of this report. The majority of the area is covered by Devensian and Holocene sands of low potential for prehistoric archaeological receptors, however, it is reiterated that sediments within some of these vibrocores are similar to the sediments within the adjacent Area 240 associated with finds of prehistoric artefacts, denoted as Unit 3b (Wessex Archaeology 2011a; 2011b).

There are 9 seabed anomalies of archaeological and possible archaeological interest within the Study Area.

Archaeological Discrimination	Number of Anomalies	Interpretation
A1	1	Anthropogenic origin of archaeological interest
A2	8	Uncertain origin of possible archaeological interest
A3	0	Historic record of possible archaeological interest with no corresponding geophysical anomaly
Total	**9**	

One anomaly from within the study area, **7001**, has been classified as a possible wreck (A1 archaeological discrimination). This anomaly was mainly identified from the multibeam bathymetry and sub-bottom profiler data, where it is seen to be a mound measuring approximately 46 x 18 x 4m. Scour measuring up to 1m deep has been identified to the north and south of the feature, suggesting it is an anomalous hard feature located on the seabed rather than an isolated sand wave. The feature was poorly resolved on the sidescan sonar data, and so further detail was not visible (**Figure 6**). Eight other seabed anomalies may relate to unknown wrecks of ships and aircraft (**Appendix II**). There are no recorded losses and named locations within the Study Area but there is significant regional potential for aircraft and maritime losses which may relate to these kinds of anomalies (Wessex Archaeology 2008a; Wessex Archaeology 2010a).

An Environmental Impact Assessment (EIA) of direct and indirect effects (including cumulative and in-combination impacts) of dredging activity upon the known and unknown cultural heritage receptors within the MSA was undertaken underpinned by a regional and study area specific baseline with geophysical and geotechnical assessments of the seabed and sub-seabed of the Area 228 study area. The EIA methodology is focused upon the value and/or sensitivity of identified cultural heritage receptors and the likely magnitude of dredging-induced impacts where appropriate evidence exists. Due to the significantly unknown distribution of cultural heritage receptors on or beneath the seabed a precautionary approach is taken where direct evidence is not available.

Positive impacts aiding the preservation of all archaeological receptors are likely to occur due to the sediment plume produced by dredging activity. Negative effects of substrate removal, bathymetric change and sediment transport were also assessed. The EIA is summarised as follows:

Receptors of Prehistoric Archaeology; *isolated prehistoric finds* and *sites of prehistoric archaeological interest* are judged to be potentially exposed to negative impacts of **major negative significance**. This impact may be reduced to **moderate negative significance** with the proposed mitigation strategies.

Receptors of Maritime Archaeology; *unknown uncharted wreck sites* and *isolated maritime finds* were judged to be potentially exposed to negative impacts of **major negative**

significance and **moderate-major negative significance**, respectively. This impact may be reduced to moderate/minor negative significance with the proposed mitigation strategies.

Receptors of Aviation Archaeology; *unknown uncharted aircraft crash sites* and *isolated aircraft finds* were judged to be potentially exposed to negative impacts of **major negative significance** and **moderate-major negative significance**, respectively. This impact may be reduced to **minor/moderate negative significance** and **minor negative significance**, respectively with the proposed mitigation strategies.

Mitigation recommended includes:

- use of the TCE/BMAPA Protocol for Archaeological Discoveries;
- the use of exclusion zones to avoid impacts on known archaeology;
- a monitoring programme, at five yearly intervals, to assess the state of archaeological assets.

Effective mitigation may be achieved through avoidance of known cultural heritage receptors such as the possible unknown wreck (**WA 7001**), which may involve exclusion zones. In addition, the analysis of geotechnical cores will contribute to effective mitigation (Gribble and Leather 2011). The continued industry good-practice of reporting finds of archaeological interest through the TCE/BMAPA/EH Protocol (2005) will also contribute to any overall mitigation strategy.

AGGREGATE DREDGING LICENCE APPLICATION

Environmental Impact Assessment
Area 228

Report ref.: 78670.03

Acknowledgements

Wessex Archaeology was commissioned by Volker Dredging Limited (VDL) to undertake an Environmental Impact Assessment of a provisional licence renewal within part of Area 228. Will Drake at VDL is thanked in this respect.

The report was compiled by Dr Andrew Bicket and written by Stuart Churchley, Jack Russell and David Howell. Illustrations were created by Kitty Foster. The project was managed by Toby Gane. Quality control was provided by Euan McNeill.

A summary of archaeological site data in the Area 228 Study Area was obtained from the National Monuments Record (NMR), Swindon. Copyright restrictions apply to any data that may be obtained by the NMR.

- Digital Map Data © (2004) XYZ Digital Map Company.
- UKHO Data supplied under Wessex Archaeology Licence Number 820/020220/11).

AGGREGATE DREDGING LICENCE APPLICATION

Environmental Impact Assessment
Area 228

Report ref.: 78670.03

Contents

Tables

Figures

AGGREGATE DREDGING LICENCE APPLICATION

Environmental Impact Assessment
Area 228

Report ref.: 78670.03

1. INTRODUCTION

1.1.1. Wessex Archaeology (WA) was commissioned by Volker Dredging Limited (VDL) to undertake an Environmental Impact Assessment (EIA) in preparation for a licensing renewal application for aggregate extraction from a portion of Area 228. Licence Area 228 is located 12km east of Great Yarmouth.

1.1.2. This report comprises a desk-based archaeological assessment of Area 228 and considers the potential for further finds based on the wider cultural landscape in which this area is set. The report will identify any potential impacts from marine aggregate extraction operations within these areas and will provide information and guidance on managing these impacts.

1.1.3. For the purposes of this report, the marine archaeological resource is considered to comprise:

- Prehistoric archaeology;
- Maritime archaeology;
- Aviation archaeology.

2. AIMS AND OBJECTIVES

2.1.1. The aim of this environmental impact assessment, is to corroborate existing archaeological data and evidence, with recent geophysical and geotechnical sampling.

2.1.2. The objectives of this assessment are:

- To set out the statutory, planning and policy context relating to the marine historic environment;
- To provide an overview of the marine archaeological resource within Dredging Area 228 based upon existing archaeological records, existing archaeological assessments and secondary sources;
- To identify known cultural heritage receptors that may be impacted by the proposed development;
- To summarise the potential for as yet undiscovered marine sites that may be impacted by the proposed development; and
- To assess the significance of the effects of the potential impacts and to recommend appropriate mitigation if required.

3. STUDY AREA

3.1.1. Coordinates for Area 228 were supplied in WGS 84 decimal degrees format by the Crown Estate website (**Table 1**). The provisional renewal area would be predominately two thirds of the existing licence dredging area; these coordinates are provided in **Table 2**. The WGS 84 geographical co-ordinates were projected into the Universal Transverse Mercator projection, Zone 31 Northern hemisphere (UTM 31N) (**Figure 1**). A Marine Study Area (MSA) was created around the renewal area coordinates in **Table 2** which has been buffered by 1 km in order to provide context to the area of interest, and to ensure sufficient capture of any inaccurately positioned historical records. The MSA defines the search area of documentary sources of wreck records discussed in **section 4.2**.

Vertex	WGS84 (degrees decimal minutes)		UTM Zone 31N	
	Easting	Northing	Easting	Northing
1	01 55.3907	52 33.1232	426990	5822987
2	02 00.7902	52 33.6232	433104	5823826
3	02 00.7903	52 31.9234	433061	5820675
4	01 55.3908	52 31.2234	426937	5819465

Table 1: Licence Dredging Area 228 corner coordinates

Vertex	WGS84 (degrees decimal minutes)		UTM Zone 31N	
	Easting	Northing	Easting	Northing
1	01 55.3907	52 33.1232	426990	5822987
2	01 58.4721	52 33.4049	430479	5823458
3	01 58.4938	52 32.6699	430484	5822095
4	01 58.8537	52 32.7216	430892	5822185
5	01 59.1880	52 31.7156	431244	5820315
6	01 55.3908	52 31.2234	426937	5819465

Table 2: Provisional renewal area for Licence Dredging Area 228 and 1km study area

3.1.2. The potential for archaeological remains is considered with reference to archaeological studies within Suffolk and Norfolk and closely aligned to baseline studies undertaken on the AODA MAREA (Wessex Archaeology 2010a) and EC REC (Limpenny *et al*. 2011), alongside recent work undertaken at Area 240 (Wessex Archaeology 2011a; 2001b).

4. ARCHAEOLOGICAL DATA SOURCES

4.1. LEGISLATION

4.1.1. The statutory planning and policy context relating to the historic environment in the Area 228 is set out in **Appendix I** of this report.

4.1.2. In summary, the legislation which relates specifically to the maritime historic environment in English territorial waters is the **Protection of Wrecks Act 1973**. The **Merchant Shipping Act 1995** is also relevant as it plays a significant role in the reporting of recovered marine archaeological material. Furthermore, the **Protection of Military Remains Act 1986** relates to the marine historic environment with regards to military ship and aircraft remains of historic interest. The introduction of the **National Heritage Act 2002** has given English Heritage (EH) responsibility for archaeology below the low watermark. This includes historic wrecks and historic landscapes in, or under the seabed, out to the 12 nautical mile territorial limit around England. Beyond the 12 mile limit EH should be considered a stakeholder and consulted at the Environmental Impact Assessment (EIA) stage.

4.1.3. There are currently no protected shipwrecks within Licence Dredging Area 228 or the surround 1km buffer although there is potential for unknown aircraft wrecks (Wessex Archaeology 2008a).

4.2. SOURCES

4.2.1. The 1km buffered MSA has been used to define the search areas for archaeological and related data. The main sources consulted in the assessment are as follows:

- Records of UKHO wrecks and obstructions
- Records of Named Losses, other wrecks, maritime obstructions and terrestrial sites of all periods held by the National Monuments Record, recently renamed as the National Record for the Historic Environment (NRHE);
- Various secondary sources relating to the palaeo-environment and to the Palaeolithic and Mesolithic archaeology of Northern Europe with specific reference to the ALSF *Seascapes Project* (Southwold to Clacton) (Oxford Archaeology 2007) and information derived from BMAPA discoveries (BMAPA and English Heritage 2005);
- Various secondary sources relating to historic shipping patterns, as well as those sources relating to known and potential wreck sites and causalities, with specific reference to ALSF *England's Shipping* (Wessex Archaeology 2003) and ALSF *Navigational Hazards* (Bournemouth University 2007);
- ALSF *Air Crash Sites at Sea* (Wessex Archaeology 2008a) and various secondary sources relating to historic aviation patterns;
- Various other Wessex Archaeology sources relating to previous studies carried out within the MAREA area;
- Geotechnical data, comprising vibrocore logs, provided by Hanson Aggregates Marine Ltd (HAML) and Volker Dredging Ltd (VDL) (**see section 5**);
- Geophysical and geotechnical data and interpretations created during the East Coast Regional Environmental Characterisation (REC) (Limpenny *et al*. 2011),

the AODA MAREA (Wessex Archaeology 2010a) and recent work undertaken at Area 240 (Wessex Archaeology 2011a, 2011b) (**see section 6**).

4.2.2. The NRHE database was also queried for known and charted wreck sites, Named Losses and obstructions. UKHO wrecks and obstructions were also queried for both live and dead features. Although there is duplication in some of this data, utilising the NRHE wreck records allowed for an indication of the density of maritime activity and its history within Area 228 and a surrounding buffer to be inferred, despite the imprecise locations of many of the vessels.

5. GEOTECHNICAL ASSESSMENT METHODOLOGY

5.1. DATA SOURCES

5.1.1. Wessex Archaeology was commissioned by Volker Dredging Limited (VDL) to undertake a Stage 1 review of vibrocore logs. Licence Area 228 is located *c*. 12km east of Great Yarmouth.

5.1.2. A recent vibrocore survey comprising a total of 25 vibrocore logs (VC101 to VC125) and photographs (Gardline 2011b) have been reviewed in order to better understand the sedimentary sequence, palaeoenvironmental and archaeological potential of aggregate Area 228. It is noted that no log for vibrocore VC104 is contained within the survey report. The locations and depths of the vibrocores are given in **Table 3**.

Vibrocore sample ID	WGS 84 UTM Z31N		Seabed (m below OD)
	Easting	Northing	
VC101	427249	5822689	27.6
VC102	427782	5822728	29.1
VC103	428371	5822728	26.6
VC104	428968	5822998	-
VC105	429500	5823149	25.8
VC106	427221	5822001	27.3
VC107	428769	5822500	26.4
VC108	429280	5822300	27.9
VC109	429753	5822002	25.4
VC110	430268	5821998	26.9
VC111	427211	5821385	28.4
VC112	428870	5821710	29.9
VC113	429269	5821497	25.87
VC114	430079	5821459	27.37
VC115	427220	5820761	29.1
VC116	428199	5820729	30.6
VC117	429250	5821001	27.9
VC118	429790	5821001	29.4
VC119	430541	5820997	25.8
VC120	427262	5819998	27.3
VC121	428329	5819995	28.7
VC122	429349	5820499	30.2
VC123	430191	5820497	24.3
VC124	429376	5820177	25.8
VC125	430497	5820327	24.4

Table 3: Vibrocore ID, location and depth

5.1.3. The elevation of the vibrocores has been calculated using the bathymetric data of Gardline (2011a). These have been converted to Ordnance Datum using the figure of Chart Datum (CD) being elevated at 1.5m below Ordnance Datum (OD) at Lowestoft (Admiralty Chart 1528).

5.2. GEOTECHNICAL ASSESSMENT - PROCESSING

5.2.1. The data has been compared to previously reviewed vibrocore surveys (Andrews Survey 2002) the East Coast Regional Environmental Characterisation Survey

(Limpenny *et al.* 2011) the geological maps and interpretations produced by the British Geological Survey (Cameron *et al*. 1995) and to specific archaeological work in adjacent aggregate extraction areas (Wessex Archaeology 2011a; 2011b).

5.2.2. In order to better understand the vibrocore data it has been entered into ArcGIS and Rockworks databases so that it can be viewed and compared with other data.

6. GEOPHYSICAL ASSESSMENT METHODOLOGY

6.1. DATA SOURCES

6.1.1. A UKHO wreck search and NRHE search were carried out prior to this assessment. Any sites, either previously recorded in these databases or identified during this geophysical assessment, which are located outside of the survey areas are deemed beyond the scope of the current project and are subsequently not included in this report.

6.1.2. Further background information was obtained from the Gardline Environmental survey report and vibrocore survey (Gardline 2011a; 2011b) and previous vibrocore survey undertaken by Andrews Survey (Andrews 2002).

6.1.3. The geophysical used for this report were assessed for quality and each system rated using the following criteria in **Table 4**:

Data Quality	Description
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 the 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 to 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 4: Criteria for assigning data quality rating

6.1.4. The sidescan sonar data have been rated as “Variable” using the above criteria. Frequent ‘snatching’, probably due to weather conditions encountered during the survey, was observed on all records, and the outer 10m – 20m of the range used was often poorly resolved. Because of this it can not be guaranteed that all sites of potential archaeological interest from within the supplied study area have been identified.

6.1.5. The sub-bottom profiler data have been rated as “Variable” using the above criteria. A large amount of ringing was observed on all records which masked a large amount of data. Processing was undertaken to reduce this effect but, due to the ringing being created by the seismic source and so being within the same frequency range as the actual data, only a limited amount could be achieved. Because of this it can not be guaranteed that all features of potential archaeological interest from within the supplied study area have been identified.

6.1.6. The multibeam bathymetry data were rated as “Good” using the above criteria.

6.2. GEOPHYSICAL DATA – TECHNICAL SPECIFICATIONS

6.2.1. The data assessed were obtained by Gardline Environmental between the 22nd and 24th April 2011 on the MV Ivero. The dataset consisted if sidescan sonar, sub-bottom profiler (boomer) and multibeam bathymetry data.

6.2.2. Gardline used an Edgetech 4200-FS dual frequency sidescan sonar operated at both frequencies (100/420kHz) and a range of 150m range per channel. Variable towfish layback was monitored using a cable counter and the values input to the navigation system during acquisition. The data were recorded digitally using Edgetech Discover software, and supplied to WA as both *.jsf* and *.xtf* files.

6.2.3. An Applied Acoustics surface-towed boomer operated at 250J, combined with a Gardline 120/ver2 trailing hydrophone, were used to acquire the sub-bottom profiler data. A fixed layback was used for the positioning of the system. The data were recorded digitally using Coda DA200 acquisition system and were provided to WA as *.sgy* files.

6.2.4. The multibeam bathymetry data were acquired using a Kongsberg Simrad EM3002D 300kHz system coupled with a Seapath motion reference unit. The data were recorded digitally using Kongsberg Simrad SIS software and provided to WA as a *.xyz* file.

6.2.5. Primary positioning for the survey was provided by a DGPS utilising a Seapath GPS receiver, secondary positioning was provided by a Hemisphere Crescent DGPS system, and tertiary positioning was provided by a Trimble BD950. All received corrections from the Fugro Starfix Network, with further corrections provided to the Hemisphere Crescent GPS from the EGNOS differential network.

6.2.6. All positions for the survey were recorded in and expressed as WGS 1984, UTM Zone 31N.

6.3. GEOPHYSICAL DATA – PROCESSING

6.3.1. 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 give an understanding of the geological nature of the area and were then interpreted for any objects of possible anthropogenic origin. This involves creating a database of anomalies within Coda by tagging individual features of possible archaeological potential, recording their positions and dimensions, and acquiring an image of each anomaly for future reference.

6.3.2. A mosaic of the sidescan sonar data is produced during this process to assess the quality of the sonar towfish positioning. The survey lines are smoothed, and the navigation corrected either with CNV files provided by the survey company who acquired the data or individual fixed laybacks as recorded in the survey logs. This allows the position of anomalies to be checked between different survey lines and for the layback values to be further refined if necessary.

6.3.3. The form, size, and/or extent of an anomaly is a guide to its potential to be an anthropogenic feature, and therefore of its potential archaeological interest. 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 of a feature as a result of past impacts from, for example, dredging or fishing. The application of a ratings system is therefore a means of prioritising sites in order to inform further staged of the interpretation process, and on its own is not definitive.

6.3.4. 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.

6.3.5. The shallow seismic data were processed by WA using Coda Seismic+ software. This software allows the data to be visualised 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.

6.3.6. The shallow seismic data were interpreted with a 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 1,600ms-1. This is a standard estimate for shallow, unconsolidated sediments.

6.3.7. Any small reflectors which appear to be buried material such as a wreck site covered by sediment were also recorded, the position and dimensions of any such objects noted in a gazetteer, and an image of each anomaly acquired. It should be noted that anomalies of this type are rare, as the sensors much pass directly over such an object in order to produce an anomaly.

6.3.8. The multibeam bathymetry data were used to provide a vertical reference for the sub-bottom profiler data, and were fully analysed to identify any unusual seabed structure that could be shipwrecks or other anthropogenic debris. The data were gridded and analysed using Fledermaus software, which enables 3-D visualisation of the acquired data and geo-picking of seabed anomalies.

6.4. GEOPHYSICAL DATA – ANOMALY GROUPING AND DISCRIMINATION

Seabed Features

6.4.1. The previous section describes the initial interpretation of all available geophysical data sets, which were conducted independently of each other. This inevitably leads to the possibility of any one object being the cause of numerous anomalies in different data sets and apparently overstating the number of archaeological features in the study area.

6.4.2. To address this fact, the anomalies were grouped together along with the results of the desk-based study of known archaeological sites. This allows one ID number to be assigned to a single object for which there may be, for example, a UKHO record, a magnetic anomaly, and multiple sidescan sonar anomalies.

6.4.3. Once all the geophysical anomalies and desk-based information have been grouped, as discrimination flag is added to the record in order to discriminate against those which are not thought to be of an archaeological concern. These flags are ascribed in **Table 5**.

Non-Archaeological	U1	Not of anthropogenic origin
	U2	Known non-archaeological feature
	U3	Non-archaeological hazard
Archaeological	A1	Anthropogenic origin of archaeological interest
	A2	Uncertain origin of possible archaeological interest
	A3	Historic record of possible archaeological interest with no corresponding geophysical anomaly

Table 5: Criteria discriminating relevance of feature to proposed scheme

6.4.4. All the sites that have been identified within the study areas are presented in **Appendix II** and discussed in this report. Recommendations have been made for mitigation measures should the sites be impacted by the proposed extraction.

6.4.5. The grouping and discrimination of information at this stage is based on all available information and is not definitive. It allows for all features of potential archaeological interest to be highlighted, while retaining all the information produced during the course of the geophysical interpretation and desk-based assessment for further evaluation should more information become available.

Sub-seabed Features

6.4.6. The previous section describes the initial interpretation of the sub-bottom profiler dataset. The tagged features were exported from Coda Seismic+ software. The individual tagged layers were then grouped into features. Each feature may comprise one or more tagged layers.

6.4.7. Relevant geotechnical data were also integrated into the geophysical data interpretation.

6.4.8. Once the geophysical anomalies have been grouped a discrimination flag is added to the record in order discriminate against those which are not thought to be of an archaeological concern. These flags were ascribed as detailed below (**Table 6**).

