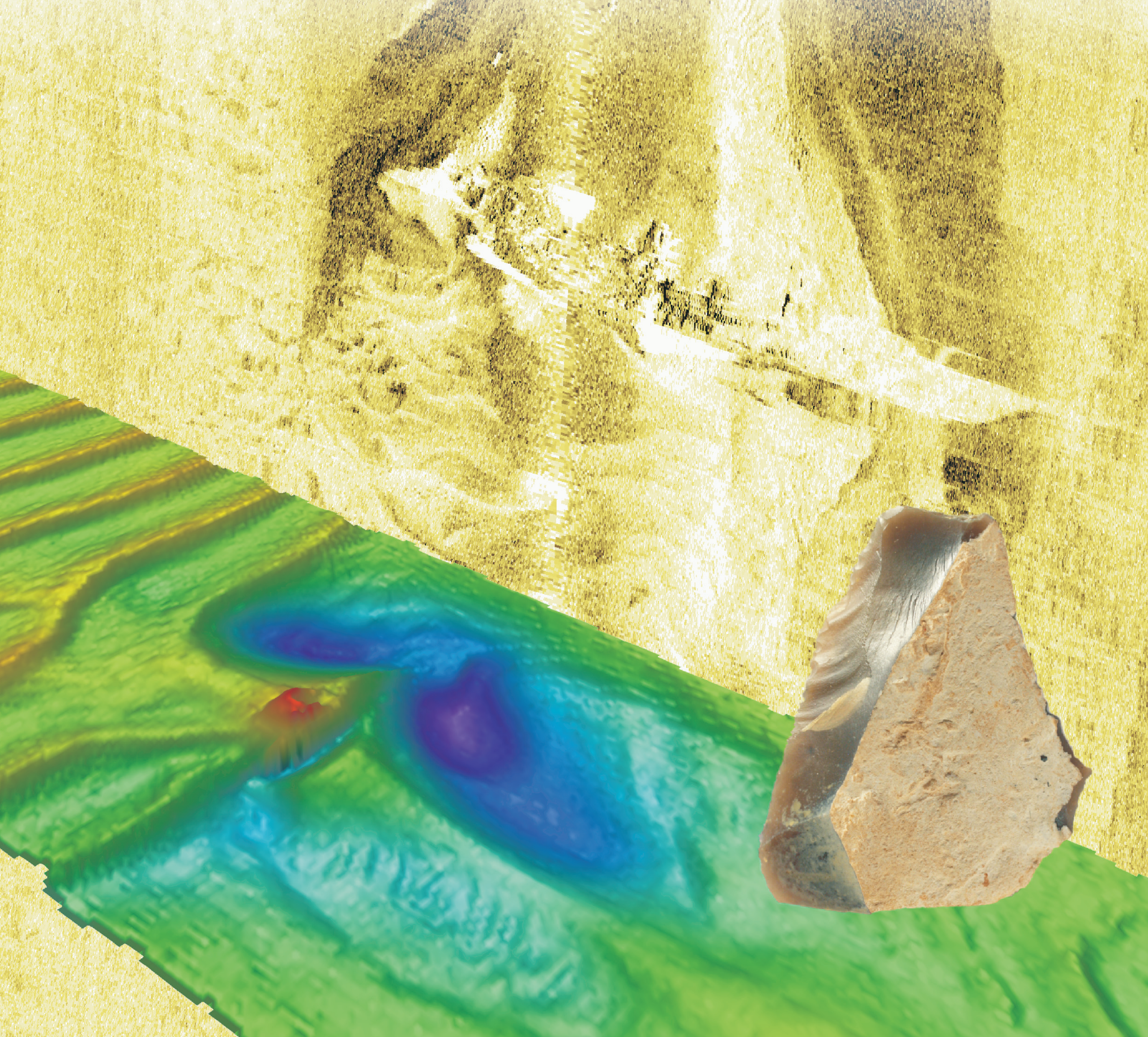
Wessex Archaeology

AODA Marine Aggregate Regional Environmental Assessment

Archaeological Desk-based Assessment

Final Report



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AODA MARINE AGGREGATE
REGIONAL ENVIRONMENTAL ASSESSMENT

ARCHAEOLOGICAL DESK-BASED ASSESSMENT

FINAL REPORT

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AODA MARINE AGGREGATE
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Summary

Wessex Archaeology was commissioned by MarineSpace Ltd. on behalf of the Anglian Offshore Dredging Association (AODA) to undertake the archaeological assessment for a Marine Aggregate Regional Environmental Assessment (MAREA) of an area off the East Anglian coast of England incorporating parts of Norfolk and Suffolk.

The aims and objectives of the MAREA process are:

- To inform and support the industry's applications for licence renewals or new applications;
- To allow regulators to better understand the regional context and impacts of these applications;
- To provide a regional perspective for the marine aggregate industry and inform the site specific Environmental Impact Assessments (EIAs), providing a baseline assessment of the regional environment to be used in the preparation of individual EIAs;
- To provide objective, evidence-based assessments of the distribution and importance of regional resources (living and non-living) and the potential impacts from the proposed activities on these resources at a regional level;
- To provide a context for site specific EIAs within the relevant MAREA area and to identify site specific issues that individual EIAs may need to focus on more specifically;
- To provide an assessment of the impacts of development scenarios by the aggregate extraction industry based on industry projections, and in relation to those due to other human activities and natural variability;
- To provide a robust assessment of cumulative and in-combination impacts at a regional level using consistent definitions and interpretations of such impacts, and thus contribute towards assessments of the magnitude and scale of such impacts in individual EIAs.

The aim of this study is to identify the baseline archaeological resource within all the existing and planned future dredging operation areas at a regional scale. This report will contribute towards the MAREA process which will consider the potential cumulative and in-combination effects of the existing and planned dredging operations on the marine environment as a whole within this region.

This assessment provides an analysis of the known and potential archaeological resource within the MAREA Study Area. Information was sought from the National Monuments Record (NMR), the regional Historic Environment Records (HERs) and SeaZone data. Geotechnical

and geophysical data were also reviewed and integrated with the archaeological baseline. The known and potential archaeological resource reviewed is sub-divided into three sections, as follows:

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

Geophysical (sidescan sonar, multibeam echosounder, sub-bottom profiler and magnetometer), geotechnical (vibrocore) and seabed sampling (grab sample) data acquired for the East Coast Regional Environmental Characterisation were reviewed as part of the study.

Within the MAREA Study Area 171 specific features of prehistoric interest were identified, namely evidence of submerged land surfaces. Features associated with the Pre-Anglian include the preservation of sediments of likely archaeological potential and a series of cuts and fills possibly associated with buried channel systems. The majority of the features are associated with the Early Devensian Brown Bank Formation and include cuts and fills, erosion surfaces and infilled depressions. Remnants of land surfaces attributed to the Early Holocene are identified in the near shore area of the MAREA Study Area. These include a shallow, meandering channel dated to the Early Holocene and remnant intertidal deposits, including infilled depressions and cut and fill features.

Records of wrecks, shipping casualties and seabed features were sought from the National Monuments Record, Suffolk and Norfolk Historic Environment Records and the United Kingdom Hydrographic Office (UKHO), via SeaZone.

Wreck and other site records and geophysical anomalies were combined into a gazetteer of known sites and then compared and reviewed in the light of secondary sources. Information that could not be mapped in the GIS was compiled in a project archive and used qualitatively.

Based on the coverage of the geophysics data, the known maritime resource of the MAREA Study Area can be summarised as follows:

- 128 charted UKHO wreck or obstruction sites are located within the MAREA Study Area and covered by geophysics data. Of these, 55 were verified by the geophysical data; 73 charted wreck and obstruction sites were not identified in the geophysical data;
- 3 previously uncharted wrecks were identified in the geophysics data within the MAREA Study Area;
- 406 geophysical anomalies of uncertain origin with possible archaeological interest. 319 of these were only seen as magnetic responses.

There are currently two protected wrecks within the MAREA Study Area. The Dunwich Bank wreck is protected under the Protection of Wrecks Act (1973) and the HMS *Exmoor* protected under the Protection of Military Remains Act (1986).

In addition to the known archaeological resource, the desk-based assessment summarises the potential for currently unknown and uncharted resource within the MAREA Study Area. This assessment is drawn from a baseline review based on secondary sources alongside records relating to shipping and aircraft casualties for the MAREA Study Area.

This desk-based assessment is to inform the impact assessment which is being conducted by Emu Ltd.

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Acknowledgements

This Regional Environmental Assessment was commissioned by MarineSpace Ltd. on behalf of the Anglian Offshore Dredging Association (AODA).

Data was provided by AODA, the National Monuments Record, the regional Historic Environment Records and SeaZone. We are grateful to the staff of these organisations for their co-operation.

Nikki Cook compiled this report with contributions from Louise Tizzard, Stuart Churchley and Antony Firth. Louise Tizzard undertook the geophysical and geotechnical data assessment with contributions from David Howell. Kitty Brandon prepared the illustrations. Euan McNeill and Nikki Cook managed the project for Wessex Archaeology. Quality Control was provided by Euan McNeill.

Data Licences

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

The digital use of Chart 2182 was made under licence (ref: HO 820/020220/11). The following notice applies:

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1 INTRODUCTION

1.1.1 Wessex Archaeology was commissioned by MarineSpace Ltd. on behalf of the Anglian Offshore Dredging Association (AODA) to undertake a Marine Aggregates Regional Environmental Assessment (MAREA) for a large terrestrial and offshore study area in the southern North Sea off the coast of Norfolk and Suffolk.

1.1.2 This report provides an assessment of the known and potential archaeological resource within the MAREA Study Area through reviewing primary data retrieved by geotechnical and geophysical surveys, records held by national and regional inventories and secondary sources.

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 aims and objectives of the MAREA process, outlined in the Marine Aggregate Regional Environmental Assessment Scoping Report, and based on Research Advisory Group (RAG) guidance (Emu Ltd 2008) are as follows:

- To inform and support the industry's applications for licence renewals or new applications;
- To allow regulators to better understand the regional context and impacts of these applications;
- To provide a regional perspective for marine aggregates and inform the site specific Environmental Impact Assessments (EIAs), providing a baseline assessment of the regional environment to be used in the preparation of individual EIAs;
- To provide objective, evidence-based assessments of the distribution and importance of regional resources (living and non-living) and the potential impacts from the proposed activities on these resources at a regional level;
- To provide a context for site specific EIAs within the relevant MAREA area and to identify site specific issues that individual EIAs may need to focus on more specifically;
- To provide an assessment of the impacts of development scenarios of the aggregate extraction industry based on industry projections, and in relation to those due to other human activities and natural variability;

- To provide a robust assessment of cumulative and in-combination impacts at a regional level using consistent definitions and interpretations of such impacts, and thus contribute towards assessments of the magnitude and scale of such impacts in individual EIAs.