Non-Archaeological	U2	Sediment layer, that on review, is not of archaeological interest or there is not enough data to class the feature as of archaeological interest
Archaeological	A1	Feature of probable archaeological interest either because of its palaeogeography or likelihood for producing palaeoenvironmental material e.g. palaeochannel, cut and fill, gravel terraces
	A2	Feature of possible archaeological interest e.g. gas blanking, fine-grained in-fills, ravinement surface

Table 6: Criteria for discriminating relevance of sub-seabed features

6.4.9. The grouping and discrimination of information at this stage is based on all available information and is not definitive. It allows for all features thought to be of archaeological interest to be highlighted while retaining all the information produced during the course of the geophysical interpretation for further evaluation should more information become available.

7. IMPACT ASSESSMENT METHODOLOGY

7.1. INTRODUCTION

7.1.1. The impacts of the proposed dredging activity will be assessed for each cultural heritage receptor by comparing baseline environmental conditions as set out below with the conditions that would develop following the commencement of the activity.

7.1.2. As acknowledged by a number of noted sources (*e.g.* http://www.offshorewind.co.uk/Assets/archaeo_guidance.pdf), uncertainty can arise when assessing potential cultural heritage receptors. Predominately such uncertainty surrounding receptors manifests itself through the limited recourses available, either by documentary sources with poor spatial locations; or geophysical anomalies that have archaeological potential but require further investigation in order to be verified as genuine receptors.

7.1.3. In this assessment, and in accordance with normal EIA practice, where there is significant uncertainty the 'precautionary principle' (as outlined in http://www.offshorewind.co.uk/Assets/archaeo_guidance.pdf) is applied both in terms of rating the significance of impacts and in determining appropriate mitigation.

7.1.4. The methodology used is based on an in-house Wessex Archaeology approach informed by COWRIE and, where possible, is aligned with the general EIA methodology applied by Volker Dredging Ltd. In the Impact Assessment Criteria compiled in the TEDA MAREA (Wessex Archaeology 2010b) an 'impact' is considered to be a change (positive or negative) in the existing baseline for a given receptor that occurs as a consequence of an activity associated with dredging in the Study Area. This impact may be significant in its own right or when added to existing impacts.

7.1.5. The impact assessment is focused upon four phases of evaluation:

- Potential Impacts (outlined in **section 7.2**);
- Impact Significance (outlined in **section 7.3**);
- Mitigation;
- Residual Impacts (discussed jointly with mitigation in **section 12.5**).

7.2. POTENTIAL IMPACTS

7.2.1. There are several direct and indirect effects that have been identified as relevant for the impact assessment of marine aggregates extraction upon cultural heritage receptors; these comprise direct and/or indirect effects.

Direct effect:

- Substrate removal – direct effect on cultural heritage receptors where the sediments in which they lie are removed or disturbed by dredging.

Indirect effects:

- Bathymetric changes - lowering of the seabed across licence areas may affect archaeological receptors beyond the dredging footprint by exposing previously buried material through erosion, making it vulnerable to physical, chemical or biological attack, degradation and loss.

- Sediment flux - as a proxy for seabed erosion/deposition and including the effects of suspended sediment plume and fine sand dispersion, sediment flux has the potential to be either positive or negative for archaeological receptors. Where it results in the burial of sites through sediment deposition it is likely to be positive, but net sediment loss or erosion may expose previously buried archaeological material.

7.2.2. These effects have been assessed to lead to a range of potential impacts to cultural heritage receptors, which are outlined in **Table 7**.

Impact	Nature of Impact	Type of Impact
Direct damage to both *in situ* and derived archaeological material	Negative	Direct
Damage and dispersal of *in situ* material resulting in the disturbance of relationships between structures, artefacts and their surroundings or contexts	Negative	Direct
Loss of derived prehistoric artefacts and isolated wreck and aircraft artefacts and debris within the volume of aggregate	Negative	Direct
Destabilisation of sites through the removal of overlying or adjacent sediments prompting exposure and leading to instability, erosion or corrosion and decay	Negative	Indirect
Burial of sites due to re-deposited sediment, potentially protecting and promoting the favourable preservation of sites	Positive	Indirect

Table 7: Impacts upon cultural heritage receptors from marine aggregates dredging

7.2.3. Direct negative impacts during dredging operation comprise damage, disturbance or destruction of submerged prehistoric archaeology, shipwrecks and crashed aircraft by way of negative effects such as sediment removal (leading to indirect effects from bathymetric change) and indirect destabilisation or degradation via a process initiated by other impacts.

7.2.4. Indirect impacts can also include a change to the water quality, ocean currents, and sediment transport and erosion patterns. These can be positive as well as negative and comprise:

- Increased erosion to submerged prehistoric archaeology, shipwrecks and crashed aircraft uncovered as a result of changes in bathymetry, scour or sedimentation;
- Increased protection afforded to submerged prehistoric archaeology, shipwrecks and crashed aircraft buried as a result of changes in scour or sedimentation.

7.2.5. For example, positive impacts may occur as a result of the sediment plume generated during dredging activity, where redistributed sediment settles on the seafloor providing an additional thickness of sediment cover that may help to protect cultural heritage receptors. This positive, indirect impact should not be regarded as direct mitigation to negative, direct impact from substrate removal or other negative impacts.

7.3. ASSESSMENT OF IMPACT SIGNIFICANCE

7.3.1. The significance of an impact to cultural heritage receptors is derived from an assessment of the **magnitude of the impact** (**Table 8**) and the **value and/or sensitivity of the receptor** where this can be judged (**Table 9**) and which is based upon changes to the baseline conditions of the study area and specific cultural heritage assets.

7.3.2. Cumulative impacts within the region are also discussed in **Section 12.4** in relation to:

- Aggregate Dredging and Disposal;
- Offshore Wind Farm development;
- Shipping and Ports;
- Commercial fishing;
- Subsea cables and pipelines.

Magnitude of Impact

Magnitude	Definition
High	Major loss or alteration to key elements/features of the baseline conditions such that post development character/composition/attributes will be fundamentally changed.
Medium	Loss or alteration to one of more key elements/features of the baseline conditions such that post development character/composition/attributes of baseline will be partially changed.
Low	Minor shift away from baseline conditions. Change arising from the loss/alteration will be discernible but underlying character/composition/attributes of baseline condition will be similar to pre-development circumstances/patterns.
Negligible	Very slight change from baseline condition. Change barely distinguishable, approximating to a 'no change' situation in most cases.

Table 8: Terms used to define the magnitude of impact upon cultural heritage assets

7.3.3. The magnitude of impacts is based on the level of change to known cultural heritage assets or potential cultural heritage assets relative to baseline conditions as set out in **Table 8**. This is derived from guidance provided by COWRIE (Wessex Archaeology 2007; Oxford Archaeology *et al*. 2008), JNAPC and other guidance set out in **Appendix I**.

7.3.4. If impacts were likely to adversely affect statutorily protected assets or features of national or international importance this would lead to an impact major negative significance. There are currently no cultural heritage assets of this nature in the MSA.

7.3.5. Any archaeological sites and material within areas of substrate removal will be damaged, destroyed, scattered or destabilised as a result of the negative impacts outlined in **Table 7**. Therefore, unmitigated negative impacts are likely to be medium to high.

Value and/or Sensitivity of Receptors

Value / Sensitivity	Definition
High	Feature of National and/or International Importance OR above average example and/or high potential to contribute to knowledge and understanding and/or outreach
Medium	Feature of Regional Importance OR average example and/or moderate potential to contribute to knowledge and understanding and/or outreach
Low	Feature of Local Importance OR below average example and/or low potential to contribute to knowledge and understanding and/or outreach
Negligible	Poor example and/or little or no potential to contribute to knowledge and understanding and/or outreach

Table 9: Terms used to define the sensitivity of a receptor to impacts

7.3.6. In order to asses the impacts of marine aggregate extraction within the MSA, the value and sensitivity of each cultural heritage receptor must be considered. This assessment of value considers whether the receptor is rare, protected or threatened. The *recoverability* of cultural heritage assets following dredging impacts is also a key consideration.

7.3.7. Cultural heritage assets have **no recoverability** to negative impacts (such as physical damage) upon them. They are a finite resource and their *in situ* context (in terms of spatial relationships with other cultural heritage assets, sedimentary units and (palaeo)geographical location for example) is critical to their intrinsic value and sensitivity. Thus the sensitivity of archaeological materials to negative impacts (direct and indirect) is likely to be **high**. The magnitude of the impact(s) can be reduced in some cases by inherent mitigation that occurs as a consequence of existing dredging activity strategies (*i.e*. the avoidance of known wrecks), or additional mitigation strategies designed to offset or minimise the magnitude of negative impacts upon cultural heritage receptors, thereby reducing the significance of negative effects.

7.3.8. There are no widely-accepted criteria or definitive methodology for undertaking the assessment of value to potential prehistoric landscapes or sites. However, the rarity of *in situ* or derived Palaeolithic and Mesolithic material means that any finds of this date will be of high sensitivity due to their National and International Importance. The known palaeochannel systems that traverse the Study Area directly impact all Study Areas (*i.e.* are within the study buffer zones) to varying extents. The potential for surviving palaeolandscapes is consequently high for all types of sedimentary units (highlighted by the distribution of geophysical anomalies in **Figure 5**).

7.3.9. All cultural heritage receptors (of prehistoric archaeology, maritime archaeology and aviation archaeology) will not be able to recover following negative impacts such as substrate removal. Sedimentary receptors such as gravels and sediments of which may preserve prehistoric submerged sites or artefacts, or are of palaeoenvironmental and palaeogeographical interest have no adaptability and tolerance to substrate removal or erosion from indirect effects from bathymetric change or sediment transport. Therefore in addition to their high value, they have a high sensitivity to disturbance. Isolated prehistoric, maritime and aviation finds may have a reduced value if their context cannot be securely established; therefore their sensitivity is regarded as moderate. However, these kinds of isolated finds may indicate unknown sites and are an important component of the archaeological record.

7.3.10. The redeposition of sediments following sediment transport of the settling of sediment plumes associated with dredging area is a positive impact, aiding the

preservation of cultural heritage receptors. Subsequently sensitivity to sediment plume effects is regarded as **low**.

7.3.11. While the archaeological assessment has identified the potential for wrecks, aircraft and prehistoric land surfaces of potentially high sensitivity, each will need to be considered on a site by site basis if they are impacted by development.

		Value/Sensitivity			
		High	**Medium**	**Low**	**Negligible**
Magnitude	**High**	Major	Moderate	Minor	Not Significant
	Medium	Moderate	Minor	Minor	Not Significant
	Low	Minor	Minor	Not Significant	Not Significant
	Negligible	Not Significant	Not Significant	Not Significant	Not Significant

Table 10: Assessment of Impact Significance based on the Magnitude of the impact and the Value/Sensitivity of the receptor

7.3.12. The terms of significance outlined in **Table 10** are defined in **Table 11** based upon the existing guidance (see **Appendix I**, Wessex Archaeology 2007; Oxford Archaeology *et al*. 2008).

Significance	Definition
Not Significant	Impacts that are slight or transitory and those that are within the range of natural environmental and social change.
Minor Negative	The impact is undesirable but of limited concern.
Moderate Negative	The impact gives rise to some concern but it is likely to be tolerable (depending on its scale and duration).
Major Negative	The impact gives rise to serious concern and is judged unacceptable
Minor Positive	The impact is of minor significance but has some environmental benefits.
Moderate Positive	The impact provides some gain to the environment.
Major Positive	The impact provides a significant positive gain to the environment.

Table 11: Definition of terms in the assessment of impact significance

7.3.13. As outlined above, for potential receptors *(e.g. unknown uncharted wreck sites* and *unknown uncharted aircraft crash sites* and *isolated finds* of all periods) where there is insufficient data to fully assess the value, the sensitivity of each site has been judged as potentially **high**, partly because inherent mitigation such as avoidance would not occur. This precautionary approach for potential receptors is in line with existing COWRIE guidance (Wessex Archaeology 2007).

7.3.14. If further information regarding these sites becomes available, for example through diver, ROV or further geophysical survey, it is possible that the value or sensitivity (linked to a better understanding of their value or importance) may be amended. The magnitude of impacts may also be reduced as the distribution and extent of previously unknown receptors can be avoided or effectively mitigated against. As a result significance of negative effects may be amended. For example, further geophysical work, particularly for Area 510/2 will enable a more complete identification of anomalies and assist in the confirmation of wreck positions.

7.4. CUMULATIVE IMPACTS

7.4.1. Cumulative impacts deriving from other offshore activities in the region are discussed in **Section 12.4**:

- offshore wind farm developments;
- shipping and ports (including dredging);
- commercial fishing;
- subsea cables and pipelines.

8. PREHISTORIC ARCHAEOLOGY BASELINE

8.1. INTRODUCTION

8.1.1. The following section presents an outline of known geological and archaeological data from the proposed area of renewal of aggregate extraction within Area 228 verified by geophysical and geotechnical assessment. It will also incorporate a broader overview of the East Coast region and Southern North Sea, drawing from geophysical and geotechnical evidence from the adjacent Licence Area 240.

8.1.2. A regional overview by period is then developed highlighting the potential prehistoric archaeological record in support of the Impact Assessment (**Section 11**).

8.1.3. The archaeological potential of the region has been considered with specific reference to remains that have become submerged as a result of sea level rise.

8.1.4. The term Before Present (BP) is used throughout this report when describing the age of archaeological events which occurred from the Lower Palaeolithic to the Mesolithic period. The BP time scale is predominantly used to report raw radiocarbon ages which cannot be directly correlated with a calendar date due to the inconsistency of C^{14} levels within the atmosphere. For the purposes of this report, the Mesolithic period will adopt the 9,500-5,500 BP timescale. AD 1950 commonly forms the arbitrary origin for the BP age scale. From the Neolithic period onwards, the time scales Before Christ (BC) and *Anno Domini* (AD) are used. Geological time, prior to periods of archaeological interest, is expressed in millions of years (Ma). Major glacial an interglacial stages are also referred to in terms of Marine Isotope Stages (MIS) to facilitate correlation with other sources.

8.1.5. For the purposes of this report the discussion of prehistoric archaeology section has been divided into three phases:

- Pre-Devensian, *c.* 970,000-110,000BP (MIS 25 - MIS 5e), encompassing the period from the earliest evidence of hominin occupation of the UK (Parfitt *et al.* 2010). This period corresponds to the Lower and Middle Palaeolithic;
- Devensian to Late Glacial Maximum (LGM), *c.* 110,000-18,000BP (MIS 5d to MIS 2), encompassing the onset of the last glaciation up to and including the LGM. This period includes the Middle and Early Upper Palaeolithic which saw the transition from Neanderthals to modern humans around 44-41ka (Higham *et al*. 2011);
- Post-LGM and early Holocene, *c.* 18,000-6,000BP (MIS 1), encompassing the period of human re-inhabitation of the British Isles following the LGM through to the final inundation of the AODA MAREA Study Area during the Mesolithic.

8.1.6. The contexts of archaeological remains are very important, and in broad terms they are defined as either primary contexts or secondary contexts. Archaeological sites discovered in a primary context can be defined by those in which the spatial relationship of finds has not altered since they were deposited. Artefacts found in their primary context are not necessarily exactly at their point of deposition (*in situ*), but the overall artefact movement is small on a regional scale (Emu *et al.* 2009: 30). Artefacts discovered within their secondary contexts are those which have been derived or moved from their original positions by natural processes. Archaeological material discovered in secondary contexts may be associated with fluvial re-depositing, glacial processes and marine regressions and transgressions. Although discoveries from secondary contexts are by their very nature, derived artefacts,

recent work has shown that they have the potential to provide information on patterns of human land use and demography (Ashton and Lewis 2002; Hosfield and Chambers 2004).

8.1.7. A large proportion of the submerged archaeological resource is likely to be composed of artefacts within their secondary context (Westerley *et al.* 2004). Subsequently primary context sites have an added importance in the information they can provide.

8.2. GEOLOGICAL SETTING – GEOPHYSICAL ASSESSMENT

8.2.1. The interpretation of the sub-bottom profiler data is outlined below and illustrated in **Figure 3**, with individual features described in **Appendix II**.

8.2.2. Due to the quality of the assessed sub-bottom profiler data, the precise stratigraphy of the Study Area could not be identified. However, from BGS information (BGS 1991; Cameron *et al*. 1992) indicates the general stratigraphy comprises Westkapelle Ground Formation overlain by Yarmouth Roads Formation.

8.2.3. The Westkapelle Ground Formation has been interpreted as a delta front deposit of Lower Pleistocene age (Cameron *et al*. 1992). As such, it is deemed too old to be of archaeological potential.

8.2.4. The Yarmouth Roads Formation has been interpreted as a delta top/delta plain deposit of Lower to Middle Pleistocene age (Cromerian Complex) age. The upper sequences of this Formation are known to be contemporaneous with deposits of the Cromer Forest Bed Formation (Moorlock *et al*. 2000) and associated with evidence for hominid occupation at Happisburgh and Pakefield (Parfitt *et al*. 2005; 2010). However, since the deposits have been poorly resolved by the sub-bottom profiler in this study, it is difficult to determine whether these later deposits from within the Yarmouth Roads Formation are present within the Study Area.

8.2.5. BGS data indicates that a large channel filled with sediments of the Brown Bank Fomation (Upper Eemian to Lower Devensian) cuts into the Yarmouth Roads Formation across the Study Area in a north-south orientation. However, recent work undertaken for Aggregate Dredging Area 240 (to the north of the Study Area) (Wessex Archaeology 2011a), the East Coast Regional Environment Characterisation (Limpenny *et al*. 2011) and the results of this study suggest that this is not the case.

8.2.6. Two channel edges (**7505** and **7506**) have been tentatively identified within the geophysical data at the western edge of the Study Area (**Figure 3, Figure 4**). These approximately coincide with the previously mapped location of the Palaeo-Yare from previous studies (Wessex Archaeology 2011a; Limpenny *et al.* 2011), and are interpreted as relating to the same river system.

8.2.7. The Palaeo-Yare, an offshore extension of the existing River Yare, is thought to have originated during the Late Anglian Period, though subsequent sea level changes due to glacial/interglacial cycles have caused periods of re-activation of the original channel involving re-incision and deposition of younger fill. This produces a multi-period channel system displaying a complex internal stratigraphy and a discontinuous record of deposition of approximately 430,000 years (Wessex Archaeology 2011a).

8.2.8. Deposits of the Brown Bank Formation are thought to comprise part of this complex fill, though only a weak response from the channel edge was identified on the provided geophysical data so it is impossible to determine which fills are present within the Study Area.

8.2.9. Importantly, the Palaeo-Yare channel feature here has a high potential to contain deposits of Wolstonian age, or "Unit 3b" as identified during previous work undertaken at Area 240 (Wessex Archaeology 2011a). This unit is thought to have been the source of the Palaeolithic finds recovered from Area 240 and are directly associated with the Palaeo-Yare. However, due to the quality of the data set, the presence of this unit can not be confirmed and as such it is impossible to map its possible extents.

8.2.10. Features **7500**, **7501**, **7502**, **7503**, **7504** and **7507** are all isolated simple cut and fill features tentatively identified within the data. These are small features identified along single lines, and not interpreted as coherent channel structures. Vibrocore samples from this area (Andrews 2002; Gardline 2011b) contain an amount of clay and silt in contrast with the gravelly sand of the surrounding seabed.

8.2.11. These have been interpreted as representing overbank/flood plain deposits from the Palaeo-Yare river system, with most of these features indicating localised accumulations of these deposits. Features **7502** and **7503** are slightly different in that they appear to be distinct channel edges, and possibly represent silted up minor channels from a braid plain system.

8.2.12. As with the main Palaeo-Yare channel, these sediments are expected to be multi-period in nature, and could represent deposits of Late Anglian, Wolstonian, Early Devensian or Early Holocene age. They also potentially contain the "Unit 3b" deposits identified in Area 240 (Wessex Archaeology 2011a; 2011b), though, as the composition of this unit is similar to the underlying and overlying sediments, it has not been clearly identified within the geophysical data. This does not, however, definitively preclude Unit 3b from being present in this location, especially since it is known to be extensively present in adjacent areas.

8.2.13. Numerous artefacts associated with the Palaeo-Yare and its surrounding deposits have been recovered from Area 240 to the north and west of the Study Area (Wessex Archaeology 2011a; 2011b). These have been recovered from the sand, gravely sand and gravel bank deposits which form the target for aggregate dredging in the area, and are Wolstonian (Middle Palaeolithic) in age. Although no such artefacts have been recovered from Area 228 itself, this suggests past use of this river system by hominins and indicates other similar archaeological material may be present within the Study Area, alongside material important to palaeoenvironmental studies. However no such artefacts have been recovered from Area 228 itself, either during dredging or by reporting through the BMAPA Protocol

8.2.14. The superficial seabed sediments across the Study Area generally comprise sandy gravel and gravelly sand (BGS 1988) and are often worked into mega ripples and sand waves, indicating they are mobile at present.

8.2.15. These Holocene sediments range in thickness from a thin veneer to up to possibly 6m thick beneath a large east – west trending sand wave observed in the northeast of the study area, though the data are unclear. Superficial overburden overlying the outlined shallow geological features appears to be generally 2m to 4m thick.

8.2.16. As mentioned above, deposits of Unit 3b are potentially present within Area 228. However, due to extensive previous dredging of the upper, more gravelly, layers of this unit, it is possible that any implements that may once have been present may have already been removed. This would mean the remaining sediments of Unit 3b are of a lower, but still not insignificant, archaeological potential, and the potential impact of dredging through the remnants of these deposits would still need to be considered.

8.3. GEOLOGICAL SETTING – GEOTECHNICAL ASSESSMENT

8.3.1. The results of the review of the 25 logs show that sediments generally fall into 4 main categories. It is noted that, from the vibrocore logs alone it is difficult to ascribe each sediment type into distinct sedimentological units. This is due to the complexity of deposition and erosion within the area which is related to numerous fluctuations in climate and sea level over the Pleistocene and Holocene epochs. These have included successive glacial, alluvial, terrestrial and shallow marine depositional environments.

Clay *c*. 28.62 to 29.99m below OD

8.3.2. An interesting feature of two of the vibrocores (**VC101** and **VC113**) were thin bands of horizontally bedded clay within fine sands located towards the base of the observed sequence in both cores. The clay was up to 50mm in thickness (VC113). These two cores are located in the western part of the survey area adjacent to Area 240 (**Figure 2**). Within Area 240, similar sediments elevated between 31 and 33m below OD were OSL dated to 735 - 734 ka (a minimum age estimate) indicating a Cromerian Complex age (older than MIS 19), equivalent to the Yarmouth Roads Formation (Wessex Archaeology 2011a).

Sands and Gravels *c*. 26 to 33m below OD

8.3.3. All of the vibrocores except **VC107** contained grey and beige coloured sands and gravels with no molluscan inclusions. The gravels comprised flint with quartz, quartzite, basalt, limestone and sandstone. Some other inclusions of note within these sediments were organics within vibrocore **VC120**. It is considered likely that these sediments relate to glaciofluvial alluvial deposition.

8.3.4. Work in the adjacent dredging area (Area 240) has identified similar deposits, at similar elevations and are thought to date to the Wolstonian MIS 7/6 period (Wessex Archaeology 2011a). This date places them within the “Unit 3b” identified during the previous Area 240 work, which is interpreted as being the level from which archaeological artefacts have been recovered. If this is the case, it suggests that deposits of this age are widespread across the area in both the Palaeo-Yare channel deposits and the over bank deposits described in Section 8.2.

Clays silts and sands *c*. 28 to 31m below OD

8.3.5. There is a group of vibrocores located in the central and eastern part of the area including **VC108**, **VC109**, **VC112**, **VC113**, **VC114**, **VC118**, **VC119** and **VC112** which contain silts and clays and which are in some cases, sandy, gravelly and shelly. These are interpreted as belonging to estuarine and alluvial deposits.

8.3.6. It is possible that these are associated with “Channel A” identified from the Area 240/ East Coast REC projects (see **section 8.2**, palaeochannel depicted in **Figure 3** and **Figure 4**) and could be overbank deposits. It is also a possibility that they relate to the Brown Bank formation mapped in the area by the British Geological Survey (Cameron *et al*. 1992), though this formation was not definitively identified during the geophysical assessment. Palaeoenvironmental and dating evidence acquired during

the East Coast REC project indicates that the upper sediments of similar channel infills are Devensian (MIS 3) outer estuarine/lagoonal deposits (Limpenny *et al.* 2011).

Shelly sands and gravels *c.* 24 to 30 m below OD

8.3.7. These sediments occur within all of the vibrocores except **VC114**. These sediments fall into two major categories, more recent seabed sediments and older Pleistocene shallow marine sediments. As mentioned above it is difficult to ascribe these sediments to a particular date but there are some stratigraphic and sedimentological reasons why some of them can be classed as more recent than others.

8.3.8. One vibrocore, **VC109** contained shelly sands and gravels underneath a deposit of possibly glaciofluvial alluvium (see above) which hints at a possible Pleistocene date for the sediment within that core.

8.3.9. There are some finer, well sorted, winnowed sands with small shell fragments which may relate to recent sand waves and recent seabed sedimentation and are recorded as the uppermost sediment within vibrocores **VC103**, **VC105**, **VC111**, **VC123** and **VC125**. Other shelly sands and gravels, forming the uppermost sediment within vibrocores **VC101**, **VC102** and **VC108** contained clinker, which is an indication of a more recent origin of these sediments.

8.3.10. The archaeological potential of the sediments is discussed in **section 12** of this report however it is reiterated that sediments within these vibrocores are similar to the implementiferous sediments within the adjacent Area 240.

8.4. REGIONAL OVERVIEW OF PREHISTORIC ARCHAEOLOGY

Known Prehistoric Sites

8.4.1. In recent years the East Anglian coast has proved to be crucial for understanding the earliest occupation of northern Europe (Parfitt *et al*. 2005, 2010). The potential is that it could contain over 50 miles (80km) of Palaeolithic archaeology, that has only until recently been explored to any real depth. The recent investigations by the Ancient Human Occupation of Britain (AHOB) project has considerably enhanced our understanding of early human colonisation of what is now eastern England and the southern North Sea since it started in 2001 (http://www.ahobproject.org/).

8.4.2. There are no known prehistoric sites specifically from Area 228. However within the locality of the dredging area, recent key discoveries have provided an insight into the potential for further finds of prehistoric archaeological material that would certainly present a greater illustration of the previous land surfaces and its uses. Several reported finds of possible prehistoric origin have been made under the BMAPA protocol and from grab samples from the neighbouring Area 240 (Wessex Archaeology forthcoming).

8.4.3. In particular the ongoing investigation into the internationally important Palaeolithic artefacts and sedimentary deposits recovered from material dredged from Area 240 (Tizzard *et al*. 2011, Bicket *et al*. forthcoming), has greatly enhanced what is known about the adjacent licence area (discussed below). There will be a sub-regional study of the Palaeo-Yare that will help define the known and potential archaeological resource in the region. Recent work in Area 240 has established that there are Palaeolithic receptors beyond the existing exclusion zones, and there is likely to be extensions of the unit bearing these receptors beyond the immediate boundaries of Area 240. This work has also looked at methodological trials for monitoring these deposits and this is still in development but may have implications

for mitigation in other areas of the region, including 228 (Wessex Archaeology 2011b).

Pre-Devensian (970,000 - 110,000 BP)

8.4.4. During the pre-Devensian period (970,000 - 110,000 BP) the entire north-west European landscape was shaped by a series of marine transgressions and regressions that were associated with fluctuating glacial and interglacial conditions arising from changes in global climate.

8.4.5. The pre-Devensian includes: the pre-Anglian (970,000-478,000 BP; MIS 25 - 13), a period of eight temperature phases ranging from a boreal type environment, to a climate resembling the Mediterranean conditions today; The Anglian glacial ice sheet (478,000-423,000 BP; MIS 12) that covered the majority of the British Isles; The Hoxnian interglacial (423,000-380,000 BP; MIS 11) a predominately temperate environment; The fluctuating climate of the Wolstonian (380,000-130,000 BP; MIS 10-6), and; the Ipswichian interglacial (*c*. 130,000-110,000 BP; MIS 5e).

8.4.6. Within the vicinity of Area 228 the large palaeo-rivers, the Bytham and ancient Thames, dominated the landscape as they transported sands and gravels eastwards from the Midlands across East Anglia. The discovery of the Bytham River's deposits in the 1980s had major implications for our understanding of geological history and the timing of the first humans in Northern Europe (Rose *et al.* 2001). It also presented for the first time the potential for further archaeological remains to be recovered.

8.4.7. Further to this although the Thames was dramatically shifted southward to a position in line with its present day flow, not all pre-existing landscape features - or pre-Anglian deposits - were completely destroyed and scattered by the Anglian ice sheet that spread southward around 450,000 years ago (Flemming 2002: 6). The identification by the Outer Thames Estuary REC of a pre-Anglian (Cromerian Forest Bed, 780,000 to 450,000 BP) channel in an area interpreted as lying beneath the Anglian ice margin represents this theory (Emu *et al*. 2009).

8.4.8. On land Cromerian marine and coastal deposits (Norwich Crag and Wroxham Crag) crop out extensively throughout the Norfolk and Suffolk coastline, interlocking with river terrace sequences of both the Bytham River and the ancient Thames (Lee *et al.* 2004). Two major flint working discoveries were recorded within the shoreline cliffs base, at Happisburgh, Norfolk, and Pakefield, Suffolk which would have been in close proximity to where the Bytham and Thames rivers converged. The work, undertaken by AHOB, has shed new light on the human occupation of East Anglia and northern Europe as a whole.

8.4.9. The 2002 excavations in Pakefield, approximately 8 miles inshore from Licence Area 228, revealed human activity some 700,000 years ago within a Mediterranean-type climate. The insect and plant remains illustrated a variety of habitats with reed marsh, open grasslands and oak woodlands populated by large mammal species with a rhinoceros tooth, and large predatory animals such as hyena.

8.4.10. Excavations at Happisburgh (Site 3) provided further extraordinary preserved evidence. 70 flint tools and flakes of the oldest known human occupation site of northern Europe were dated to *c*. 780,000 BP (Parfitt *et al.* 2010). During the excavation fossil plant, pollen and beetles provided an insight into the environmental conditions. They illustrated early humans were occupying an area at the southern edge of the boreal forest zone (cold winter averaging -3°C and short summers with temperatures rising to between 16-18°C), that contained conifer forests, freshwater

pools and marshes, with the coastline of the North Sea Basin close by (Parfitt *et al.* 2010). Such evidence of early humans inhabiting throughout colder periods certainly extends the potential range of human activity throughout the pre-Devensian.

8.4.11. Offshore, in the vicinity of Area 228, the Cromer Forest-bed Formation and associated Bytham River sands and gravels are comparable to that of the Yarmouth Roads Formation, deposited during the Praetiglian to Cromerian age (approximately 2.3Mya-450,000BP). Specifically the AODA MAREA palaeo-environmental assessment (**Group 1**) identified six features of pre-Anglian deposits within its Study Area (Wessex Archaeology 2010a).

8.4.12. A deep channel was also identified approximately 4.5km to the east of Area 228 in the prospection line data acquired as part of the Seabed Prehistory: Great Yarmouth project (Wessex Archaeology 2008b). Orientated north to south, the feature was observed as a symmetrical cut feature observed between 7.3 m and 18.3 m sub-seabed. Cut into the underlying Yarmouth Roads Formation, this channel is interpreted as being the same as Channel A identified during work on the adjacent Area 240 (Wessex Archaeology 2011a), the history of which has been found to be complex. Originally interpreted as a channel of Anglian age, the feature was likely re-activated during subsequent periods of low relative sea level resulting in a multi-period complex of fill deposits, potentially ranging from the Anglian to the Mesolithic.

8.4.13. It is very possible that Lower Palaeolithic material of human origin may be preserved *in situ* within late Cromerian Yarmouth Road deposits. However, of greater interest was the discovery of flint hand axes from SBV Flushing Wharf in the Netherlands, situated within North Sea aggregate dredged by Hanson from Area 240 off Great Yarmouth. Following these finds, the potential was clear for further archaeological remains to be investigated. Believed to be from the Wolstonian period theses flint hand axes discovered in 2008 have provided greater clues of the extent of prehistoric persevered remains in the licence dredging area adjacent to Area 228.

8.4.14. Inspired by these finds, four stages of systematic investigative approaches were carried out. Stage 1 reviewed existing geophysical data and vibrocore logs of Area 240 acquired in 2005 and between 1999 and 2007 respectively. Further geophysical data acquisition, processing and interpretation were completed in 2009 throughout Stage 2. Both stages revealed a complex history of deposition and erosion throughout Area 240 with two channel features (Channel A and Channel B) dominating the area (Tizzard, Baggaley & Firth 2011).

8.4.15. Channel A is situated to the north of where the artefacts were recovered from SBV Flushing Wharf were dredged from Area 240 (**Figure 3**). It is orientated directly through the eastern extent of Area 240 running northwest to southeast and potentially including the entire eastern half of Area 228, extending to the northern fringe of Area 251. The adjacent floodplain of sand and gravels encompasses much of the remaining seabed of Area 240 and the remaining western half of Area 228. The age of the cut feature is potentially from as early as the Late Anglian Glacial period (*c*. 430,000BP).

8.4.16. Stage 3 cited specific locations for sediment sampling in 2009. The Clamshell samples recovered 15 flint flakes of by-products from human manufacture. These discoveries certainly confirmed the origin of the assemblage recorded by Mr Meulmeester, the archaeologist who discovered the artefacts at SBV Flushing Wharf.

8.4.17. Subsequent vibrocores recovered for environmental analysis during the summer of 2010 have illustrated the complex changes in land surfaces from the Cromerian Complex to the Mesolithic. Two of these, specifically VC7 and VC8, established a similar brackish, muddy marine environment potentially from the Ipswichian and the Holocene respectively.

8.4.18. To the north of Area 240 further potentially significant indicators of course-grain fill, possibly deposited during the Wolstonian Glaciation with other finer-grained infill sediment, possibly corresponding to the beginning of the Ipswichian Interglacial, were also observed (Wessex Archaeology 2008b).

Devensian to LGM (110,000 - 18,000 BP)

8.4.19. During the Middle Ipswichian Interglacial the landscape to the east of what is now Great Yarmouth progressively changed from freshwater glacial run-off to an open expanse of estuarine conditions, with the Devensian ice sheet only extending as far south as the present day Humber estuary (Bicket 2011).

8.4.20. Direct evidence from recent MALSF and English Heritage funded projects within Area 240 have enhanced our knowledge of early European human occupation within the vicinity of Area 228, with evidence that is of international significance from this period of early human activity.

8.4.21. The period (*c.* 60,000 to 25,000 BP; MIS 3) is thought to be a phase of climatic instability switching rapidly from interstadial to interglacial period. At around 40,000 BP, the arrival of early modern humans or Cro-Magnons in Britain is recorded, an example of which is the red "lady" of Paviland Cave on the Gower Peninsula, Wales, which has been dated to *c.* 27,000 BP. However, archaeological evidence for the period is sparse (especially in East Anglia and from *c.* 25,000 BP onwards for approximately 10,000 years). This probably due to climatic instability and an increasingly cooler environment towards the Devensian glacial maximum. For this period there is no evidence for human occupation in Britain (Stringer 2008).

Post LGM to Middle Holocene (18,000 - 5,000 BP)

8.4.22. The post-Late Glacial Maximum would see a dramatic rise in sea level from a eustatic low of *c.* 120 m below present day levels during the glacial maximum (Cameron *et al*. 1992). However, the climate oscillated, with the Windermere/Bølling-Allerød Interstitial approximately 12,000 to 11,000 years ago, closely followed by a resurgent cold environment known as the Loch Lomond/Younger Dryas stadial that also lasted around 1,000 years from 10,800 BP.

8.4.23. During such climatic instability the earliest recorded reoccupation of Britain is thought to have occurred after 14,700 BP from dated human remains in Gough's Cave, Cheddar, Somerset. Late Upper Palaeolithic human remains have also been recorded at Great Orme Head, Conway in northwest Wales and dated to around 12,000 BP (Jacobi and Higham 2009).

8.4.24. Recently discovered cave art (currently being officially dated at the National Museum of Wales) are believed to be date to *c.* 14,000 BP in the Gower peninsular, when the ice sheet was some 2km to the north. With further engravings on animal bones found in Creswell Crags in Derbyshire dated to approximately 12,000 years ago, and illustrating similar human occupation of Britain during volatile climatic periods very close to the southern limit of the ice sheet. Closer to Area 228 a barbed bone point dating to 11,740 ± 150 BP was trawled up between the Leman and Ower Banks off Lowestoft (Dix and Westley 2004; Verhart 1995).

8.4.25. The pre-Boreal period (10,000 - 9,500 BP) which occurred towards the beginning of the Early Mesolithic period in Britain, saw a marked improvement in climate, accompanied by the development of a closed birch and pine forest environment within the general vicinity of Area 228 as regional sea levels were approximately 65m below present day level (Allen and Sturdy 1980: 4).

8.4.26. The evidence for rationality within the archaeological and faunal record and how humans moved within the landscape are still very much unknown. However, with a more consistent climate and greater human adaptability it is likely that few regions in Britain went unexplored. Given a landscape with access to major river valleys and a burgeoning resource of plants and animals, it is highly likely that Late Upper Palaeolithic human groups were present within the onshore vicinity of Area 228.

8.4.27. During stage 2 of the Area 240 investigations a second channel, Channel B, was also observed on the sub-bottom profiler data, bathymetric data and topographic trace. It was approximately 1km wide and 4m high situated in the northwest corner of Area 240. Peat samples recovered from a vibrocore from the channel, and dating to 10,140 ± 35 BP and 8355 ± 35 BP, are believed to be connected to the River Yare, with the peats comparable to the regional Breydon Formation (Tizzard, Baggaley & Firth 2011).

8.4.28. A peat sample was also dredged up and reported through the BMAPA/EH/TCE protocol (Cemex_0296) in November 2009, from a 1.4km track on the western limits of Area 251. The water-logged plant remains within the peat indicated deposition in an ox-bow lake. The presence of opercula of *Bithynia*, a species associated with flowing channels, suggests that some of the material may be derived from overbank flooding. The assemblage in general suggests the peat was formed on boggy ground with generally adjacent to a flowing river or stream, with only slight evidence for larger bodies of standing water (Wessex Archaeology 2010b).

8.4.29. At the location where the peat was dredged there was no indication in the EC REC geophysics data of a channel infill deposit, although small localised areas where the seabed reflector was slightly stronger and brighter were recorded. It is important to note that generally the seabed is disturbed, probably due to dredging activities and this may be hiding any normal response attributed to the presence of peat.

8.4.30. It is logical to assume humans during this period would have utilised the resources available in East Anglia even as the gradual inundation occurred with an estimated rise in relative sea level between 8,500 and 7,500 BP, from a mean high water of -25.5m OD to that of -8.9m OD (Devoy 1979). Recent monitoring work within Area 240 may suggest Holocene human activity from a range of environmental and organic artefacts, which will require further examination as to their archaeological significance within the region and whether the materials are in primary or secondary contexts (Wessex Archaeology 2011b).

8.4.31. The Atlantic period (7,200 - 5,500 BP) saw the end of the Late Mesolithic period and the start of the Neolithic in Britain. During this stage, the landscape within the East Anglian region and elsewhere in lowland Britain developed predominantly into mixed oak forest, comprising of alder, oak, elm and lime (Allen and Sturdy 1980: 4; Austin 1997: 10).

8.4.32. With the transgression and rise in sea level there would be continued inundation into lowland areas and significant erosion of the coastline over the course of the last 7,000 years. Many villages and towns along the coast, including Dunwich City and medieval Sizewell are known to have been lost to erosion (Comfort 1994; Weston

and Weston 1994). It is likely that this ongoing erosion has therefore resulted in the displacement and redistribution of archaeological material into the sea which dates from the prehistoric period to the present.

9. MARITIME ARCHAEOLOGY BASELINE

9.1. INTRODUCTION

9.1.1. Maritime sites can be defined as broadly comprising either stricken vessels or debris which has been accidentally or deliberately lost overboard from a vessel. As an island nation, the UK has a long maritime history and there is potential for the archaeological evidence of maritime sites of all periods dating from the Mesolithic period to the present within Area 228.

9.1.2. The evidence for coastal and maritime activity within the vicinity of Area 228 will be discussed with regards to the composite time line for shipwrecks around England, produced by Wessex Archaeology (2008c). The timeline takes into account the broad chronology of shipbuilding and employment and draws out a few generalisations regarding the age and special interest of vessels:

- **Pre-1508 AD**: The earliest category within the time line covers the period from the earliest Prehistoric evidence for human maritime activity to the end of the medieval period, *c.* 1508. So little is known of watercraft or vessels from this period and archaeological evidence of them is so rare that all examples of craft are likely to be of special interest.
- **1509-1815**: The second category covers the period from 1509-1815, encompassing the Tudor and Stuart periods, the English Civil War, the Anglo-Dutch Wars and later the American Independence and French Revolutionary Wars. Wrecks and vessel remains from this date range are also quite rare, and can be expected to be of special interest.
- **1816-1913**: Category three falls into the period 1816-1913, a period which witnessed great changes in the way in which vessels were built and used, corresponding with the introduction of metal to shipbuilding and steam to propulsion technology. Examples of watercraft from this period are more numerous and as such it is those that specifically contribute to an understanding of these changes that should be regarded as having special interest.
- **1914-1945**: The fourth category on the time line extends from 1914-1945, encompassing the First World War (WWI), the inter-war years and the Second World War (WWII). This date range contains Britain's highest volume of recorded boat and ships losses. Those which might be regarded as having special interest are likely to relate to technological changes and to local and global activities during this period.
- **Post 1946**: The last category extends from 1946 through the post-war years to the present day. Vessels from this date range would have to present a rather strong case if they are to be considered of special interest.