2.1.2 The aim of this study is to identify the baseline archaeological resource within all the existing and planned future dredging operation areas at a regional scale. This report will contribute towards the MAREA process which will consider the potential cumulative and in-combination effects of the existing and planned dredging operations on the marine environment as a whole within this region. Wessex Archaeology was commissioned to carry out the desk-based assessment; Emu Ltd. is conducting the impact assessment.

3 STUDY AREA

3.1.1 Coordinates were supplied by Emu Ltd. defining the MAREA Study Area. The coordinates were supplied in WGS 84 decimal degrees (**Table 1**). The MAREA Study Area was further defined in different co-ordinate systems to enable data searches to be carried out by the different holding agencies. The WGS 84 geographical co-ordinates were projected into the Universal Transverse Mercator projection, Zone 31 Northern hemisphere (UTM 31N), and transformed onto the Ordnance Survey of Great Britain 1936 datum (OSGB36) and presented as British National Grid Coordinates Easting and Northing (**Table 1**)

Corner	WGS84 (decimal degrees)		UTM Zone 31N		OSBG 36	
	Longitude	Latitude	Easting	Northing	Easting	Northing
1	1.48396	52.8928	398009	5861422	634452	338498
2	2.36329	52.90077	457172	5861422	693521	342617
3	2.37533	52.14823	457258	5777709	699408	259021
4	1.51054	52.14048	398071	5777709	640310	254942

Table 1: MAREA Study Area coordinates

3.1.2 Throughout the report all coordinates are presented in WGS84 (UTM31). Where necessary all coordinate conversions were made using Quest Geodetic calculator by Quest Geo Solutions Limited.

3.1.3 In order to provide a comprehensive account of the baseline environment within the MAREA Study Area, the potential for archaeological remains is considered with reference to archaeological studies within Suffolk and Norfolk. Archaeological evidence from the Thames regional area to the south and Doggerland to the north is also considered variously throughout this report with respect to evidence for hominin/human activity within the wider region.

3.1.4 The MAREA Study Area (**Figure 1**) extends eastwards from the coastlines of Norfolk and Suffolk, and also covers an inland area from Happisburgh in the north to Aldeburgh in the south. The northernmost extent of the MAREA Study Area is situated approximately 4km east of Mundesley on the Norfolk coast. To the south, the MAREA Study Area is situated approximately 2.5km south of Aldeburgh on the Suffolk Coast. The MAREA Study Area covers an area measuring approximately 84km north-south and 60km east-west. **Figure 1** also shows the AODA licensed dredge areas in the Anglian region as of July 2010.

4 METHODOLOGY

4.1 LEGISLATION

4.1.1 The statutory planning and policy context relating to the historic environment in the MAREA Study Area 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 is currently one protected wreck within the MAREA Study Area; the Dunwich Bank wreck. This site is designated under Section 1 of the Protection of Wrecks Act 1973 and is depicted on **Figure 2**.

4.1.4 Under the Protection of Military Remains Act 1986, there is one wreck site within the MAREA area; HMS *Exmoor* (**Figure 2**).

4.2 SOURCES

4.2.1 The MAREA Study Area has been used to define the search areas for archaeological and related data. The principle sources consulted in the assessment are as follows:

- Records of UKHO wrecks and obstructions, collated and provided by SeaZone Ltd;
- Records of Named Losses, other wrecks, maritime obstructions and terrestrial sites of all periods held by the National Monuments Record (NMR);
- Records of terrestrial sites from both the Suffolk and Norfolk Historic Environment Records (HERs);
- 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 2008) and various secondary sources relating to historic aviation patterns;
- Various other Wessex Archaeology sources relating to previous studies carried out within the MAREA area;

- Geophysical and geotechnical data acquired during the East Coast Regional Environmental Characterisation (REC);
- Geotechnical data, comprising vibrocore logs, provided by Hanson Aggregates Marine Ltd (HAML) and Volker Dredging Ltd. (VDL).

4.2.2 Terrestrial site data from the Suffolk and Norfolk HERs was requested, but limited to sites with recorded Palaeolithic, Mesolithic and prehistoric material due to the extent of the landward Study Area. The terms of the HER search was predicated on the assumption that only settlement or other sites/finds dating to the Mesolithic period or earlier would be preserved as submerged landscapes within the marine element of the MAREA Study Area, following sea level changes known to have occurred during the Holocene, which have resulted in the present-day coastline largely unchanged since the Neolithic. As such, this HER data was requested in order to look for any patterns of early human activity within the landward area which could indicate the potential for similar sites/finds in the area now submerged beneath the sea, but which was once a terrestrial landscape.

4.2.3 All terrestrial sites from all periods were requested from the NMR, and this data has been used in researching the regional historic environment assessment for the landward portion of the MAREA Study Area, as well as informing the maritime history of the MAREA Study Area from the Mesolithic period onwards. At this strategic level of assessment it was considered that the NMR data was sufficient for the level of broad-scale regional overview required for the MAREA.