9.1.3. Of the vessels which passed through or close to Area 228, it can be assumed that many are likely to have foundered, as a result of natural causes (sea and weather), collision or war. Across the offshore approaches to the north and east of Area 228 a series of shallow long narrow gravelly sandbanks run from northwest to southeast of the Southern North Sea causing substantial risk to larger vessels in bad weather (Bournemouth University 2007: 37). As a whole the sandbanks of the Southern North Sea are considered as containing a high potential of shipping losses, with a high potential for preservation of archaeological material (Bournemouth University 2007: 33).

9.1.4. Research in to the East Anglian wreck sites within the AODA MAREA (Wessex Archaeology 2010a) and EC REC (Limpenny *et al*. 2011) study areas demonstrated a noticeable pattern of shipping losses, directly proportional to maritime activity during World War I and World War II.

9.1.5. In the following sections, the known maritime features verified by geophysical assessment within the Study Area are discussed.

9.1.6. A regional overview by period is then developed highlighting the potential maritime archaeological record in support of the EIA (**section 11**) within the context of regional studies of recorded losses and maritime and aviation archaeology developed within the AODA MAREA (Wessex Archaeology 2010a) and EC REC (Limpenny *et al*. 2011) projects.

9.2. MARITIME ARCHAEOLOGY – GEOPHYSICAL ASSESSMENT

Charted Maritime Sites

9.2.1. The area for renewal within Area 228 contains no UKHO charted wreck sites or NRHE recorded losses. Within the 1km buffer however there are three UKHO charted wreck sites, two 'Live' (**UKHO10452** and **UKHO10668**) and one 'Dead' (**UKHO10457**). The NRHE recorded losses covers two sites (**NRHE UID 880004** and **NRHE UID 912977**), both of which appear to correspond to the UKHO charted wreck sites. A further NRHE record (**NRHE UID 1531698**) represents a fragment of cattle femur reported as a BMAPA/EH/TCE find. Currently this find cannot be attributed as a prehistoric find or more recent loss at sea.

Potential Maritime Resource

9.2.2. There are no shipping casualties/recorded losses recorded within Area 228 (Wessex Archaeology forthcoming), however there is a substantial historical legacy of maritime activity in the vicinity of, and passing through the study area summarised below. There is therefore significant potential for unknown wreck sites and maritime cultural heritage material.

Geophysically assessed seabed features

9.2.3. A total of 13 sidescan sonar and three multibeam bathymetry anomalies were individually identified within the geophysical survey area. These were grouped, together with any recorded wrecks and obstructions within the area covered by the geophysical data, to produce a list of nine sites of potential archaeological interest located within the study area. These are characterised in **Table 12**:

Archaeological Discrimination	Number of Anomalies	Interpretation
A1	1	Anthropogenic origin of archaeological interest
A2	8	Uncertain origin of possible archaeological interest
A3	0	Historic record of possible archaeological interest with no corresponding geophysical anomaly
Total	**9**	

Table 12: Sites of Archaeological Potential

9.2.4. Furthermore, these sites of potential archaeological interest can be classified by probable type, which can further aid in assigning archaeological potential and importance (**Table 13**).

Anomaly Classification	Number of Anomalies
Wreck	1
Debris	4
Mound	2
Rope / Chain	2
Total	**9**

Table 13: Types of anomalies identified

9.2.5. The individual sites identified in the geophysical survey are discussed below. They are also described in **Appendix II** and should be referred to **Figures 4**.

9.2.6. As an aggregate extraction area, the seabed of Area 228 has been extensively modified by previous long lived dredging activities, with scarring and an irregular bathymetry being visible across much of the study area. This is most evident in the west of the study area, though two probably more recent dredging lanes are visible in the multibeam bathymetry data (**Figure 5**).

9.2.7. This extensive disturbance of the seabed makes identifying seabed features of possible archaeological interest difficult, as it is problematic to distinguish them from features created by man-made disturbance. Sand waves and mega ripples identified within the study also indicate the seabed sediment is mobile, and as such can periodically cover and expose features of archaeological potential.

9.2.8. One anomaly from within the study area, **7001**, has been classified as a possible wreck. This anomaly was mainly identified from the multibeam bathymetry and sub-bottom profiler data, where it is seen to be a mound measuring approximately 46 m x 18 m x 4 m. Scour measuring up to 1 m deep has been identified to the north and south of the feature, suggesting it is an anomalous hard feature located on the seabed rather than an isolated sand wave. The feature was poorly resolved on the sidescan sonar data, and so further detail was not visible (**Figure 6**).

9.2.9. This has been classified as a possible wreck both here and in the previous Gardline report (Gardline 2011a), though further work such as a high-resolution sidescan sonar and magnetometer survey would be needed to confirm this. It is located on the edge of a well defined dredging lane in the northeast of the study area, and could have potentially being previously affected by dredging activity.

9.2.10. Two curvilinear dark reflectors (**7002** and **7008**) were identified within the survey area, and have been classified as possible lengths of rope or chain. Both were intermittently visible within the data and so are interpreted as being partially buried. These were both located outside of the dredged areas, and so are unlikely to be features caused by dredging activities.

9.2.11. Anomalies **7003**, **7004**, **7005** and **7006** have all been classified as pieces of possible debris, though their precise natures all differ. 7004 is a small scatter of reflectors associated with a small mound, and possibly indicates a debris field or partially buried structure. Similarly, **7005** also possibly represents a debris field; though it is located within the lee of a large sand wave so could just be an accumulation of coarse sediment. **7003** is a large dark reflector with surrounding scour, indicating a single, hard object, whilst **7006** is characterised by a linear alignment of small dark reflectors and could either be a series of small pieces of debris or a single partially buried piece.

9.2.12. As magnetometer data were not acquired during the survey, the compositional nature of these pieces of debris cannot be estimated.

9.2.13. Anomalies **7000** and **7007** were identified solely from the multibeam bathymetry data and are visible as small, isolated mounds orientated differently from the natural features in the area. These could represent areas of buried structures or debris, or seabed features created as a result of dredging activity.

9.3. REGIONAL OVERVIEW: PRE-1508 AD

Early Prehistoric (Palaeolithic - Mesolithic)

9.3.1. There is no evidence for Palaeolithic watercraft pre-dating the Devensian glacial maximum (*c.* 40,000-18,000 BP) in the UK. However, examples from elsewhere in the world suggests that early modern humans were engaged in maritime activities, with the suggestion that the colonisation of Australia *c.* 40,000 BP involved island-hopping in or on primitive watercraft (Lourandos 1997).

9.3.2. It has been suggested by human settlement patterns around the North Sea that open water voyages were conducted as early as 7,000 BC, during the Mesolithic period. The oldest logboat in Europe has been assigned the date range 7,920-6,470 BC and was found in Pesse in the Netherlands (McGrail 2004: 173). Further examples of Mesolithic logboats include one discovered in Noyen-sur-Seine (France) dated to *c.* 7,190-6,340 BC (McGrail 2004: 173) and another from Lough Neagh in the north of Ireland, radiocarbon dated to *c.* 5,300 BC (Breen and Forsyth 2004). It is generally thought that logboats were used for transport and fishing in inland and sheltered waters during the Mesolithic period. However, ethnographic evidence suggests that logboats can be modified making them suitable for calm sea journeys.

9.3.3. Other simple craft seen in later contexts, such as the hide boat, may also have been used, although their light construction would make them much less likely to survive without extremely good preservation conditions. The marine transgression of the Mesolithic period saw the fairly rapid inundation of the lowland areas of the southern North Sea and the deposition of Holocene alluvial muds over the former land surfaces on which Mesolithic activity may have taken place. As such there is the potential for the survival of remains of such early craft beneath the alluvial deposits which are currently offshore.

Neolithic and Bronze Age (4,000 - 700 BC)

9.3.4. The landscape of the Neolithic and early Bronze Age (4,000-700 BC) encompassed the clearing of broad areas of woodland with settlement amongst the rich marshlands and estuarine environments. Overall, conditions would have provided a diverse resource for humans to exploit, however, archaeological evidence for settlement on land adjacent to Area 228 is relatively scarce (Brown and Murphy 1997).

9.3.5. The earliest examples of British Middle to Late Bronze Age watercraft from the Humber Estuary and at Dover represent a functional development of adapting timber into planks in order to utilise the varying environments for their own benefit, either for ferrying within fast-flowing estuaries or simply searching for foodstuffs within quiet upper reaches and creeks (McGrail 2004).

9.3.6. The technological advances illustrated by the Dover boat from the late Bronze Age are believed to be at a time of greater human interaction, resulting in the transference of materials, belief, concept, traditions and ideas, either reciprocal or

forced (Agbe-Davies & Bauer 2010: 15-20). Such a growth in social cohesion and a broadening in relationships were all established by elite individuals spreading structural linkages, resulting in the establishment of a coastal economy (Chapman 2008: 348-52).

9.3.7. It is possible that trading activities took place within the general onshore vicinity of Area 228 during the Bronze Age. This is illustrated by the large context of finds all along the southern coastline of Britain establishing wider continental social links. Examples of trade exist in the discovery of what has been interpreted as a shipwreck, comprising 363 Middle Bronze Age objects, including bronze palstaves, axe heads and rapiers of Continental origin offshore at Langdon Bay, Kent; Bronze Age weapons discovered off Moor Sands in Devon, and; a number of early tin ingots from within the Erme Estuary, also in Devon (Muckelroy 1978; Fenwick and Gale 1998).

9.3.8. Generally evidence of Bronze Age coastal activity in Norfolk and neighbouring Suffolk appears to be sparse (Hegarty and Newsome 2004: 23-27). However, the Suffolk coast has a high proportion of surviving barrows on upland sandy areas with the concentration of land occupation within Suffolk's river valleys. A rare find representing trade links with the north of England during this age was that of a small jet plaque object, discovered during an excavation of multi-period occupation site at South Lowestoft (Gisleham parish) in 2006, which suggests that large scale trade networks were becoming established at this time.

Iron Age and Roman (700 BC - 500 AD)

9.3.9. The Iron Age that followed (700 BC - AD 43) would see a similar structure of lifestyle to that of the Late Bronze Age, with a low density of activity along river valleys and sustained woodland clearance across East Anglia (Bryant 1997).

9.3.10. Direct evidence for early Iron Age seacraft is rare in the UK. A single plank from Ferriby dated to *c.* 775-700 or 530-375 BC, suggests a continuing use of the plank-boat tradition. Of the 22 logboats recorded from the Thames and its tributaries, a number have been firmly dated to the Iron Age (Marsden 1996: 222) attesting to seafaring activity within the wider context of Britain's east coast. And it is possible that the *Iceni* people of East Anglia were also trading with the content at this time, as pottery and coins have been discovered similar to those traditions of the *Belgic* tribes from Northern France and Belgium (Cunliffe 1974: 75-88).

9.3.11. The Romano-British period (43-410 AD) brought a closer unity between Britain and the Southern North Sea margin as trade with the continent expanded and diversified, with the established port of *Londinium* by AD 50 attracting a vast quantity of shipping and merchant carriers (Merrifield 1983: 32-6). The leaders of the *Iceni* would offer support to the Roman Emperor Claudius almost immediately after the invasion, however around AD 61 an almost successful war led by Boudicca restored temporary independence for the East Anglian tribe (Cunliffe 1974: 122).

9.3.12. Direct maritime archaeological evidence from this period is, however, best represented in the capital with the Blackfriars ship I, the New Guy's House boat and the County Hall ship (Marsden 1994: 15-130), all of which exemplify the varying ability of craftsman, and the performance and function of vessels of this time.

9.3.13. The Romans also developed ports along the Suffolk and Norfolk coastline and rivers. The military establishment garrisons were used as chain linkages essentially to protect the exposed eastern reaches of Roman-occupied Britain. One such garrison and small market town existed at Caister-on-Sea (*Venta Icenorum,* market-

place of the *Iceni*), north of Great Yarmouth. Providing a clear entry port to the rich farmlands of East Anglia, Caister also offered the shortest sea crossing to the mouth of the Rhine, directly crossing Area 228. Archaeological finds from Caister provide evidence for extensive North Sea trade and may have been used more as a supply base as well as a coastal defence (Gurney 2005: 28).

9.3.14. There is some evidence that Dunwich was also a port (Comfort 1994: 4), as was Ipswich. Excavations by Charles Green, between 1958 and 1961 at Burgh Castle Great Yarmouth, identified the Roman fort of *Gariannonum* that formed part of the 'Saxon Shore'. The occupation is believed to have existed by the mid 4th century, which included two buildings and a later hoard of glass possibly linked to a period of transition to the ensuing Saxon occupation. Both closely situated fortified sites (Caister and Burgh Castle) illustrate a coherent defensive strategy against coastal invasion from the Saxons and would also have provided natural havens for ships heading between the northern extremities of the Roman Empire at South Shields fort on Hadrian's Wall and Antonine Wall in Stirlingshire to *Londinium* (Allen and Fulford 1999).

Early Medieval and Medieval (AD 500 - 1508)

9.3.15. The Saxon settlers that proceeded the Roman occupation introduced a network of trade and migration routes that extended throughout the southern North Sea, as evidenced by Scandinavian-style clinker-built vessels during the Early Medieval period (410-1066 AD). This tradition of shipbuilding construction was fundamentally important to the culture and identity of communities living within the onshore vicinity of Area 228 at this time (Bruce-Mitford 1972; Evans, 1994).

9.3.16. Many notable and less documented ship and boat finds have been discovered on the East Anglian coast. With the Ashby Dell boat of 1830 thought to be from the 4th or 5th century, and similar to the Nydam 2 ship from Jutland from between AD 310 - 350. Additionally, the famous ship burial of Sutton Hoo 2 of *c.* AD 630 (which is in the region) is also similar to a continental ship find, the Kvalsund Ship, of AD 700 found in western Norway (McGrail 2004).

9.3.17. From around the 8th century a series of Viking raids and settlement along the eastern shores of England causing cultural influences to gradually converge and envelop the vibrant Saxon communities of East Anglia. After a further invasion in 1066, by the Normans of northern France, stability returned to the region which finally provided the impetus for the area to benefit from its strategic geographical position. The documented losses from this period recorded in the AODA MAREA (Wessex Archaeology 2010a) and East Coast REC (Limpenny *et al. 2011*) infer an international nature of trading and fishing networks from the 11th to 16th centuries, which encompassed the far North, Baltic and Mediterranean Seas; all passing through the vicinity of Area 228 (Wessex Archaeology 2010a; Emu 2009). The rich marine resources of the North Sea would encourage the development of large fleets of ships at Dunwich, Southwold, Lowestoft and Great Yarmouth (Williams 1988).

9.3.18. Fish was an important facet to the medieval diet with many monastic houses sending ships to the North Sea (Hutchinson 1994: 129, 144). English 'Doggers' of 30 to 40 tonnes, with crew of 20 to 30, began fishing in Icelandic waters from the 14th century onwards (Hutchinson 1994: 57). These fleets acted in convoy throughout the 15th century reaching a peak in the early 16th century (Marcus 1954: 296). Great Yarmouth in particular became one of the major herring markets in Europe and Mediterranean states during this period (Hutchinson 1994: 129).

9.3.19. The late medieval period would see the development of both warships and merchant vessels adapted to cope with an increase in tonnage and the increased threat of piracy. In order to facilitate the propulsion of these more substantial vessels, it became common practice to increase the single mast to three or even four masts and extra rigging. The introduction of the carvel technique of flush planking also became a universal technique of construction for larger craft throughout Europe, although the clinker technique continued to be used on smaller vessels and to embellish the upper works of status craft. The development of reliable navigation techniques had further implications on medieval maritime activity, enabling long oceanic voyages and greater distances to be travelled (Kemp 2002).

9.4. REGIONAL OVERVIEW: 1509 - 1815

9.4.1. General events that took place during this period would see the mercantile communities of northern Europe make substantial economic endeavours to encompass new transoceanic network links between the North Sea and the East and West Indies. Such links would ultimately contribute to the beginning of a 'Golden Age' in Northern European fortunes (Glete 1999: 19). This would also bring with it politically competitive and aggressive repercussions.

9.4.2. Within a century further advance in shipbuilding technological capabilities and cheaper ordnance meant that conflicts at sea became organised, larger in scale and more destructive. The East Anglian coast would be the stage for two significant naval battles during the 17th century: the battle of Lowestoft, the opening engagement of the Second Anglo-Dutch war in 1665 and the Battle of Sole Bay (Southwold Bay) in June 1672 during the Third (and final) Anglo-Dutch war.

9.4.3. A total of 20 Dutch ships and two English vessels were lost in the course of the Battle of Lowestoft. Losses suffered at the Battle of Sole Bay included three Dutch ships and four ships from the combined English and French fleet. Interestingly a total of 14 cannonballs have been discovered in the last five years in dredging Areas 430, 240, 242, and 296 through the BMAPA Protocol. It is possible that the majority of these finds, over the great range of dredging areas, are linked to the Battle of Lowestoft and the Battle of Sole Bay.

9.4.4. Alongside overseas ventures, inland navigation and local coasting continued to be important within the post-medieval period. East Anglia was at the forefront of the 'Agricultural Revolution' in the 18th century, whereby communications were developed to serve the farming economy (Gilman 1997: 67). Consequently, a number of Parliamentary Acts were passed towards the end of the 17th century in East Anglia in order to improve these inland routes within the region (Gould 1997: 74).

9.4.5. In national terms the scale of trade and shipping that traversed Area 228 on a regular basis would have been propelled to new heights to sustain the ever growing industrial demands. Statistics from the Lloyds Register of the English and Welsh regions in 1776 attributed 10% of the total of shipbuilding tonnage to East Anglia (Goldenberg 1973: 424; Stammer 1999: 254). At the beginning of the 18th century the total of British owned shipping tonnage was approximately 323,000 tons. By 1788 this figure was over 1 million tons with the most important single contributor to the general nationwide expansion being the coal trade, essentially London's demand for the raw material. This was generally supplied from the north-east coast (Mathias 1983: 86).

9.4.6. With regards to the post-medieval period, there is a greater potential for finding associated evidence in Area 228, than in any previous period of human maritime activity. A significant proportion of these remains are likely to be associated with the late 18th century and early 19th century, while remains from the earlier Tudor period would be of a rare and therefore would be of greater significance.

9.5. REGIONAL OVERVIEW: 1816 - 1913

9.5.1. During the course of the 19th century the technological innovations of the Industrial Revolution brought fundamental changes in maritime technology, which amongst other advances in naval engineering, enabled the development of steam propulsion and iron and steel construction.

9.5.2. Despite such technological advances the Industrial Revolution was more of a gradual transition within the maritime sector, as the early years of this period continued to be dominated by wooden sailing vessels such as schooners, brigs, brigantines and snows (Breen and Forsythe 2004: 127-128). This was primarily due to the restraint of cemented cultural traditions and the uneven economic spread of such progression; with the local inland harbours closest to Area 228 were examples of this.

9.5.3. Sailing smacks for instance continued to be built to different building traditions, with Great Yarmouth boats favouring elliptical sterns, and Lowestoft smacks designed with square counter sterns. At the turn of the century, around two thousand such craft were trawling in the North Sea, and many that were too large for the harbours were worked from the beaches until the harbours were improved. This intensity of fishing activity was reflected in the casualty losses within the AODA MAREA Study Area, accounting for approximately 16% of all vessels with a known function within the UKHO data (Wessex Archaeology 2010a).

9.5.4. Great Yarmouth was a dominant force in the North Sea fishing market during the 19th century with the well established herring stock exported *en masse* to the Mediterranean and with an expanding market to Northern Europe in the 20th century. To the south, Lowestoft's Parkeston Quay in particular was to emerge as an important centre during the 19th century (Gould 1999: 74).

9.5.5. Norfolk's and Suffolk's principle export however was that of agricultural goods such as grain across the North Sea with the import of timber from Scandinavia and Baltic. The largest bulk import was coal from the north-east until the railways began to take over, although smaller loads of an *ad hoc* nature were transported by Tramps, a knock-on development of the industrial age. Ship building was also at its peak in the mid 19th century.

9.5.6. On a broader scale the opening of the Suez Canal in 1869 enabled Britain to enhance previously established markets and capitalise on new ones. The steamship was at the forefront of British trade expansion, and in the 1870s British merchant tonnage was larger than the combined tonnage of the next three major European maritime nations (Simper 1982: 61).

9.5.7. Throughout the 19th century and early 20th century the expanding diversity of trade and the variety of vessels that worked in the southern North Sea means that Area 228 was directly traversed by local, regional and international maritime vessel types. Therefore the likelihood of maritime archaeological remains being uncovered by the dredging process is regarded as high.

9.5.8. The necessary continuation of the movement of cargo to and from the capital meant the East Coast was *en route* from the industrial heartland and northern coalfields throughout the First and Second World Wars. Both conflicts developed separate strategies in which to disrupt shipping, based around the available technologies of the time, with the East Coast witnessing a large proportion of maritime wartime casualties during both conflicts.

9.6. REGIONAL OVERVIEW: 1914 - 1945

9.6.1. At the turn of the 19th to 20th century the Royal Navy underwent a rapid revolutionary change which effectively resulted in the total replacement of the frontline ships of the fleet with the Dreadnought class (Roberts 1997: 7). Much of this was down to the perceived aggressive warship building programme of the German Imperial Navy. The arms race that ensued would be the foundations for a global conflict the likes of which had never been seen before.

9.6.2. In an effort to cripple Britain's war effort, the German Imperial Navy began a strategy of unrestricted attacks against all British shipping. The North Sea coastal trade became a legitimate target with Norwegian and Dutch shipping also heavily affected (Halpern 1995). The strategy centred on deploying U-Boat's to the North Sea surrounding ports and looking out for coastal convoys to attack. At the height of the rampage (between February and April 1917) the German U-boats sank 500 merchant ships, with the second half of April seeing an average of 13 ships sinking each day (Hewitt 2008: 17).

9.6.3. Mine laying was also an effective tactic, accounting for total of 1 million tons of Allied Merchant shipping sunk during World War I (Steffen 2005: 802). To combat these strategies the British Navy established convoy networks with escorting minesweepers that were usually local fishing trawlers acquired and customised by the Admiralty. Recorded losses from the First World War are predominantly situated in close proximity to the coastline and in particular the major ports, and potentially reveal the German strategy in the southern North Sea (Wessex Archaeology 2010a and Limpenny *et al*. 2011).

9.6.4. Although the British continued convoys during World War II many were still lost predominately by torpedoes from MTBs (E-Boats) or gunfire from submarines and fighter/bomber aircraft (Larn and Larn 1997). The distance between the coast of Norfolk and Suffolk and the coasts of German occupied France and Holland was relatively short, and ships were lost off Norfolk almost daily between 1939 and 1941 (Larn and Larn, 1997). The archaeological record from the research undertaken during the EC REC study area has therefore a disproportionate focus toward 20th century shipping losses that, although important in its own right, belie the technological advances of shipbuilding made in the previous 100 years (Wessex Archaeology 2010a).

9.6.5. Although there are no recorded losses within Area 228 from either World War I or World War II, it is possible due to the scale and coverage of the activity during these periods that some remains are buried and yet potentially likely to be identified.

9.7. REGIONAL OVERVIEW: POST 1945

9.7.1. Although ships and boats lost post-1945 are less numerous than in the preceding wartime years, the overall volume of seafaring activity continues to be very high in the southern North Sea area (Wessex Archaeology 2009: 61). The potential exists for the presence of currently uncharted wreck sites from this period.

10. AVIATION ARCHAEOLOGY BASELINE

10.1. INTRODUCTION

10.1.1. Although the extent of knowledge of air crash sites on the seabed is limited, Wessex Archaeology has broadly characterised the resource by drawing out a few generalisations on importance and special interest (Wessex Archaeology 2009: 62). It is with regards to the three broad chronological divisions outlined by Wessex Archaeology that aviation archaeology will be discussed here:

- **Pre-1939**: The period of intense and rapid development of a new technology, from the advent of powered flight to the outbreak of World War II. Although at least 119 different aircraft models were used by the military in the UK during this period, examples of only 24 survive today anywhere in the world. This, alongside the fragility of the airframes and the relative scarcity of flights over water deem any aircraft remains dating to this period of special interest;
- **1939-1945**: By the onset of World War II, advances in technology had greatly extended the reliability and range of aircraft. Such technological innovation enabled aircraft to increasingly undertake long-range flights, including many flights across Area 228 and the wider buffered Study Area. This period also saw the highest number of aircraft casualties - and human casualties - in the history of aviation and as such has special significance;
- **Post-1945**: A period characterised by the rapid development of jet propulsion technology and its use in both military and civilian aviation applications.

10.2. KNOWN AVIATION CRASH SITES

10.2.1. There are no known aircraft wrecks sites with Area 228. However, we know from a variety of sources that there was a high level of activity during WW2 as well many crashes, as evidenced by RAF search and rescue documentation, in the area (Wessex Archaeology 2008a).

10.3. UNKNOWN AVIATION CRASH SITES

10.3.1. As mentioned above, there is significant potential for unknown aviation crash sites to occur in the vicinity of Area 228. This is largely due to the considerable wartime activity during WW2 over the southern North Sea. Search and Rescue records from WW2 have been assessed by Wessex Archaeology (2008a) in order to examine the potential for aircraft crash sites at sea. Regionally, there is a high concentration of recorded losses of aircraft with relatively poor spatial accuracy. Furthermore, debris is likely to occur over a relatively large area and perhaps at some distance from the initial loss of the aircraft (Wessex Archaeology 2008a). Therefore there is significant potential for unknown aircraft crash sites in the vicinity of the Area 228 (discussed below); if military losses, these sites would be automatically protected under PMRA 1986 as war graves.

10.4. REGIONAL OVERVIEW

Aviation Archaeology Pre-1939

10.4.1. The development of military and naval aviation began just prior to the World War I. Initially, airpower was conceived as an adjunct of the army and navy, and it was the task of the Royal Naval Air Service (RNAS), founded in July 1914, to patrol the east coast of Britain and provide airborne defence and anti-submarine duties (English

Heritage 2000). During this period aircraft were constructed of canvas-covered wooden frames and were extremely fragile. Aviation engineering at this time was relatively basic, and due to their fragile structure a number of aircraft broke up in flight (Wessex Archaeology 2009: 64).

10.4.2. A number of aircraft dating to World War I are recorded to have been lost around the UK, some of which are likely to have resulted in crashes in coastal waters. A total of 28 fixed wing aircraft and 15 airships were lost by the German Imperial Air Service and Navy during raids on the UK mainland during World War I (Wessex Archaeology 2009: 65). During the same period, 34 aircrew from British Home Defence Squadrons were also lost (Holyoak 2002: 659). It is possible that some of these losses occurred at sea, although it is unlikely that aircraft from this period will be encountered within Area 228.

Aviation Archaeology: 1939 - 1945

10.4.3. The potential for aviation archaeological remains from this period are high as the English Channel and the North Sea formed a frontier between the Allies and Axis Europe during this period, becoming a significant focus for this high volume of aviation activity (Wessex Archaeology 2008a: 16). Hostile aircraft activity was particularly concentrated off the east and south coasts of the UK throughout World War II.

10.4.4. Suffolk and Norfolk were direct entry and exit points for offensive operations over Continental Europe and the North Sea, with the RAF mainly flying at night and the USAF undertaking daylight bombing raids of Germany. There were also significant defences in place to fight off numerous invading enemy aircraft, and therefore the East Anglian area, both onshore and offshore, saw a tremendous amount of aviation activity during this time. Despite the scale of aviation activity, the known aircraft crash sites which have been identified are few.

10.4.5. However, evidence of the comprehensive nature and dispersal of aviation archaeology from World War II within the East Anglian region has been highlighted by the recorded finds from the BMAPA protocol since 2005 (BMAPA and English Heritage 2005). Eleven discoveries were recorded in total throughout the licence dredging areas within the AODA MAREA (Wessex Archaeology 2010a) which included a large quantity of aluminium wreckage from World War II, some of which is identifiable with a particular make of aircraft. The potential for similar finds within Area 228 are high due to the high level of aviation activity between Britain and the continent.

Aviation Archaeology: 1945 - Present

10.4.6. Despite the volume of aviation activity across the UK, there have been very few major losses. The Department of Transport's Air Accident Investigation Branch (AAIB) lists 120 civil aircraft losses at sea around the UK between 1946 and 1994, most of which comprise light aircraft or in more recent years helicopters associated with the North Sea oil and gas industry (Wessex Archaeology 2009: 68). Unlike in preceding years, the majority of military aircraft losses are due to training accidents rather than combat operations (Wessex Archaeology 2009: 66).

11. UNCERTAINTY AND THE PRECAUTIONARY APPROACH

11.1. PALAEOLANDSCAPES AND ASSOCIATED ARTEFACTS

11.1.1. Palaeolandscapes can be inferred from the interpretation of sub-surface geology and modern bathymetry with reference to likely periods of exposure due to lower sea levels. The extent of particular landscapes can be mapped. The proportion of overall palaeolandscape lost to dredging in a licence area can be estimated; the proportion lost cumulatively to dredging and other activities can also be estimated. As a result there is some degree of certainty over value and magnitude of impact.

11.1.2. However, it should be noted that the extent of palaeolandscapes from various periods are largely unmapped and may be largely within a 'development area', but may equally extend beyond the bounds of a development scheme. It is also not known how much of the palaeolandscape remained after the last transgression. Furthermore, it is not known how much of the palaeolandscape in the area is influenced by different/multiple periods of sub-aerial exposure, as in Area 240 for example (Tizzard *et al*. 2011).

11.1.3. There could conceivably be a small area of sediment in the area which is all that remains of the palaeolandscape, from a particular period, which could be completely removed by dredging. It would be a very difficult and resource hungry investigation to map and date all the units in the area to the level of detail that would be required to fully delineate the geological units that comprise the palaeolandscape, *e.g*. that undertaken for the Area 240 project (*ibid*.). This would still only map potential and would not identify sites or artefacts.

11.1.4. On balance, taking into consideration the range of heritage assets that can reasonably be anticipated, there appears to be some certainty over value but less over magnitude of impact.

11.2. KNOWN CHARTED WRECKS

11.2.1. A charted or recorded wreck may be present but its 'history of build, use, loss, survival and investigation'[1] may be unknown, meaning value is unknown leading to an increased degree of uncertainty. The precautionary approach is to assign high value and, *if* it is impacted, magnitude and significance are relatively certain but possibly over-assessed. Mitigation is possible and the relative certainty (*e.g*. for exclusion zones) over how successful it will be in avoiding impacts means that the residual impact can potentially be reduced.

11.2.2. A charted wreck may be present, its history known, a value assigned (high, medium, low) and *if* it is impacted, magnitude and significance are certain. Mitigation is possible and the relative certainty (*e.g*. for exclusion zones) over how successful it will be in avoiding impacts means that the residual impact can be reduced.

11.3. ANOMALIES

11.3.1. Based on an interpretation of geophysical data only it may not be clear if an anomaly actually is archaeological/cultural heritage material. Therefore the precautionary approach is to assume it is. The value is unknown so the precautionary approach is to assume it is high. *If* it is impacted, magnitude is

[1] 'BULSI' system taken from *Assessing Boats and Ships 1860 - 1950: Methodology Report* Wessex Archaeology, 2011, Unpublished report 70861.04

assumed to be high (for damage, removal, and lower for indirect effects) and significance becomes major. Mitigation is possible and relative certainty (*e.g*. for exclusion zones) over how successful it will be in avoiding impacts means that the residual impact can be reduced.

11.4. POTENTIAL FEATURES

11.4.1. Based on certain characteristics of the area (*e.g*. present or historical sea lane, proximity to ports, maritime hazards, aircraft routes *etc.*) there is the potential for material to be present but as yet undiscovered.

- For a recorded loss with history established (therefore value known: high, medium, low) and location unknown: *If* it is present in the licence area and *if* it is impacted, magnitude will be high (precautionary) and significance can be assessed. Mitigation is possible but there is less certainty over how successful it will be in avoiding impacts. The potential residual impact can possibly be reduced.
- For a recorded loss with no history established (therefore value unknown and assumed to be high on a precautionary basis) and location unknown: *If* it is present in the licence area and *if* it is impacted, magnitude will be high (precautionary) and significance will be assessed as Major. Mitigation is possible but with less certainty over how successful it will be in avoiding impacts. The potential residual impact can possibly be reduced.
- Complete unknowns (*i.e*. no history, no location) would translate to a complete precautionary approach.

12. IMPACT ASSESSMENT

12.1. CULTURAL HERITAGE RECEPTORS

12.1.1. Within the Study Area, three themes have been used to categorise the cultural heritage resource across the study area: Prehistoric Archaeology; Maritime Archaeology and Aviation Archaeology. Under these themes a number of receptors have been identified (**Table 14**).

Theme	Receptor
Prehistoric Archaeology	Isolated prehistoric finds
	Sites of prehistoric archaeological interest
Maritime Archaeology	Unknown uncharted wreck sites
	Isolated maritime finds
Aviation Archaeology	Unknown uncharted aviation crash sites
	Isolated aircraft finds

Table 14: Summary of cultural heritage receptors identified within the MSA

12.1.2. There are currently no known prehistoric sites but the potential for palaeolandscapes in the MSA means that the possibility of encountering such cultural heritage assets must be considered. Similarly there are no recorded aircraft crash sites in the study area but the potential for unknown sites is significant and must be assessed.

12.1.3. It is not possible to fully assess the significance of impacts to unknown, potential archaeological sites or materials. However, if encountered by dredging activity (or indirect effects derived from it), any damage or degradation of these sites will be permanent. Impacts are likely to be judged of considerable negative significance.

12.1.4. If archaeological assets are not present then there will be no impact, where they are encountered mitigation strategies such as those described below (**Section 12.5**) could be considered to reduce the magnitude of negative impacts and thereby the significance of their effect. The residual significance of impacts from dredging activity are included in the summary table at the end of each receptors section for negative impacts only:

- Prehistoric Archaeology (**Table 15**);
- Maritime Archaeology (**Table 17**);
- Aviation Archaeology (**Table 19**).

12.2. ASSESSMENT OF SIGNIFICANT IMPACTS

Prehistoric Archaeology

12.2.1. The proposed scheme involves dredging and aggregate extraction from within Area 228. Dredging activity has previously been undertaken, though this has mainly been concentrated in the west of the Study Area so far with the eastern portion appearing relatively unaffected to a depth were Quaternary deposits of prehistoric archaeological interest. Future dredging activity in the eastern portion of the study area may then directly (and indirectly) affect areas of seabed that retain relatively pristine deposits of prehistoric archaeological interest similar to artefact-rich deposit Unit 3b encountered across much of the neighbouring Area 240 which has proven Palaeolithic importance (**section 8.3**, Tizzard *et al*. 2011; Bicket *et al*. forthcoming).

12.2.2. Eight seabed features of possible archaeological potential (**7000**, **7002**, **7003**, **7004**, **7005**, **7006**, **7007** and **7008**) were also observed widely distributed within the MSA. As these are features of possible archaeological potential, it is recommended that they be considered on a site by site basis. Where a feature lies within a proposed dredging area it is recommended that further work be carried out to definitively determine its nature and archaeological potential. Where sites lie outside of such areas, no further work should be necessary provided the sites are avoided.

12.2.3. Additionally, shallow geological features of possible archaeological potential, mainly the main channel of the Palaeo-Yare (**7505** and **7506**), have also been identified within the study area. However, it is expected that the sand and gravel unit of these deposits is the target for the proposed aggregate extraction. Considering this, it is recommended that current protocols be implemented (*e.g*. the Protocol) during dredging activities and any items of potential archaeological interest be reported in accordance with the guidance outlined in the protocol.

12.2.4. These palaeolandscape features and sedimentary fills represent the potential for the receptors *isolated prehistoric finds* and *sites of prehistoric archaeological interest*. The full distribution and archaeological potential of these receptors is unclear. Where dredging activity encounters these receptors, receptors that may incorporate *in situ* artefactual and contextual sedimentary material they are likely to be exposed to direct impacts of **high magnitude**. As these receptors may preserve *in situ* prehistoric archaeological sites of Palaeolithic periods (of at least national importance) their potential value will be **high**. Therefore the significance of negative effects upon these receptors is likely to be of major negative significance. Additional mitigation strategies may serve to reduce this significance (**Section 12.5**).

12.2.5. Positive effects developing from the sediment plume are summarised in **Table 16**; as no damage is envisioned for Prehistoric Archaeology receptors no mitigation is required and no further discussion is made.

Negative Effects: Substrate Removal, Bathymetry Change, Sediment Transport		
Impact Assessment Criteria	**Prehistoric Archaeology Receptors**	
	Isolated Prehistoric Finds	**Sites of Prehistoric Archaeological Interest**
Magnitude of Impact	High	High
Value / Sensitivity of Receptor	High	High
Significance of Effect	**Major Negative**	**Major Negative**
Residual Impact following Mitigation	**Moderate Negative**	**Moderate Negative**

Table 15: Summary of variables assessed with regards to substrate removal, bathymetry change and sediment transport upon prehistoric archaeology receptors

Positive Effects: Sediment Plume		
Impact Assessment Criteria	**Prehistoric Archaeology Receptors**	
	Isolated Prehistoric Finds	**Sites of Prehistoric Archaeological Interest**
Magnitude of Impact	Low	Low
Value / Sensitivity of Receptor	High	High
Significance of Effect	**Minor Positive**	**Minor Positive**

Table 16: Summary of variables assessed with regards to sediment plume upon prehistoric archaeology receptors

Maritime Archaeology

12.2.6. The proposed scheme involves dredging and aggregate extraction from within Area 228. Dredging activity has previously been undertaken, though this has mainly been concentrated in the west of the Study Area; the eastern portion is likely to have been dredged considerably since 1998, and also prior to modern monitoring procedures (summarised in TCE/BMAPA 2008: 13) which suggest that the potential for encountering unknown maritime archaeology receptors is reduced. Within the impact assessment below, this is manifest as a reduction in the *sensitivity* of maritime archaeology receptors.

12.2.7. There are currently no receptors of *known charted wreck sites* within the licence area.

12.2.8. One possible previously unrecorded wreck site (**7001**) has been identified in the east of the Study Area on the edge of a section of the seabed already subjected to dredging. However, the nature of the site is uncertain, so it is recommended that further work be undertaken at this location prior to dredging to ascertain the true nature of the feature and more definitively determine its archaeological potential. Due to this uncertainty, this feature is considered as the receptor *unknown uncharted wreck sites*. Alternatively, an exclusion zone (100m from extents) can be instituted around the wreck site to afford protection and mitigate impacts.

12.2.9. The position of the feature adjacent to an area of prior intensive dredging suggests it may be exposed to direct and indirect negative impacts of direct damage and disturbance and destabilisation which will be permanent. If this feature is exposed to these negative impacts they will likely be of **high magnitude**. The value is currently unknown however the sensitivity of this receptor is likely to be **low** due to the long history of dredging across the study area. Therefore it is judged that the significance of direct and indirect effects upon this receptor is likely to be of **minor negative significance**.

12.2.10. The potential for encountering unknown wreck material is partly related to the preservation potential of the sediments in the region. The sandy seabed sediments may have good potential for the preservation of wooden and steel wrecks (Bournemouth University 2007).

12.2.11. In addition to this possible wreck site (**7001**) - identified through the geophysical assessment - there are several seabed features that may relate to maritime archaeology receptors such as unidentified debris and ropes or chains (**Appendix II** and **Figures 4 and 5**). These features represent the receptor *isolated maritime finds*. Where these receptors can be avoided negative effects are likely to be avoided. However, there is potential in the MSA for unknown receptors of *isolated maritime finds* (and further *unknown uncharted wreck sites* which are perhaps buried or otherwise obscured from the geophysical survey, especially as magnetometry data were not available).

12.2.12. Where these receptors are encountered during dredging activity they are likely to be exposed to negative effects of **high magnitude**. The value of *isolated maritime finds* will be constrained by there being out of context; the sensitivity of this receptor is likely to be **low** due to the long history of dredging across the study area. Therefore it is judged that the significance of direct and indirect effects upon this receptor is likely to be of **minor negative significance**.

12.2.13. Additional mitigation strategies may serve to reduce this significance (**Section 12.5**).

12.2.14. Positive effects developing from the sediment plume are summarised in **Table 18**; as no damage is envisioned for Maritime Archaeology receptors no mitigation is required and no further discussion is made.

Negative Effects: Substrate Removal, Bathymetry Change, Sediment Transport		
Impact Assessment Criteria	**Maritime Archaeology Receptors**	
	Unknown Uncharted Wreck Sites	**Isolated Maritime Finds**
Magnitude of Impact	High	High
Value / Sensitivity of Receptor	Low	Low
Significance of Effect	**Minor Negative**	**Minor Negative**
Residual Impact following Mitigation	**Not Significant**	**Not Significant**

Table 17: Summary of variables assessed with regards to substrate removal, bathymetry change and sediment transport upon maritime archaeology receptors

Positive Effects: Sediment Plume		
Impact Assessment Criteria	**Maritime Archaeology Receptors**	
	Unknown Uncharted Wreck Sites	**Isolated Maritime Finds**
Magnitude of Impact	Low	Low
Value / Sensitivity of Receptor	Low	Low
Significance of Effect	**Not Significant**	**Not Significant**

Table 18: Summary of variables assessed with regards to sediment plume upon maritime archaeology receptors

Aviation Archaeology

12.2.15. The proposed scheme involves dredging and aggregate extraction from within Area 228. Dredging activity has previously been undertaken, though this has mainly been concentrated in the west of the Study Area; the eastern portion is likely to have been dredged considerably since 1998, and also prior to modern monitoring procedures (summarised in TCE/BMAPA 2008: 13) which suggest that the potential for encountering unknown aviation archaeology receptors is reduced. Within the impact assessment below, this is manifest as a reduction in the *sensitivity* of maritime archaeology receptors.

12.2.16. There are no *known charted aircraft crash sites* within the MSA and geophysical assessment has detected no specific examples however magnetometry data was not available and may be beneficial for examining the potential for unknown aircraft crash sites and other potential cultural heritage receptors within the MSA.