4.2.4 The NMR database was also queried for known and charted wreck sites, Named Losses and obstructions. SeaZone data was also consulted for records of UKHO wrecks and obstructions, which could be queried for both live and dead features. Although there is a duplication in some of this data, utilising the NMR wreck records allowed for a comprehensive picture of the density of maritime activity and its history within the MAREA Study Area to be inferred, despite the imprecise locations of many of the vessels.

4.3 APPROACH

4.3.1 The sources outlined in **Section 4.2** were consulted to provide a review of the known and potential archaeological resource within the MAREA Study Area. This review was considered with regards to three separate fields of enquiry, comprising prehistoric archaeology (**Section 5**), maritime archaeology (**Section 6**) and aviation archaeology (**Section 7**).

4.3.2 In order to assess the potential for prehistoric sites within the MAREA Study Area, various secondary sources (e.g. finds recorded under the BMAPA Finds Protocol (BMAPA and English Heritage 2005); evidence reported in books and journals, previous archaeological investigations in the area were reviewed alongside the HER and NMR datasets relating to the prehistoric terrestrial record within the onshore extent of the MAREA Study Area. The HER and NMR terrestrial records were superimposed on a base map of the MAREA Study Area in the ArcView 9.3 Geographical Information System (GIS) software package and queried based on their period classification to provide an understanding of the distribution and density of the known prehistoric archaeological resource within the MAREA Study Area.

4.3.3 Geophysical and geotechnical data were also used to assess the prehistoric archaeology within the area.

4.3.4 Geophysical data (sub-bottom profiler and multibeam echosounder) data were assessed and interpreted with the aim of identifying prehistoric features of interest, namely indicators of former land surfaces. Any discernable patterns of these features which occur on a broad scale within the MAREA Study Area were also identified.

4.3.5 An assessment of 337 vibrocore logs was undertaken in conjunction with the results of the geotechnical assessment in order to better understand the sedimentary sequence within the MAREA Study Area and evaluate the geoarchaeological and palaeoenvironmental potential of sediments within the region. A total of 38 vibrocores were acquired as part of the East Coast REC survey; the remainder were provided by the aggregate industry.

4.3.6 Geophysical data, acquired as part of the EC REC survey, were interpreted to assess the maritime archaeological resource within the MAREA Study Area. Geophysics data included sidescan sonar, magnetometer and multibeam echosounder datasets.

4.3.7 A review of the maritime archaeological resource within the MAREA Study Area was obtained through a consideration of various secondary sources alongside records of charted wreck sites, shipping casualties and seabed features, collated from the NMR and SeaZone. These records were superimposed on a base map of the MAREA Study Area in the ArcView 9.3 GIS software package.

4.3.8 The SeaZone records relating to charted sites were queried based on their feature classification into wrecks and obstructions. Charted wreck sites are likely to be subject to mitigation following an EIA, at which stage the appropriate level of archaeological mitigation will be determined by an assessment of the importance of each individual site. Charted obstructions represent sites where the archaeological nature is not fully understood, and may also be subject to mitigation following EIA. Consequently, the entire wreck and obstruction data was queried by date and reviewed with regards to a composite timeline (Wessex Archaeology 2008d) which sub-divides vessels into a date range based on generalisations regarding wreck sites which are likely to be of special interest.

4.3.9 Data regarding recorded shipping losses (for which there are currently no known seabed remains) listed by the NMR was assessed in order to provide a review of the potential for unknown and uncharted shipwreck sites within the MAREA Study Area. The data relating to shipping losses was also queried by date with regards to the composite timeline (Wessex Archaeology 2008d) discussed above. The shipping casualties were displayed proportionately and were divided by the date ranges outlined by the composite timeline (Wessex Archaeology 2008d). The Named Locations were represented by a polygon, the sizes of which were representative of the number of shipping casualties lost at each Named Location.

4.3.10 Records relating to aircraft crash sites listed by SeaZone and those relating to aircraft losses listed by the NMR were considered alongside the records for WWII Air/Sea Rescue Operations. Along with an assessment of historic aviation patterns, this data was used to provide an understanding of the density and general distribution of aircraft activity, thus highlighting the potential for the discovery of aircraft crash sites within the MAREA Study Area.

4.3.11 The review of the potential for unknown and uncharted archaeological sites within the MAREA Study Area was further supplemented by an assessment of site survival and visibility within the region. Through a consideration of the geological nature and seabed topography of the MAREA Study Area alongside various secondary resources, it was possible to highlight the potential for unknown sites of archaeological interest to exist which may be impacted by existing or future dredging operations.

4.4 GEOPHYSICAL ASSESSMENT

4.4.1 Geophysical data for the EC REC project were acquired by the EC REC consortium on the R/V *CEFAS Endeavour* during two surveys: the geophysical cruise between 27th September and 30th October 2008, and the ground-truthing cruise between the 18th May and 14th June 2009 (Cefas 2009; Cefas 2009a).

4.4.2 During the first survey, the geophysical cruise, multibeam echosounder (MBES), sidescan sonar, magnetometer, sub-bottom profiler (boomer source) and Acoustic Ground Discrimination System (ADGS) data were acquired.

4.4.3 The survey design comprised a regular grid line pattern over the EC REC survey area (approximately 3300 km^2), with an average spacing between the corridors of *c.* 2.7km (**Figure 3**). It should be noted that the survey area covered by the EC REC is smaller than that covered in this report. As such, the geophysical data corridors do not cover certain areas of the MAREA Study Area (**Figure 3**).