12.2.17. Regionally, there is a high concentration of recorded losses of aircraft with relatively poor spatial accuracy. Furthermore, debris is likely to occur over a relatively large area and perhaps at some distance from the initial loss of the aircraft (Wessex Archaeology 2008a). There is, therefore, considerable potential for *unknown uncharted aircraft crash sites* and also *isolated aircraft finds*, due to the high concentration of 20th century wartime activity in the region as well as the undefined seabed features observed within the MSA. There are also recorded losses from the region suggesting there is good potential (but an unquantifiable resource) for encountering *unknown uncharted aircraft crash sites* and *isolated aircraft finds*.

12.2.18. Particularly where substrate removal results in a direct impact to the archaeological record, the physical remains of any recorded (but still undiscovered) aircraft losses would be unable to tolerate the effects, resulting in a permanent change in the receptor. As such, the receptor has no ability to return to its pre-impact state. Although the positions of such sites are not known, the relatively short span of time since they were deposited on the seabed suggests that wreckage could be expected to survive in some form within the Study Area. Due to the uncertainty regarding their precise location and the potential, therefore, for impact from aggregate dredging, recorded aircraft losses should be regarded as a receptor of high sensitivity.

12.2.19. Therefore the magnitude of direct impacts to *unknown uncharted aircraft crash sites* and *isolated aircraft finds* is likely to be **high** if encountered by dredging activity (Wessex Archaeology 2010a). The value of *unknown uncharted aircraft crash sites* will be **high** if encountered as material of this nature can be automatically protected under PMRA 1986 as a war grave. However, due to the long history of dredging within the study area surface or near-surface aviation archaeology receptors are likely to have been previously impacted resulting in a low sensitivity to dredging impacts. Therefore negative impacts to this receptor are likely to be of **major negative significance**.

12.2.20. The value of *isolated aircraft finds* may be constrained by their being out of context indicating a **medium** value. However, due to the long history of dredging within the study area surface or near-surface aviation archaeology receptors are likely to have been previously impacted resulting in a low sensitivity to dredging impacts. Therefore negative impacts to this receptor are likely to be of **minor negative significance**.

12.2.21. Additional mitigation strategies may serve to reduce this significance (**Section 12.5**).

12.2.22. Positive effects developing from the sediment plume are summarised in **Table 20**; as no damage is envisioned for Aviation Archaeology receptors no mitigation is required and no further discussion is made.

Negative Effects: Substrate Removal, Bathymetry Change, Sediment Transport		
Impact Assessment Criteria	**Aviation Archaeology Receptors**	
	Unknown Uncharted Aircraft Crash Sites	**Isolated Aircraft Finds**
Magnitude of Impact	High	High
Value / Sensitivity of Receptor	High	Low
Significance of Effect	**Major Negative**	**Minor Negative**
Residual Impact following Mitigation	**Not Significant**	**Not Significant**

Table 19: Summary of variables assessed with regards to substrate removal, bathymetry change and sediment transport upon aviation archaeology receptors

Positive Effects: Sediment Plume		
Impact Assessment Criteria	**Aviation Archaeology Receptors**	
	Unknown Uncharted Aviation Crash Sites	**Isolated Maritime Finds**
Magnitude of Impact	Low	Low
Value / Sensitivity of Receptor	Low	Low
Significance of Effect	**Not Significant**	**Not Significant**

Table 20: Summary of variables assessed with regards to sediment plume upon aviation archaeology receptors

12.3. MONITORING

12.3.1. The archaeological assessment of any further sub-bottom and sidescan sonar survey data from Area 228 will permit an evaluation of the known archaeological resource to allow more effective mitigation. Periodic monitoring by geophysical surveys from the licence area will allow the status of any proposed EZs to be assessed. Monitoring at five yearly intervals is considered sufficient for monitoring purposes on comparable licence areas.

12.3.2. Continued diligence for the reporting of finds of archaeological interest through the established EH/BMAPA/TCE protocol (2005) will directly aid the monitoring of the licence areas.

12.4. CUMULATIVE IMPACTS

12.4.1. In this Impact Assessment the main impacts of the marine aggregate extraction on archaeological receptors have been identified as the effects of substrate removal and sediment plume.

12.4.2. The following sections present an assessment of the cumulative impacts of these on each archaeological receptor.

Aggregate Dredging and Disposal

12.4.3. The impact of marine aggregate dredging on potential cultural heritage receptors has been mitigated with the application of the industry 'Protocol for the Reporting of Finds of Archaeological Interest'. This has been combined with a programme of training aiming to increase awareness of the potential archaeological resource, and the use of the protocol. In addition, EIAs are or will be a key component of future licencing applications and inherent and additional mitigation (e.g. exclusion zones around previously uncharted wreck sites) will serve to mitigate by avoidance. Consequently, the cumulative impact of dredging upon archaeological receptors with this new dredging licence area will be negligible.

Offshore Wind Farm development

12.4.4. The effect of multiple licences operating in the region, plus impacts from other developments such as offshore wind farms (OWFs) will have to be considered prior to any dredging operations.

12.4.5. Assuming that industry standard mitigation measures are applied and the proposed EZs are implemented, the indirect impacts of the dredging scheme (outlined in **section 7.2**) are expected to be negligible and hence the cumulative indirect impact is also expected to be negligible.

12.4.6. OWFs will have been subject to archaeological assessments that have identified known wrecks and assessed geophysical data as part of an attempt to identify previously unknown losses. These assessments have also considered the potential for the presence of submerged prehistoric archaeology, through geophysical and geotechnical surveys. With regard to known archaeological sites and geophysical anomalies of potential anthropogenic origin the principle means of mitigation is avoidance. Consequently the cumulative direct impact is negligible.

12.4.7. It is not possible to *predict* the cumulative impact to potential archaeological sites, including maritime and prehistoric sites, although further geophysical and geotechnical surveys that can identify these features prior to impact may help to

minimise potential impacts. Moreover, each OWF will have a scheme specific WSI and formal protocol for dealing with potential discoveries thereby reducing impacts.

12.4.8. It is known where the palaeochannels run in relation to the Study Areas, and it is likely that a significant proportion will be dredged when the cumulative effect of multiple licences are taken into account. However, this can be offset by active programmes to gain knowledge, and by the application of approved protocols for both dredging (EH/BMAPA/TCE 2005) and offshore developments (The Crown Estate 2010).

12.4.9. The percentage of the seabed that is subject to permanent negative direct impacts from the foundations of wind farms is relatively small. Therefore, it would appear that the cumulative impact of the construction of OWFs upon any submerged prehistoric deposits that may survive in the East Coast region is likely to be small. However, the large number of foundation structures planned indicates that there is still some potential for impact, although minor in relation to direct dredging impacts.

12.4.10. A positive cumulative 'perceptual' effect of offshore developments is the accumulation of archaeologically interpreted geophysical and geotechnical data regarding submerged and sub-bottom, prehistoric land surfaces and palaeoenvironmental evidence. It is anticipated that any evidence derived from the aggregate licence assessment will contribute to this body of data.

Shipping and Ports

12.4.11. The southern North Sea is a busy commercial shipping region Occasional maintenance dredging and the creation of new channels associated with ports and shipping lanes may occur.

12.4.12. New dredging works required for the maintenance of shipping channels are subject to impact assessment and the application of appropriate mitigation with regard to archaeology and cultural history. Therefore, the impact of this aggregate dredging area in-combination with activities related to shipping and ports will be negligible.

Commercial fishing

12.4.13. Commercial fishing within the East Coast region includes trawling in some channels and drift nettings around some banks and a historically-significant crab industry. While these activities may damage or destroy archaeological receptors this industry is well established and associated with specific channels and banks. Therefore, it is unlikely that this new dredging licence area in-combination with commercial fishing will have any additional impact.

Subsea cables and pipelines

12.4.14. There are no known pipelines or sub-sea cables within the Study Areas. Therefore the impact of this new dredging licence area in-combination with the sub-sea cables and pipelines is negligible.

12.5. MITIGATION AND RESIDUAL IMPACTS

12.5.1. The primary aim of the precautionary principle is the prevention of damage to receptors by proactively putting in place protective measures, rather than attempting to repair damage (which may be irreversible) after it has occurred (Wessex Archaeology 2007: 6).

12.5.2. Exclusion Zones (EZs) placed around all discrete sites or more extensive areas identified by an impact assessment prohibit development related activities within their extents and have been widely applied in offshore contexts to sites and anomalies with known or potential archaeological significance (Dix *et al*. 2007).

12.5.3. However, as the marine historic environment of the UK is still largely unknown and poorly documented it is often not possible to fully assess the extent or importance of an archaeological site. In many instances, therefore, to assist developers with planning a dredging scheme, the implementation of EZs around sites may be more appropriate.

Prehistoric Archaeology

12.5.4. The palaeolandscape features within the MSA have associated Quaternary deposits which are the main target for aggregate extraction within the MSA. The palaeolandscape features are of great interest in the understanding of submerged prehistory. The deposits associated with them are also considered to have a high potential to contain both prehistoric archaeological remains and palaeoenvironmental material pertinent to understanding the submerged prehistory of the area

12.5.5. The archaeological assessment of vibrocore logs from the MSA suggests that the aggregate resource comprises sediments similar to the internationally significant and implementiferous deposits known in the adjacent Area 240. These deposits are likely to be adversely impacted upon by dredging within the MSA.

12.5.6. Scheme specific conditions will be set-out once the final dredging licensing is approved. The conditions will set out the design and implementation of mitigation with regard to both known sites identified in this report and as yet undiscovered sites or material encountered during the course of the dredging operations.

Maritime and Aviation Archaeology

12.5.7. In order to assist in accurately locating the known and unknown wrecks within the MSA in the future, it is advised that further geophysical survey is carried out, on a monitoring basis at five yearly intervals, to enable the continuation of effective methods of mitigation against damage to archaeological receptors.

12.5.8. An EZ (of 100m on extents of the wreck) may be required around the possible uncharted wreck **7001** in order to provide effective mitigation by avoidance of this site and prevention of destabilisation by dredging in the vicinity. Standard, periodic monitoring of the licence area conducted as standard by the industry will permit future assessments of any EZs that may be required under the conditions of licence consent. The integrity and/or appropriateness of any EZs will be undertaken during this process.

12.5.9. Where preservation *in situ* is not reasonably practicable, disturbance of archaeological sites or material should be offset by appropriate and satisfactory measures, also known as preservation by record. In these circumstances, the effects of the development can be remedied by carrying out excavation and

recording prior to the impact occurring (Wessex Archaeology 2007). The impact of the development may also be remedied by re-stabilising sites that have been destabilised, but not destroyed, or by offsetting damage to a site by detailed analysis and safeguarding of otherwise comparable sites elsewhere.

Unknown Sites and Material

12.5.10. It is possible that previously unknown archaeological sites or material may only be encountered during the course of the dredging scheme. Hence, measures should be taken to reduce the impact in this instance. A formal BMAPA/EH/TCE Finds Protocol (2005) exists to ensure that any finds are promptly reported, archaeological advice is obtained, and any recovered material is stabilised, recorded and conserved.

13. REFERENCES

Agbe-Davie, AS., Bauer, AA., 2010, 'Rethinking Trade as a Social Activity: An Introduction', in Bauer,AA & Agbe-Davies, AS. (Eds.), *Social Archaeologies of Trade and Exchange: Exploring Relationships among People, Places and Things*, California, West Coast Press, pp 13-28.

Allen, JRL., Fulford, MG., 1999, 'Fort Building and Military Supply along Britain's Eastern Channel and North Sea Coasts: The Later Second and Third Centuries', *Britannia* 30: 163-184.

Allen, RH., Sturdy, RG., 1980, 'The Environmental Background', in Buckley, DG (Ed.), *Archaeology in Essex to AD150*. CBA Research Report No.34. London: Council for British Archaeology pp1-7.

Andrews Survey Ltd, 2002, *License Area 228*, *Vibrocore Survey*. Unpublished survey report, Ref: 0460/Lab(01).

Ashton, N., Lewis, S., 2002, 'Deserted Britain: declining populations in the British Late Middle Pleistocene'. *Antiquity* 76: 388-396.

Austin, L., 1997, 'Palaeolithic and Mesolithic', in Glazebrook, J., (Ed.), *Research and Archaeology: A Framework for the Eastern Counties, 1. Resource Assessment*. East Anglian Archaeology, Occasional Paper No.3: 5-11.

Bicket, A., 2011, Submerged Prehistory: Research in Context, Marine Aggregate Levy Sustainability Fund.

Bicket, AR., Firth, A., Tizzard, L., Benjamin, J., In preparation, 'Heritage Management and Submerged Prehistory in the United Kingdom' in Flatman, J., Evans, A., Flemming, N, *Submerged Prehistoric Archaeology: How Climate Change and Technology Are Rewriting History*, Springer.

BMAPA, English Heritage, The Crown Estate, 2005, 'Protocol for Reporting Finds of Archaeological Interest', Unpublished Report.

Bournemouth University, 2007, 'Enhancing our understanding of the marine historic environment: Navigational Hazards Project', Unpublished Report.

Breen, C., Forsythe, W., 2004, *Boats and shipwrecks of Ireland*, Gloucestershire: Tempus Publishing Ltd.

British Geological Survey, 1991, '1:250,000 Series, Quaternary Geology Sheet 52º N - 00º W 'East Anglia'', National Environment Research Council.

Brown, N., Murphy, P., 1997, 'Neolithic and Bronze Age', in Glazebrook, J., (Ed.), *Research and Archaeology: A Framework for the Eastern Counties, 1: Resource Assessment*. East Anglian Archaeology, Occasional Paper No. 3:12-22.

Bruce-Mitford, R., 1972, *The Sutton Hoo Ship-Burial*. London, The Trustees of the British Museum.

Bryant, S., 1997. 'Iron Age', in Glazebrook, J., (Ed.), *Research and Archaeology: A Framework for the Eastern Counties, 1: Resource Assessment*. East Anglian Archaeology, Occasional Paper No. 3: 23-34.

Cameron, T.D.J., Crosby, A. Balson, P.S., Jeffery, D.H., Lott, G.K., Bulat, J. and Harrison, D.J., 1992. The geology of the southern North Sea. British Geological Survey, United Kingdom Offshore Report, London HMSO.

Chapman J., 2008, 'Approaches to Trade and Exchange in Earlier Prehistory (Late Mesolithic-Early Bronze Age)', in Jones, A., (Ed.), *Prehistoric Europe: theory and practice*, Chichester, Wiley-Blackwell, pp 333-355.

Comfort, N., 1994, *The Lost City of Dunwich*, Terence Dalton Ltd, Lavenham, Suffolk.

Cunliffe, B. 1974. Iron Age Communities in Britainan account of England, Scotland and Wales from the seventh century BC until the Roman conquest, Oxford, Routledge.

Devoy, RJN., 1979, 'Flandrian sea level changes and vegetation history of the lower Thames Estuary', *Philosphical Transactions of the Royal Society of London Series B* 285:355-407.

Dix, J., Westley, K., 2004, 'A Re-Assessment of the Archaeological Potential of Continental Shelves', University of Southampton: Unpublished report.

Dix, J., Lambkin, D., Thomas, M., Cazenave, P., 2007, 'Modelling Exclusion Zones for Marine Aggregate Dredging', English Heritage, ALSF, University of Southampton

Emu Ltd, University of Southampton, 2009, 'Outer Thames Estuary Regional Environmental Characterisation', Unpublished report.

English Heritage, 2000, 'Survey of Military Aviation Sites and Structures: Summary Report', English Heritage, Thematic Listing Programme.

Evans, AC., 1994, 'The Sutton Hoo Ship Burial', London: British Museum Press.

Fenwick, V., Gale, A., 1998, *Historic Shipwrecks: Discovered, protected and Investiated*, Stroud, Tempus Pubishing Ltd.

Flemming, NC., 2002, 'The Scope of Strategic Environmental Assessment of North Sea areas SEA 3 and SEA 2 in regard to prehistoric archaeological remains: Technical Report SEA3_TR014', Department of Trade and Industry.

Gardline Environmental Ltd, 2011a, 'License Area 228, Geophysical Survey', Unpublished survey report, Ref: 8672/Geo(00).

Gardline Environmental Ltd, 2011b. Licence Area 228 Vibrocore Survey. Report ref. :8672/Lab(00).

Gilman, P., 1997, 'Fortifications', in Glazebrook, J., (Ed.), *Research and Archaeology: A Framework for the Eastern Counties*, *1. Resource Assessment*. East Anglian Archaeology, Occasional Paper No.3: 67-69.

Glete. J., 1999, *Warfare at Sea, 1500-1650: Maritime Conflicts and the Transformation of Europe*. Routledge. London.

Goldenberg, JA., ,1973, 'An analysis of shipbuilding sites in Lloyd's Register of 1776', *Mariners Mirror* 59: 419-435.

Gould, S., 1997, 'The Archaeology of Industrialisation and Manufacture 1750-1960' in Glazebrook, J., (Ed.), *Research and Archaeology: A Framework for the Eastern Counties, 1. Resource Assessment*. East Anglian Archaeology, Occasional Paper No.3:73-79.

Gribble, J and Leather, S., 2011, *Offshore Geotechnical Investigations and Historic Analysis: Guidance for the Renewable Energy Sector*. COWRIE Ltd, Ref: GEOARCH-09

Gurney, D., 2005, 'Roman Norfolk (c.AD 43-110)' in Ashwin, T., & Davison, A. (Eds.), *An Historical Atlas of Norfolk*, Phillimore and Co. Ltd, pp 19-20.

Halpern, PG., 1995, *A Naval History of World War I*, Oxford, Routledge.

Hegarty, C., Newsome, S., 2004, 'The archaeology of the Suffolk Coast and Intertidal zone: a report for the National Mapping Programme', Suffolk: English Heritage and Suffolk County Council.

Hewitt, N., 2008, *Coastal Convoys 1939-1945*, Pen & Sword Maritime.

Higham, T., Compton, T., Stringer, C., Jacobi, R., Shapiro, B., Trinkaus, E., Chandler, B., Gröning, F., Collins, C., Hillson, S., O'Higgins, P., FitzGerald C., & Fagan, M., 'The earliest evidence for anatomically modern humans in northwestern Europe', 2011, in *Nature* 10484.

Holyoak, V., 2002, 'Out of the blue: assessing military aircraft crash sites in England 1912-1945', *Antiquity* 76(293): 657-63.

Hosfield, R., Chambers, J., 2004, 'The archaeological potential of secondary contexts' Unpublished report.

Hutchinson, G., 1994, *Medieval Ships and Shipping*, Leicester University Press.

Jacobi, RM., Higham, TFG., 2009, 'The early Lateglacial re-colonisation of Britain: new radiocarbon evidence from Gough's Cave, southwest England', *Quaternary Science Reviews* 28: 1895-1913.

Kemp, P., 2002, *The History of Ships*, Rochester: Grange Books.

Larn, R., Larn, B., 1997, *Shipwreck Index of the British Isles: The East Coast of England*, London, Lloyd's Register of Shipping.

Lee, JR., Rose, J., Hamblin, RJO. and Moorlock, BSP., 2004, 'Dating the earliest lowland glaciation of eastern England: a pre-MIS 12 early Middle Pleistocene Happisburgh glaciation', *Quaternary Science Reviews* 23: 1551-1556.

Limpenny, SE., Barrio Froján, C., Cotterill, C., Foster-Smith, RL., Pearce, B., Tizzard, L., Limpenny, DL., Long, D., Walmsley, S., Kirby, S., Baker, K., Meadows, WJ., Rees, J., Hill, J., Wilson, C., Leivers, M., Churchley, S.,

Russell, J., Birchenough, AC., Green, SL., and Law, RJ., 2011, 'The East Coast Regional Environmental Characterisation', Cefas Open Report 08/04.

Lourandos, H., 1997, *Continent of Hunter-Gatherers: New Perspectives in Australian Prehistory*, Cambridge, Cambridge University Press.

Marcus, GJ., 1954, 'The English Dogger', *Mariners Mirror* 40: 294-296.

Marsden, P., 1994, Ships *of the Port of London: 1st to 12th centuries AD*, London, English Heritage. Archaeological Report No. 3.

Marsden, P., 1996, *Ships of the Port of London: 12th to 17th centuries*, London, English Heritage. Archaeological Report.

Mathias, P., 1983, *The First Industrial Nation: The Ecomoic History of Britain 1700-1914*, Routledge.

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

Moorlock, BSP., Hamblin, RJO., Booth, SJ., Morigi, AN., 2000, *Geology of the Country around Lowestoft and Saxmundham. Memoir of the British Geological Survey, sheets 176 and 191 (England and Wales)*, London, HMSO.

Muckelroy, K., 1978, *Maritime Archaeology*, Cambridge, Cambridge University Press.

Oxford Archaeology, 2007, 'England's Historic Seascapes Pilot Study: Southwold-to-Clacton final project report', unpublished report.

Parfitt, SA., Barendregt, RW., Breda, M., Candy, I., Collins, MJ., Coope, GR., Durbidge, P., Field, MH., Lee, JR., Lister, AM., Mutch, R., Penkman, KEH., Preece, RC., Rose, J., Stringer, CB., Symmons, R., Whittaker, JE., Wymer JJ. and Stuart, AJ., 2005, 'The earliest record of human activity in northern Europe', *Nature* 438: 1008–1012.

Parfitt, SA., Ashton, NM., Lewis, SG., Abel, RL., Coope, GR., Field, MH., Gale, R., Hoare, PG., Larkin, NR., Lewis, MD., Karloukovski, V., Maher, BA., Peglar, S.M., Preece, RC., Whitaker, JE. & Stringer, CB., 2010, 'Early Pleistocene human occupation at the edge of the boreal zone in northwest Europe', *Nature* 466: 229–33.

Roberts, J., 1997, *Battlecruisers*, Great Britain, Caxton Editions.

Rose, J., Moorlock, BSP., Hamblin, RJO., 2001, 'Pre-Anglian fluvial and coastal deposits in Eastern England: lithostatigraphy and palaeoenvironments', *Quaternary International* 79: 5-22.

Simper, R., 1982, *Britain's Maritime Heritage*, London, David and Charles Ltd.

Stammer, M., 1999, 'Slipways and steamchests: the archaeology of the 18th and 19th century wooden merchant shipyards in the United Kingdom', *The International Journal of Nautical Archaeology* 28 (3): 253-264.

Steffen, D., 2005, 'Mine Warfare and Escort Vessels' in Tucker, SC., (Ed.), The *Encyclopaedia of World War I, a Political, Social and Military History*, ABC.

Stringer, C., 2008, *Homo Britannicus. The incredible story of human life in Britain*, London, Allen Lane.

Tizzard, L., Baggaley, PA., Firth, AJ., 2011, 'Seabed Prehistory: investigating palaeolandsurfaces with Palaeolithic remains from the southern North Sea', in Benjamin J., Bonsall C., Pickard, C., Fischer A., (Eds.), *Submerged Prehistory*, Oxford and Oakville, Oxbow Books, , pp 65-74.

The Crown Estate / BMAPA, 2008, 'Marine aggregate dredging 1998 – 2007: a ten-year review', Unpublished report: http://www.bmapa.org/downloads/Ten-Year-Review.pdf.

The Crown Estate, 2010, 'Protocol for Archaeological Discoveries: Offshore Renewables Projects', Unpublished/Wessex Archaeology Report 73830.04.

Verhart, LBM., 1995, 'Fishing for the Mesolithic. The North Sea: A submerged Mesolithic landscape', in Fischer, A., (Ed.), *Man and sea in the Mesolithic: coastal settlement above and below current sea level*, Oxbow Monograph 53, London, Oxbow Books, pp 291-302.

Wessex Archaeology, 2003, 'England's Shipping: Year 1 Report', Unpublished Report, ref: 51552.02.

Wessex Archaeology, 2007, Historical Environment Guidance for the Offshore Renewable Energy Sector, COWRIE

Wessex Archaeology, 2008a, 'Aircraft Crash Sites at Sea: A Scoping Study: Archaeological Desk-based Assessment', Unpublished Report, ref: 66641.02.

Wessex Archaeology, 2008b, 'Seabed Prehistory: Gauging the Effects of Marine Aggregate Dredging. Final Report. Volume IV Great Yarmouth', Unpublished Report, ref: 57422.34.

Wessex Archaeology, 2008c, 'Selection Guide: Boats and Ships in Archaeological Contexts. Review Draft 05/02/08. Unpublished Report: http://archaeologydataservice.ac.uk/archives/view/marinemcd_eh_2008/downloads.cfm.

Wessex Archaeology, 2010a, 'AODA Marine Aggregate Regional Environmental Assessment. Archaeological Desk-based Assessment', Unpublished Report, ref: 73330.02.

Wessex Archaeology, 2010b, 'Waterlogged Plant Remains from Peat', Unpublished Report, ref: 65456.

Wessex Archaeology, 2011a, 'Seabed Prehistory: Site Evaluation Techniques (Area 240)', Unpublished Report, ref: 70754.04.

Wessex Archaeology, 2011b, 'Licence Area 240: Archaeological Monitoring of Dredging', Unpublished Report, ref: 77860.02.

Wessex Archaeology, Forthcoming, 'Information to Support an EIA for Term and Area Limited Marine Aggregate Dredging Operations in Area 228' Unpublished Report.

Weston, C., Weston, S., 1994, *Claimed by the Sea*, Wood Green Publications, Norwich, pp 87.

Williams N., 1988, *Maritime Trade of the East Anglian Ports 1550-1590*, Oxford, Clarendon Press.

APPENDIX I: LEGISLATION

Introduction

This section outlines the legal framework that applies to the maritime heritage in the MAREA Study Area (Wessex Archaeology 2010a). The Study Area encompasses waters administered by England and those of the United Kingdom Continental Shelf (beyond the 12 nautical mile (nm) limit). The maritime heritage within England's territorial waters is covered by legislation and guidance for England and the United Kingdom. The maritime heritage on the Continental Shelf is predominantly covered by international legislation and guidance, although in some cases policies from England and the United Kingdom apply.

A comprehensive assessment of Legislation pertaining to Marine and Maritime Archaeology has been prepared for English Heritage and JNAPC: (http://www.jnapc.org.uk/MALP.pdf).

Protection of Wrecks Act 1973

Under the 1973 Act, 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 from the Government. Generally, the relevant Secretary of State must consult appropriate advisors prior to designation, though it is also possible to designate a wreck in an emergency without first seeking advice.

Under Section One of the Act, wrecks and wreckage of historical, archaeological or artistic importance can be protected by way of designation. Section Two of the Act provides protection for wrecks that are designated as dangerous due to their contents and is administered by the Maritime and Coastguard Agency (MCA) through the Receiver of Wreck (RoW).

There are currently two sites designated under Section One of the Protection of Wrecks Act 1973 within the Study Area: the Dunwich Bank wreck and the South Edinburgh Channel wreck. However, if any important wreck or ship borne artefact is discovered during dredging operations, the emergency designation of an area around the find remains a possibility.

Merchant Shipping Act 1995

This Act sets out the procedures for determining the ownership of underwater finds that turn out to be 'wreck'. Within the context of the Merchant Shipping Act 1995, 'wreck' refers to items defined as 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.

If any such finds are brought ashore the salvor is required to give notice to the RoW that he has found or taken possession of it and, as directed by the RoW, either hold it to the Receiver's order or deliver it 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 (e.g. by assignment to him 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 RoW.

The Crown makes no claim on a wreck found outside UK Territorial Waters which 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.

The RoW 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 RoW will hold the wreck until the matter is settled, either through amicable agreement or by court judgement.

Protection of Military Remains Act 1986

Under the Protection of Military Remains Act 1986, 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 4 August 1914, whereas in the case of a wreck protected as a 'controlled site' no more than 200 years must have elapsed since loss.

Diving is not prohibited at a 'protected place' but it is an offence to tamper with, damage, move or remove sensitive remains. 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 to 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.

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 the criteria be established to designate all other British vessels in military service when lost, as Protected Places. There have been three tranches since November 2001 which occurred in 2002, 2006 and 2008. Under the third tranche, the type of vessel that can be protected under the Act has been substantially widened.

The records of vessels lost during both World Wars whilst on active service do not always give an exact location. Given the volume of activity which occurred throughout WWI and WWII in the general area of the Thames estuary and within the Study Area in particular, there is high potential for finding shipwrecks for which there are currently no known remains.

Code of Practice for Seabed Developers, Joint Nautical Archaeology Policy Committee 2006 (JNAPC)

The *JNAPC Code of Practice for Seabed Developers* provides a framework for seabed developers similar to the principles found in current policy and practice on land. The aim of the Code is to ensure a best practice model for seabed development. The Code offers guidance to developers on issues such as risk management and legislative implications.

European Landscape Convention (ELC) 2000

The ELC (2000) became binding on the UK from 1 March 2007. Its principal clauses require the Government to protect and manage landscapes and to integrate landscape into regional and town planning policies including its cultural, environmental, agricultural, social and economic policies. The ELC applies to the entire territory of the UK and includes land, inland water and marine areas. However, the Convention is not regarded as applying to sea areas regulated by the UK that lie beyond territorial waters.

Identifying and Protecting Palaeolithic Remains

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 PPG 16 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.

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.

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.

Military Aircraft Crash Sites (EH 2002)

This provides archaeological guidance regarding the significance and future management of military aircraft crash sites. It outlines the importance of aircraft crash sites and indicates that they should be considered where they are affected by development proposals and planning and development bodies.

Maritime Archaeology on the Continental Shelf

The mandate for regulating the maritime heritage beyond the 12 nm territorial limit is less direct. In some cases, the archaeological resource is covered by the provisions of the legislation and guidance discussed above. For example, the provisions of the Protection of Military Remains Act 1986 regarding Controlled Sites are applicable in international waters, though they are only enforceable with respect to British-controlled ships, British citizens and British companies.

Archaeological material on the Continental shelf is also covered by international laws and conventions. While wrecks are not currently regarded to form part of the natural resources of the Continental shelf which are regulated by coastal states, some indirect regulation arises from the environmental controls placed on the regulated exploitation of natural resources. In particular, insofar as Continental Shelf activities are subject to Environmental Impact Assessment under European Directives (85/337/EEC and 97/11/EC), the effects of those activities on the archaeological heritage have to be addressed and mitigation proposed. Similarly, the effects on the archaeological heritage of Continental Shelf activities have to be assessed by virtue of the Strategic Environmental Assessment Directive (2001/42/EC).

United Nations Convention on the Law of the Sea (UNCLOS) 1982

UNCLOS 1982 was ratified by the UK in 1997. Article 303 stipulates that 'states have the duty to protect objects of an archaeological and historical nature found at sea and shall co-operate for this purpose'. Article 303 also provides for coastal states to exert a degree of control over the archaeological heritage to 24 nautical miles, though the UK has not introduced any measures to implement this right.

European Convention on the Protection of the Archaeological Heritage 1992 (Revised) (The Valletta Convention)

The Valletta Convention was ratified by the UK Government in 2000 and came into force in 2001. The convention binds the UK to implement protective measures for the archaeological heritage within the jurisdiction of each party, including sea areas. Insofar as the UK exerts jurisdiction over the Continental Shelf, then it would appear that the provisions of the Valletta Convention apply to that jurisdiction.

UNESCO Convention on the Protection of the Underwater Cultural Heritage 2001 (CPUCH)

The UNESCO Convention (CPUCH) concluded in 2001, and is a comprehensive attempt to codify the law internationally with regards to underwater archaeological heritage. The UK abstained in the vote on the final draft of the Convention; however, it has stated that it has adopted the Annex of the Convention, which governs the conduct of archaeological investigations, as best practice for archaeology. In addition, although the UK is not a signatory, the convention was carried forward on 2nd January 2009 as it has now been signed or ratified by 20 member states.

International Council of Monuments and Sites (ICOMOS) Charter on the Protection and Management of Underwater Cultural heritage 1996 (The Sofia Charter)

The Charter includes a series of statements regarding best practice, intending 'to ensure that all investigations are explicit in their aims, methodology and anticipated results so that the intention of each project is transparent to all'. The UK is a member of ICOMOS.

APPENDIX II: GAZETTEER

Seabed features of possible archaeological potential

WA_ID	Classification	Easting	Northing	Archaeological Discrimination	Length (m)	Width (m)	Height (m)	Notes	Internal References
7000	Mound	427739	5822813	A2	19.0	18.0	1.2	Relatively small mound observed on the multibeam bathymetry data. Very small, poorly resolved, circular object observed on the sidescan sonar data (not tagged), much smaller than and not as high as indicated by the multibeam bathymetry. Could be a natural feature or debris.	6002
7001	Wreck	430247	5822666	A1	46.0	18.0	4.0	Large mound observed on the multibeam bathymetry and seismic data. Poorly resolved dark reflector without height (not tagged) identified on the sidescan sonar data, though shallow scour (up to 1m) identified on both sidescan sonar and multibeam bathymetry data extending north and south of the structure. Located on the edge of a dredged area, possibly a wreck.	6004, 6507
7002	Rope / Chain	430675	5822076	A2	29.5	0.7	0.0	Small, intermittent curvilinear bright reflector. Possible length of rope or chain, possibly related to a similar feature located just outside of the study area to the north.	6007
7003	Debris	428624	5821756	A2	3.8	2.1	1.1	Large, isolated dark reflector with large shadow and associated scour in an area of mega ripples and sand waves. Possible piece of partially buried debris.	6009
7004	Debris	428103	5820659	A2	31.9	11.6	0.0	Area of irregular bright reflectors, found by multibeam bathymetry data to be located at the site of a small mound orientated differently to the sand waves in the area. Possibly indicates a partially buried structure.	6011

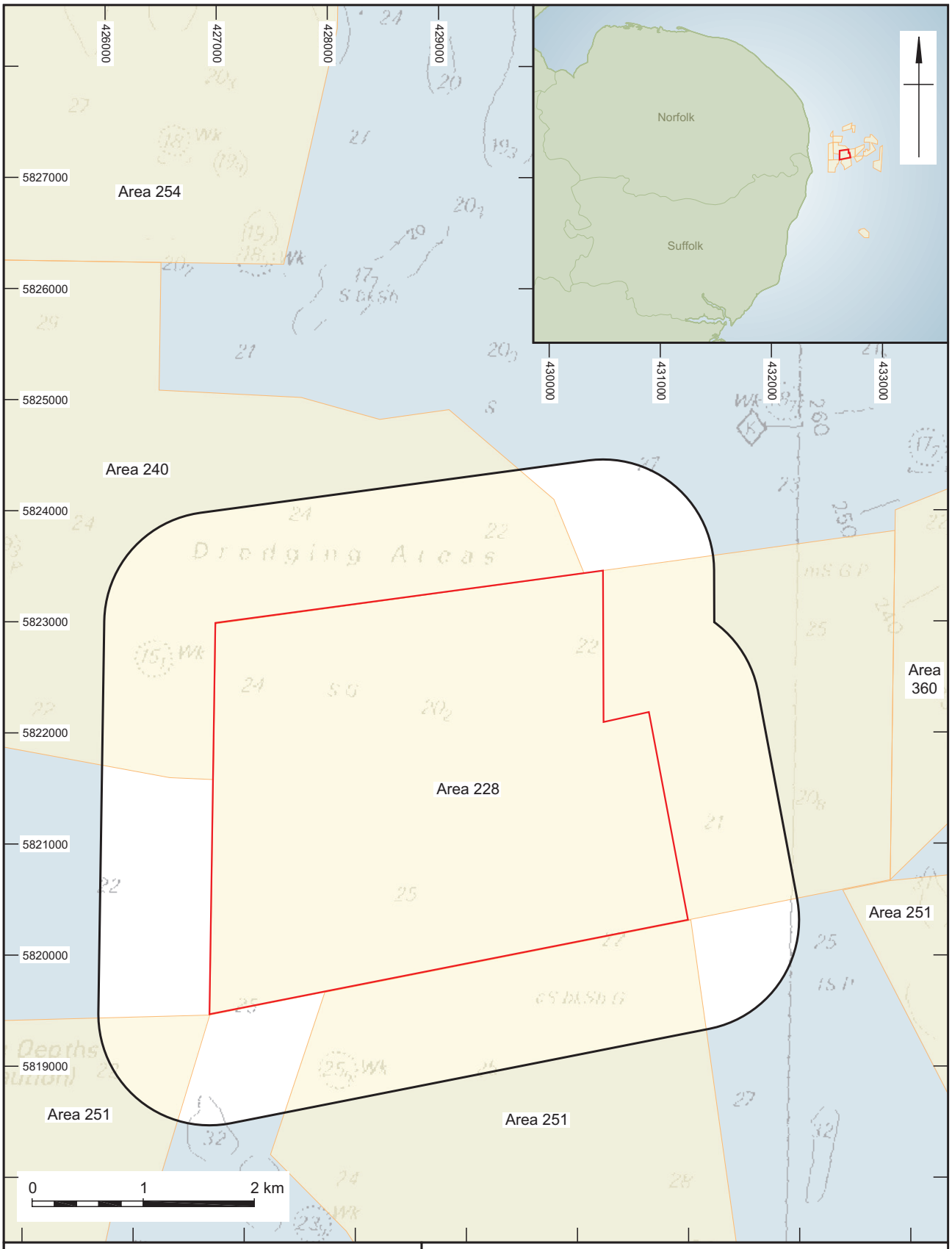
WA_ID	Classification	Easting	Northing	Archaeological Discrimination	Length (m)	Width (m)	Height (m)	Notes	Internal References
7005	Debris	428380	5820729	A2	21.0	9.2	1.7	Area of irregular bright and dark reflectors, possible small debris field. Located in the lee of a sand wave so could just represent an accumulation of coarse sediment.	6012
7006	Debris	430748	5821031	A2	12.8	1.0	1.1	Linear alignment of a number of adjacent dark reflectors with shadows. Possibly debris or a single piece of partially buried debris.	6013
7007	Mound	428087	5820202	A2	30.0	18.0	1.0	Small mound identified on the multibeam bathymetry data. No definitive associated sidescan sonar anomaly, could represent a natural feature or buried debris.	6014
7008	Rope / Chain	427004	5819622	A2	20.7	0.8	0.0	Short, curvilinear bright reflector. Possible length or partially buried rope or chain.	6015

1. Co-ordinates are in WGS84 UTM31N
2. Positional accuracy estimated ±10m

Geological features of possible archaeological potential

WA ID	Name / Classification	Archaeological Discrimination	Description	Internal References
7500	Simple Cut and Fill	A2	Possible shallow simple cut and fill feature though very poorly defined. Isolated feature not identified on adjacent lines, though this could be due to poor quality of data. Possibly represents a localised accumulation of surviving channel complex/flood plain deposits. Depth Range: 3.2m - 8.7m BSB.	6501
7501	Simple Cut and Fill	A2	Possible shallow simple cut and fill feature though very poorly defined. Isolated feature not identified on adjacent lines, though this could be due to poor quality of data. Possibly represents a localised accumulation of surviving channel complex/flood plain deposits. Depth Range: 0.9m - 4.3m BSB.	6502
7502	Simple Cut and Fill	A2	Small, shallow, possible simple cut and fill feature though is poorly defined. Dips towards the south, and southern extent not known. Possible channel edge but not identified on adjacent survey lines, though this could be due to poor quality of data. Depth Range: 2.2m - 5.2m BSB.	6503
7503	Simple Cut and Fill	A2	Small, shallow, possible simple cut and fill feature though is poorly defined. Dips towards the north, and northern extent not known. Possible channel edge or a localised accumulation of surviving channel complex/flood plain deposits but not identified on adjacent survey lines, though this could be due to poor quality of data. Depth Range: 1.5m - 3.1m BSB.	6505
7504	Simple Cut and Fill	A2	Possible shallow simple cut and fill feature though very poorly defined. Isolated feature not identified on adjacent lines, though this could be due to poor quality of data. Possibly represents a localised accumulation of surviving channel complex/flood plain deposits. Depth Range: 1.8m - 5.6m BSB.	6506
7505	Simple Cut and Fill	A1	Possible simple cut and fill feature, though base is poorly defined. Located at the end of line and northern extent unknown. Not identified on adjacent survey lines, though could be due to data quality. Possible channel edge, coincides with edge of the Palaeo-Yare identified from previous surveys, and probably relates to similar feature 6509. Mostly located outside of the provided Study Area. Depth Range: 3.4m - 9.5m BSB.	6508
7506	Base of Channel	A1	Poorly defined channel edge, observed dipping to the north and northern extent unknown. Probably marks the edge of the Palaeo-Yare identified during previous surveys, probably relates to similar feature 6508. Depth Range: 1.8m - 10.4m BSB.	6509

WA ID	Name / Classification	Archaeological Discrimination	Description	Internal References
7507	Simple Cut and Fill	A2	Possible shallow simple cut and fill feature though very poorly defined. Isolated feature not identified on adjacent lines, though this could be due to poor quality of data. Possibly represents a localised accumulation of surviving channel complex/flood plain deposits. Depth Range: 4.9m - 8.1m BSB.	6510