4.4.4 Data acquired along the north-south orientated corridors comprised two lines, with an offset of 100m. The east-west orientated corridors comprised only one line of data. Due to weather conditions during the survey not all data were acquired. A total of 36 corridors out of the planned 45 were acquired and interpreted as part of the EC REC project. The interpretation results are presented in this report.

4.4.5 Additionally, a number of short survey lines were acquired in ‘hot spot’ areas in order to provide data on specific geological and archaeological features identified in the pre-survey data gap analysis. The results of these data are incorporated into this report.

4.4.6 The ground-truthing survey conducted in May and June 2009 was undertaken to principally acquire geotechnical (vibrocore) data, sampling (clamshell grab, hamon grab, Costerus twin grab and beam trawl) data and visual (video and still photographs) data. However, as part of the survey 1194 line km of sidescan sonar and multibeam echosounder data were acquired. The results of the interpretation of these additional surveys have been incorporated into this report.

4.4.7 The lines (and coverage were appropriate) for the sub-bottom profiler, sidescan sonar (and magnetometer) and multibeam echosounder are illustrated in **Figures 4**, **5** and **6**, respectively.

4.4.8 The technical specifications and geophysical characterisation methodologies are detailed in **Appendix II**.

4.4.9 As part of the interpretation the SeaZone gridded bathymetry dataset was used to provide background detail on the geomorphology of the seabed within the MAREA Study Area. However, due to licensing restrictions no reproductions of this bathymetry dataset are illustrated in this report.

4.4.10 In addition to the survey data acquired specifically for this project, the results of previous archaeological assessments of geophysical data conducted by Wessex Archaeology in the MAREA Study Area were also reviewed in the process of this assessment (**Section 4.7**). In particular, seven prospection lines acquired during the Seabed Prehistory: Great Yarmouth project (Wessex Archaeology 2008a) were reviewed (**Figure 4**).

4.5 GEOTECHNICAL ASSESSMENT

4.5.1 A total of 337 vibrocore logs were assessed as part of this study. Of these, 38 were acquired as part of the EC REC survey. The remainder of the core logs were provided by VDL and HAML. An additional 109 vibrocores that were reviewed by Wessex Archaeology as part of the Seabed Prehistory: Site Evaluation Techniques (Area 240) project (Wessex Archaeology 2009a) have also been taken into account.

4.5.2 The positions of the vibrocores acquired as part of the EC REC ground-truthing survey were selected by archaeologist (Wessex Archaeology) and geologists (BGS) based on an initial interpretation of the sub-bottom profiler data. The positions and descriptions of the vibrocores are presented in **Appendix III** and are illustrated in **Figure 4**.

4.5.3 The vibrocore logs provided by VDL and HAML were collected as part of geotechnical investigations of aggregate resource areas in the East Coast dredging areas between 1999 and 2009. Initially, vibrocore positional data were provided to Wessex Archaeology. Due to the large number of logs made available, a sub-set of data were selected by Wessex Archaeology for further review. These were selected based on which vibrocores were within the proximity of sub-bottom profiler data lines. Nominally, vibrocores within 100m of a surveyed line were selected. Further cores were selected in areas deemed of archaeological interest based on the geophysical data.

4.5.4 **Table 2** summarises the number of vibrocore logs and the areas in which they were obtained.

Area	Number of logs	Report
228	39	Andrews Survey (2002)
202	9	Andrews Survey (2000)
436	14	Andrews Survey (2000)
212	7	Andrews Survey (1999)
242	15	Andrews Survey (1999)
328	11	Andrews Survey (1999)
328	6	Andrews Survey (2001)
328	4	Andrews Survey (2003)
361	1	Andrews Survey (1999)
361	2	Andrews Survey (2000a)
361/242	2	Andrews Survey (2003a)
401/402	11	Andrews Survey (1999)
401/402 East	9	Andrews Survey (2000b)
401/402 West	7	Andrews Survey (2000b)
401/402	53	Andrews Survey (2000c)
401/402	8	Andrews Survey (2001a)
240	25	Alluvial Mining Ltd. (1999)
240	7	Andrews Survey (2000d)
240	41	Andrews Survey (2000e)
240	27	Andrews Survey (2005)

Area	Number of logs	Report
240	9	Lankelma Andrews (2007)
495	13	EMU Ltd (2009a)

Table 2: Assessed vibrocores within the MAREA Study Area.

4.5.5 In addition to the vibrocore data acquired as part of the EC REC groundtruthing survey the results of the seabed sampling surveys are also referenced in the report, where appropriate. During the EC REC survey 158 Hamon grab, 19 clamshell grab and 30 Costerus twin grab samples were recovered (**Figure 4**). These samples were analysed onboard for any archaeological artefacts and the processed results of the sediments were analysed for archaeological purposes.

4.6 Review of Previous Assessments Conducted in the Area

4.6.1 There are significant problems of data quality and recording biases relating to national inventories such as the UKHO (provided under licence from SeaZone ltd.) and NMR. The records within these datasets relating to the known archaeological resource are limited and often poor. Conversely, information relating to the potential archaeological resource within the MAREA Study Area is extensive. Consequently, in addition to a review of secondary sources, the research pertaining to the known and potential archaeological maritime resource has been supplemented by the results of previous assessments undertaken by Wessex Archaeology in the MAREA Study Area.

4.6.2 There are a number of previous investigations undertaken by Wessex Archaeology that have a bearing on the discussion of the maritime archaeology of the MAREA Study Area, ranging from large-scale strategic projects to small-scale assessments of individual wreck sites. The results of these investigations are incorporated in **Section 6** of this report, highlighting the potential for the presence of unknown wreck sites within the MAREA Study Area.

4.6.3 Additionally, many previous investigations undertaken by Wessex Archaeology also contribute to our knowledge on the pre-history of the region. The results of these investigations are incorporated into **Section 5**.

4.6.4 **Table 3** provides a summary of previous assessments undertaken in the area. The MAREA Study Areas for these reports are illustrated in **Figure 7.**

Project Name	Project Code	Ref (Wessex Archaeology)	Contents
Great Yarmouth Area 254	50482.02	2002	Archaeological Assessment Technical report
Yarmouth Dredging Area 401/2	56230.02	2004	Desk-based assessment
Southern North Sea Aggregate Licence Area 430	62800.02	2006	Archaeological Assessment Technical report
Aggregate Licence Area 430	65220.02	2007	Archaeological assessment of geophysical data related to aircraft crash remains

Project Name	**Project Code**	**Ref (Wessex Archaeology)**	**Contents**
Aggregate Licence Area 430	65220.04	2007a	Archaeological assessment of further geophysical surveys related to aircraft crash remains
Area 202: Cross Sands	64980.01	2007c	Archaeological interpretation of geophysical data
Seabed Prehistory: Volume IV Great Yarmouth	57422.34	2008h	Archaeological assessment of geophysical and vibrocore surveys
Seabed Prehistory Round 2: Happisburgh and Pakefield Exposures Project	57422.37	2008	Archaeological interpretation of geophysical and vibrocore surveys
Area 401/2	68090.04	2008b	Archaeological assessment of geophysical data for monitoring
Area 202	68090.05	2008c	Archaeological assessment of geophysical data for monitoring
Seabed Prehistory: Site Evaluation Techniques Area 240: Existing Data Review	70751.01	2009a	Existing data review and re-interpretation of geophysical and geotechnical data
Seabed Prehistory: Site Evaluation Techniques Area 240: Geophysical Survey	70751.02	2009b	Geophysical survey
TEDA Marine Aggregate Regional Environmental Assessment	66061.04	2010	Regional environmental assessment
Seabed Prehistory: Site Evaluation Techniques Area 240: Seabed Sampling	70752.02	2010a	Seabed sampling and archaeological assessment
Seabed Prehistory: Site Evaluation Techniques Area 240: Palaeo-environmental Survey	70753.01	2010b	Vibrocore sampling and geo-archaeological logging of the vibrocores
Galloper Windfarm Project	66802.01	2010c	Archaeological desk-based assessment
East Coast Regional environmental Characterisation	70050.01	Cefas *et al.* 2010 (in prep.)	Archaeological characterisation chapters for multidisciplinary project

Table 3: Previous Assessments undertaken by Wessex Archaeology in the MAREA Study Area

5 PREHISTORIC ARCHAEOLOGY

5.1 INTRODUCTION

5.1.1 The following section presents an outline of the known geological and archaeological data for the southern North Sea. This baseline includes a discussion of all known and potential archaeological and geo-archaeological sites in the

MAREA Study Area that may be impacted by existing and future dredging operations.

5.1.2 Sea level fluctuations and numerous glacial and marine transgressions and regressions have shaped the landscape within the MAREA Study Area over time. These changes in sea level have at times caused the floor of the southern North Sea to be dry and beyond the limits of the glacial ice sheet, exposing an inhabitable environment suitable for hominin/human exploitation.

5.1.3 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. Consequently, in order to assess the archaeological potential within the MAREA Study Area, the nature and causes of these fluctuations in sea level are discussed. **Appendix IV** provides an approximate indication of relative sea level stands in the southern North Sea during the last *c.*970,000 years.

5.1.4 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 C14 levels within the atmosphere. The exception to this is the Mesolithic period, the radiocarbon ages for which can be correlated with a calendar date (9,500-5,500 BP, 8,500-4,500 BC). For the purposes of this report, the Mesolithic period will adopt the 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.

5.1.5 Major archaeological periods and significant archaeological discoveries and events are shown within **Appendix IV** to illustrate the relationship between these periods and the relative sea level stands.

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

- Pre-Devensian, *c.* 970,000-110,000 BP (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.*110,000-18,000 BP (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;
- Post-LGM and early Holocene, *c.*18,000-6,000 BP (MIS 1), encompassing the period of human re-inhabitation of the British Isles following the LGM through to the final inundation of the MAREA Study Area during the Mesolithic.

5.1.7 In broad terms, archaeological sites can be found in 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).

5.1.8 A review of the coastal and marine processes which operate during sea level rises and stillstands highlights that a large proportion of the submerged archaeological resource is likely to be composed of artefacts within their secondary context (Westerley *et al.* 2004). This serves to add importance to the few primary context sites investigated.

Overview of Known Prehistoric Sites

5.1.9 With the exception of a relatively small number of sites and finds, the known submerged prehistoric archaeology of the MAREA Study Area is sparse. This paucity of evidence is largely due to the difficulty in locating and identifying archaeological material within the submerged environment and should not be considered to indicate a lack of hominin activity within the offshore extent of the MAREA Study Area.