Study Area
Area 228
Active Dredging Areas

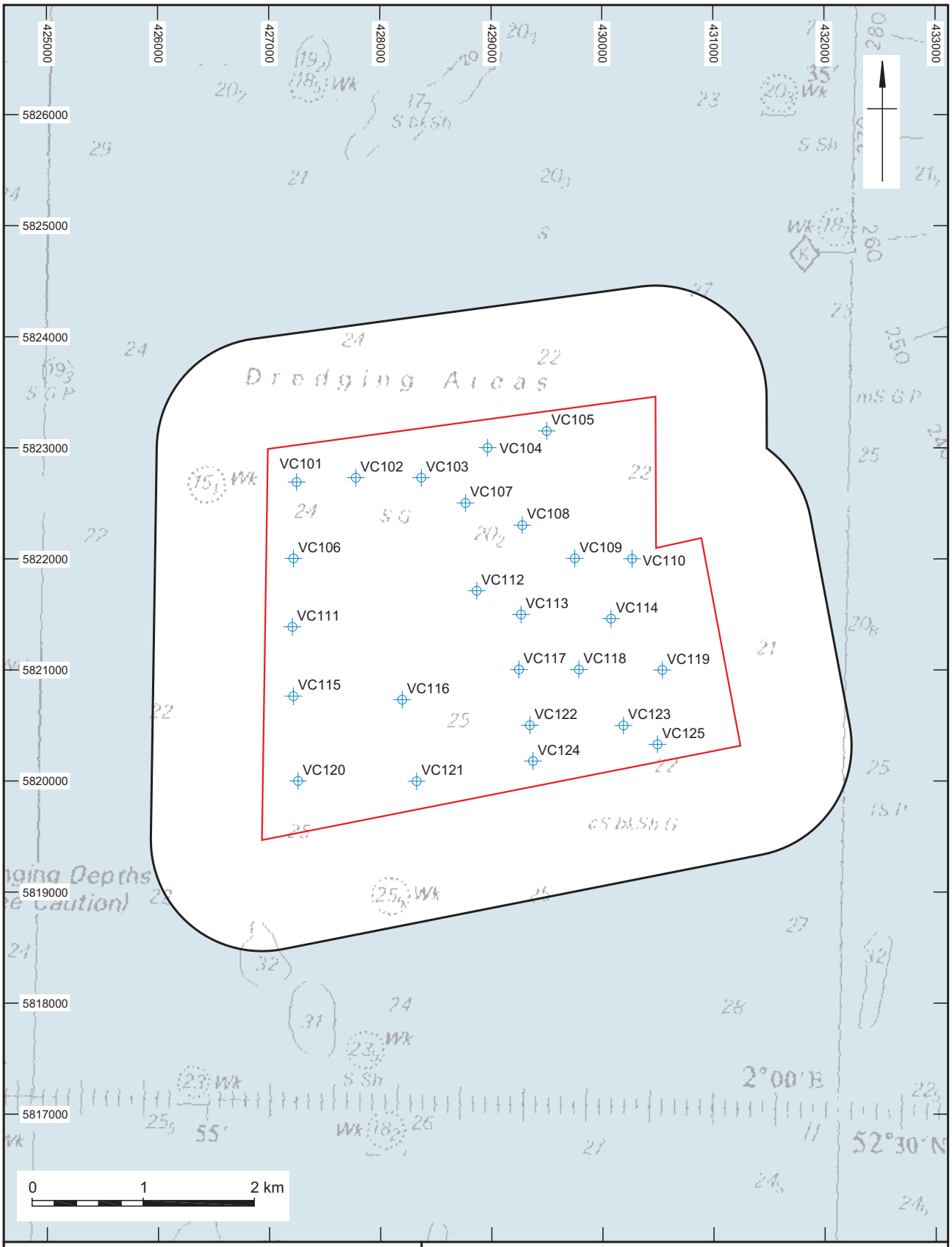
Admiralty Chart 1543 (dated 2000)
Drawing projection: UTM WGS84 z31N

Wessex Archaeology

Date:	27/09/11	Revision Number:	0
Scale:	1:50,000 @A4	Illustrator:	KJF
Path:	W:\Projects\78670\Drawing Office\Report figs\EIA\11_10_26		

Study Area location

Figure 1



Study Area
Area 228
Vibrocore location

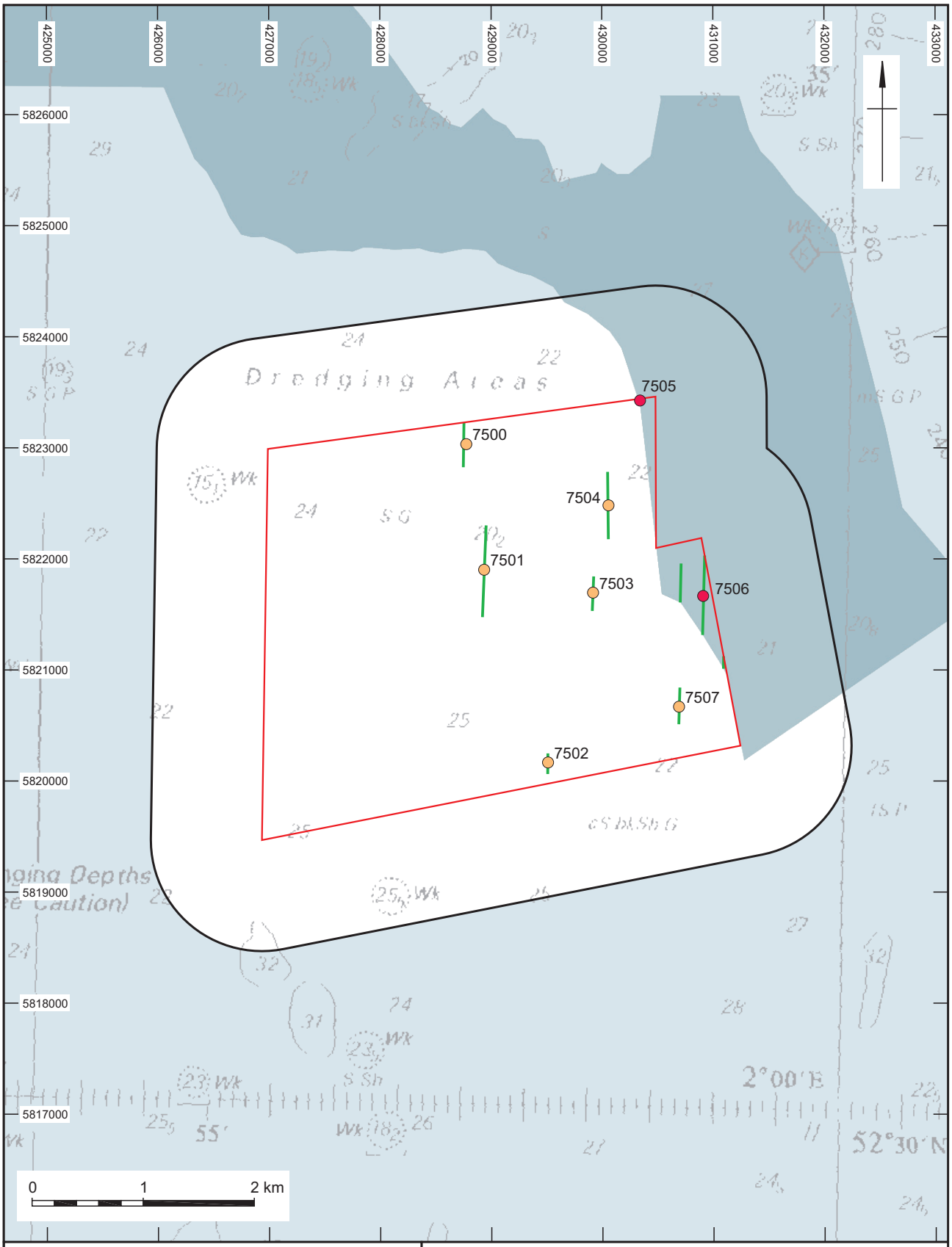
Admiralty Chart 1543 (dated 2000)
Drawing projection: UTM WGS84 z31N

Wessex Archaeology

Date:	31/10/11	Revision Number:	0
Scale:	1:50,000 @A4	Illustrator:	KJF
Path:	W:\Projects\78670\Drawing Office\Report figs\EIA\11_10_26		

Location of vibrocores

Figure 2



Study Area
Area 228
Interpreted location of the Palaeo-Yare
Features identified from seismic data
A1 - Anthropogenic origin of archaeological interest
A2 - Uncertain origin of possible archaeological interest

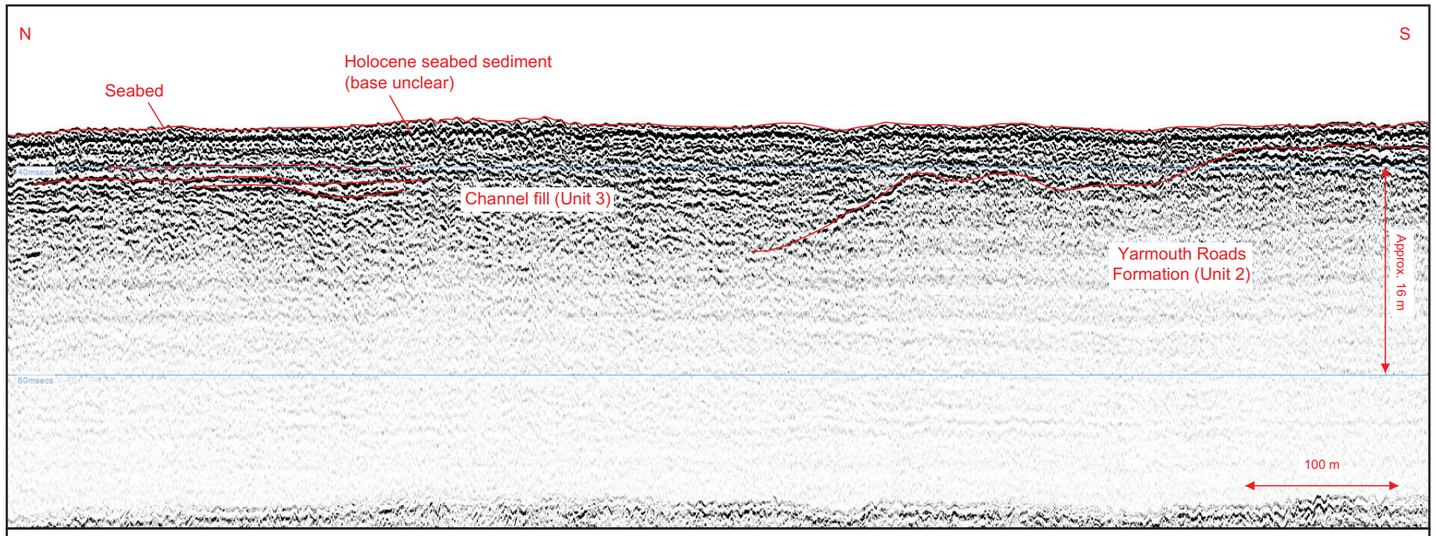
Admiralty Chart 1543 (dated 2000), Drawing projection: UTM WGS84 z31N

Wessex Archaeology

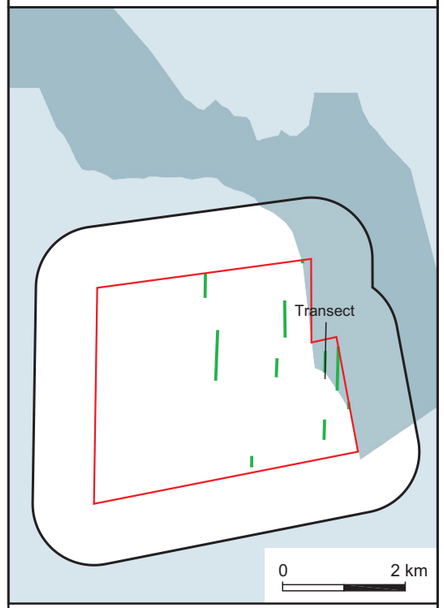
Date:	27/09/11	Revision Number:	0
Scale:	1:50,000 @A4	Illustrator:	KJF
Path:	W:\Projects\78670\Drawing Office\Report figs\EIA\11_10_26		

Shallow geological features of possible archaeological potential

Figure 3



Wessex Archaeology



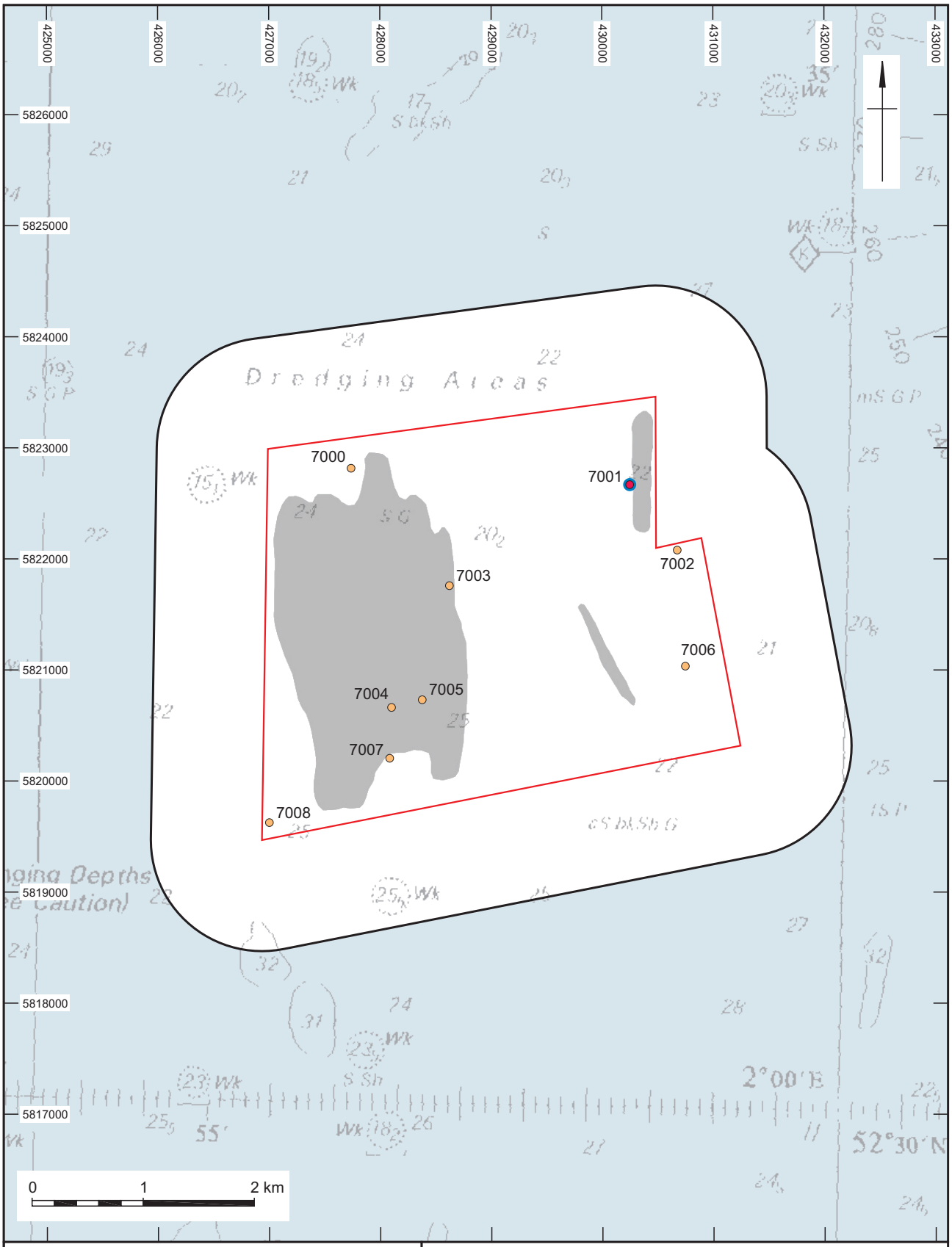
Study Area
Area 228
Interpreted location of the Palaeo-Yare
Features identified from seismic data

Drawing projection: UTM WGS84 z31N

Revision Number:	0
Illustrator:	KJF
Date:	11/11/11
Scale:	1:4000 horizontal (inset 1:100,000) @A3
Path:	W:\Projects\78670\Drawing Office\
Report figs\EIA\11_10_26	

Seismic data example of Palaeo-Yare

Figure 4



Study Area
Area 228
Previously intensively dredged areas
A1 - Anthropogenic origin of archaeological interest
A2 - Uncertain origin of possible archaeological interest
Exclusion Zone

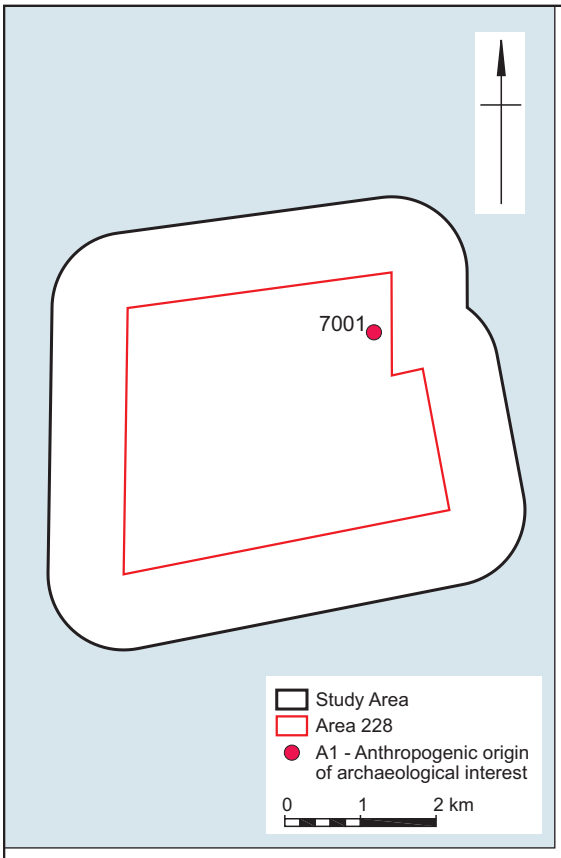
Admiralty Chart 1543 (dated 2000), Drawing projection: UTM WGS84 z31N

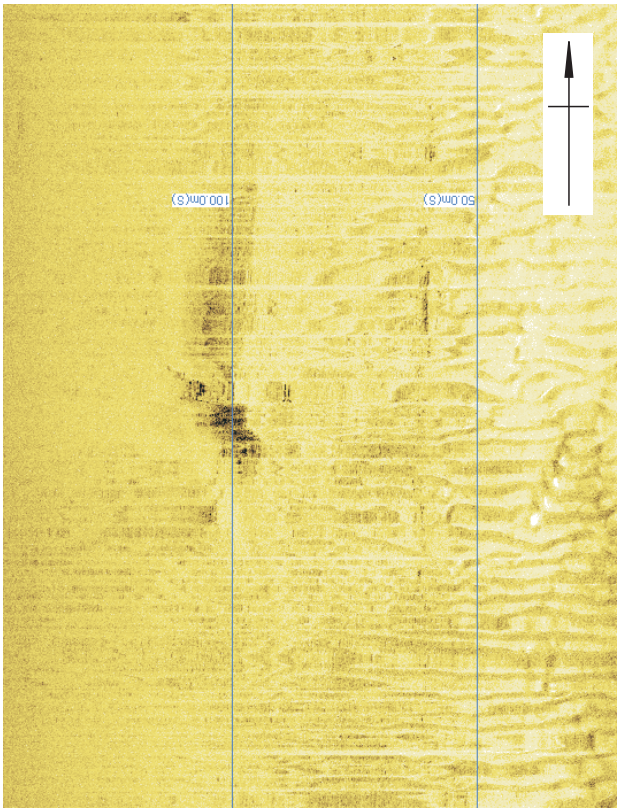
Wessex Archaeology

Date:	27/09/11	Revision Number:	0
Scale:	1:50,000 @A4	Illustrator:	KJF
Path:	W:\Projects\78670\Drawing Office\Report figs\EIA\11_10_26		

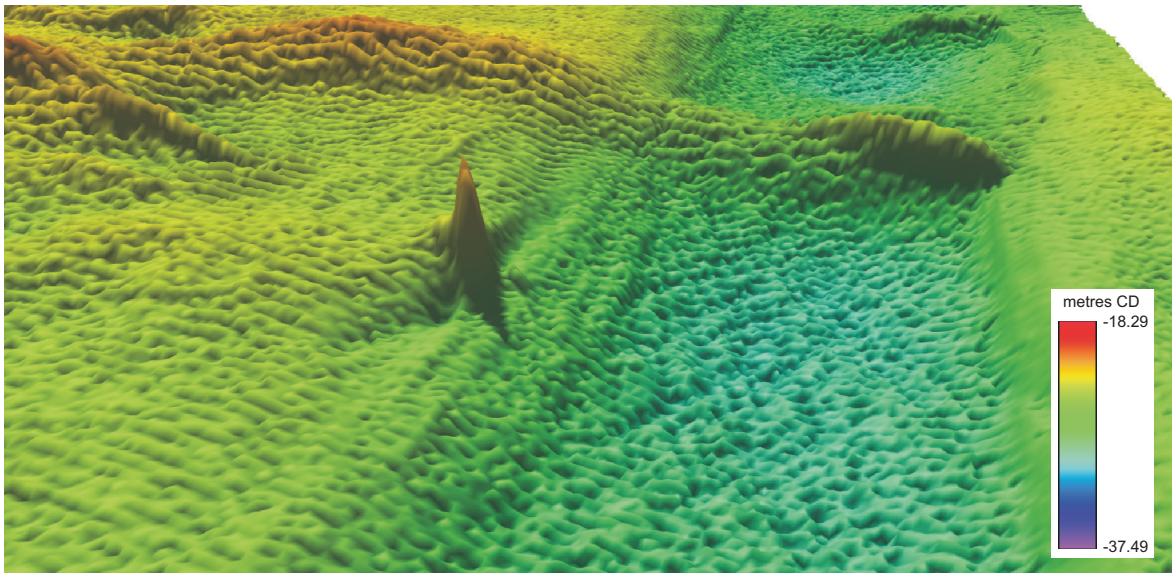
Seabed features of possible archaeological potential

Figure 5





Sidescan sonar data



Multibeam bathymetry (x10 vertical exaggeration facing NW)

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Data examples of possible wreck 7001

Figure 6

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