5.1.10 In order to compensate for the limits of the archaeological record offshore, there is a generous terrestrial portion assigned to the MAREA Study Area, in order to fully assess the known and potential prehistoric archaeological resource (**Figure 1**). Due to the changes in the configuration of the coastline from the Pre-Devensian period to the modern day, it is not unreasonable to assume that the human activity represented by terrestrial prehistoric sites also occurred within the submerged extent of the MAREA Study Area at times when it was exposed as dry land.

5.1.11 A total of 5007 NMR Monuments were recorded within the MAREA Study Area, of which 1887 represent terrestrial sites. Of these, 50 are records of Scheduled Monuments, which will be considered amongst the other terrestrial sites.

5.1.12 In order to obtain an understanding of the density and nature of prehistoric human activity along the river valleys and coastline adjacent to the MAREA Study Area, a number of queries were conducted on the NMR records, sub-dividing the sites based on their period classification.

5.1.13 A total of 1534 records were post-prehistoric in date and are thus omitted from this assessment. A further 23 records were of unspecified period and have also been omitted. Furthermore, 144 Neolithic sites, 103 Bronze Age sites and 12 Iron Age sites have also been omitted from the assessment of prehistoric sites because these periods all post-date the last marine transgression of the MAREA Study Area during the Mesolithic. As a result, no non-maritime sites (*i.e.* terrestrial or living sites) from these periods can be expected on the seabed of the MAREA Study Area. These sites have, however, been used to provide context for the discussion of coastal and seafaring activity within the vicinity of the MAREA Study Area during the Neolithic, Bronze Age and Iron Age in **Section 6**. Following these omissions, this left a reduced total of 71 NMR records, comprising sites dating to the Palaeolithic, Mesolithic and likely early prehistoric period.

5.1.14 In addition to the data supplied by the NMR, data relating to known Palaeolithic, Mesolithic and potential early prehistoric sites was also requested from the Norfolk and Suffolk regional HERs. Traditionally, regional HERs as local repositories are more regularly updated with site information than the NMR, resulting in a much larger and more comprehensive dataset. Thus, only data from the relevant prehistoric periods was requested from the HERs in order to glean a fuller picture of any known and potential prehistoric sites in the terrestrial portion of the MAREA Study Area before the last marine transgression.

5.1.15 A total of 322 records were received from Norfolk HER, although once assessed a number of these records were discounted, usually because they referred to multi-period sites with a clear bias towards later periods (e.g. sites recorded as 'prehistoric' but whose prehistoric element were clearly of Neolithic or later date). However, with the discounted records removed, there remained a total of 216 sites potentially dating to the early prehistoric period, although it should be noted that within this total there are a large number of findpsots recorded as 'prehistoric', often comprising single finds of worked flint of undiagnostic prehistoric date.

5.1.16 Suffolk HER supplied 62 records, of which 56 were relevant to this assessment. The remaining records were omitted on the grounds that they dated to the Neolithic (4 sites), Iron Age (1 site) and medieval period (1 site).

5.1.17 A number of queries were run on the NMR and HER datasets. The results of the period classification queries are presented in **Table 4** and illustrated in **Figure 8**. Sites presented by the NMR and regional HERs as lines and polygons were converted into points.

	No. of records			
Period	**NMR**	**Suffolk**	**Norfolk**	**TOTAL**
Palaeolithic (700,000-10,500 BP)	45	16	36	**97**
Mesolithic (10,500-5,500 BP / 8,500-4,000 BC)	22	13	25	**60**
Likely Early Prehistoric sites/findpsots	4	27	155	**186**
Total	**71**	**56**	**216**	**343**

Table 4: Prehistoric sites listed by the NMR and regional HERs, queried by period

5.1.18 Further queries were conducted on both the NMR and HER records attributed to the Palaeolithic period, in order to assign them, where possible into Pre-Devensian, Devensian to LGM and Post LGM sites and finds, the results of which are discussed in **Sections 5.4**, **5.5** and **5.6** accordingly. Of the 45 Palaeolithic records from the NMR, 41 did not contain sufficient information to enable a more specific date to be assigned. Two records recorded Levallois flint flakes, a technology usually assigned to the Lower or Middle Palaeolithic (*c.*600,000-40,000 BP), with the remaining two records recording Acheulian flint handaxes, thought to be of Lower Palaeolithic date (*c.*600,000-250,000 BP), making all four sites Pre-Devensian.

5.1.19 Of the 16 Palaeolithic sites recorded in the Suffolk HER for the MAREA Study Area, 6 were assigned a Lower Palaeolithic date, with the remainder generally recorded as 'Palaeolithic'. However, 4 of these remaining 10 sites described Acheulian handaxes in their description, with 1 Late Acheulian axe, all likely to date to the Lower Palaeolithic.

5.1.20 Norfolk HER recorded 36 Palaeolithic sites in the terrestrial MAREA Study Area, of which 7 were attributed to the Lower Palaeolithic and 5 to the Upper Palaeolithic (*c*.40,000-10,000 BP), with the remaining 24 sites containing insufficient information to enable a more specific date other than 'Palaeolithic' to be assigned.

5.1.21 The figures displayed in **Table 4** should not be viewed as directly representative of the volume of hominin activity within a given period. The survival of archaeological sites and artefacts is variable and depends on a complex array of interrelating factors. Moreover, there are significant problems with the quality of data provided by national inventories such as the NMR, which provide often limited datasets dependent on recording biases. However, the NMR and HER records certainly attest to hominin activity within the region throughout prehistory. This span of human activity along the river valleys and the Norfolk and Suffolk coastlines should be borne in mind when considering the potential for prehistoric sites in the both the terrestrial and offshore MAREA Study Area.

5.1.22 Two particularly important coastal sites are situated within the MAREA Study Area: Pakefield and Happisburgh. To the south of Great Yarmouth at Pakefield a number of artefacts, well-preserved faunal and plant remains have been recovered (Parfitt *et al*. 2005, Stuart and Lister 2001). The Pakefield site lies on the course of the Bytham River, and has produced a series of Lower Palaeolithic sites along its length. Numerous artefacts have been recovered since 2000 at the Pakefield site. The material suggests that flint-knapping was undertaken at the site and that the raw material source was probably locally collected from the banks of the channel (Parfitt 2008). At Happisburgh (Site 1) on the north Norfolk coast a lithic assemblage has been collected from organic muds on the foreshore and is considered to be in a primary context (Ashton *et al*. 2008). Recent discoveries at Happisburgh Site 3 include an assemblage of 78 flint artefacts (cores, flakes and tools) which were excavated from fluvial and estuarine sediments and are considered in situ rather than in secondary context (Parfitt *et al*. 2010).

5.1.23 Sites such as Happisburgh and Pakefield are of outstanding importance as they reflect the landscape in which early humans (hominins) lived and are associated with abundant proxies of environment and climate (Rose 2008). These are discussed further in **Section 5.4**.

5.1.24 In addition, numerous finds have been reported via the BMAPA/EH protocol for reporting finds of archaeological interest within aggregate areas off the East Coast (Wessex Archaeology 2006, 7007b, 2008f, 2009).

5.1.25 Between 2005 and 2010 (at the time of writing) 30 find reports have been reported as part of the protocol within the aggregate dredging areas offshore East Anglia (**Figure 9**) relating to prehistoric archaeology (**Table 5)**.

Area	Find	Description	Date	Report and year
240	Hand axes and bones	>28 hand axes and bone fragments	Bones dated between 31,000 and 65,000 BP; and >500,000 BP	Hanson_0133_A (2007 – 2008)
240	Mammoth tusk fragments	Two curved sections of tusk	Woolly Mammoth: *c.* 380,000 to 10,000 BP	Hanson_0126_A (2007 – 2008)
240	Peat concentrations	Three large concentrations of peat were discovered at various locations across three dredging lanes, indicating 200m by 130m area.		Hanson_0150_A (2007 – 2008)
240	Mammoth teeth and flint	Two mammoth teeth and two flint finds. The teeth measure 17cm and 12cm, respectively. One of the flint artefacts showed possible signs of striking and may have been the waste product during knapping.	Mammoth: *c.* 380,000 to 10,000 BP	Hanson_0180_A (2007 – 2008)
251	Animal Bone	35cm long complete bone was identified by Wessex Archaeology as a similar size to that of a horse, red deer or cattle; EH have suggested that it may be a hippopotamus radius bone.		Cemex_0093_A (2006 – 2007)
251	Animal bone	Aurochs metatarsal bone		Cemex_0307
251	Peat	Peat		Cemex_0296
254	Fragment of bone	10cm long bone fragment identified as a possible deer metatarsus		UMD_0041_A (2005 – 2006)
296	Animal bone	Suggested end of a long bone from a large mammal, possible one bigger than a horse.		UMA_0076_A (2006 – 2007)
296	Mammoth tooth	Possible milk tooth due to its size and unworn nature.	Woolly Mammoth: *c.* 380,000 to 10,000 BP	UMA_0107_A (2006 – 2007)
296	Femur fragment	Large fragment (approximately 26cm long) of a right-sided femur. High degree of rolling and abrasion on the seabed. Derived from either a large bovid, such as a cow, or a cervid such as a giant deer.		UMA_0117_A (2007 – 2008)
296	Bone	Heavily degraded and damaged bone, possibly pig, goat or cattle		UMA_0160_A (2007 – 2008)
360	Eroding peat layer	A collection of dark decaying waterlogged pieces of wood, peat, mineralised bone, antler and a piece of struck flint	Charred wood and an eroded peat ball both radiocarbon dated to >47000BP	CEMEX_0039_A (2005 – 2006)
360	Animal bone and Mammoth tooth	Fragment of Mammoth tooth and fragment of antler. Possibly *in situ* finds	Mammoth: *c.* 380,000 to 10,000 BP	Cemex_0265

Area	Find	Description	Date	Report and year
361	Ice Age Mammal remains	Fragments comprising mammoth teeth and bone, and a piece of deer bone.	Woolly Mammoth: *c.* 380,000 to 10,000 BP	Hanson_0018_A (2005 – 2006)
361	Animal bone	Fossilised humerus fragment (22cm across) possible belonged to a large mammal, such as a mammoth	Mammoth: *c.* 380,000 to 10,000 BP	Hanson_0202 (2008 – 2009)
430	Bone fragment	7cm long fragment identified as a partial distal end of the humerus bone. Mammalian in origin		UMA_0144_A (2007 – 2008)
Unknown	Struck flint flake	Flint struck by human action rather than during dredging or by natural processes. Probably waste flake with smooth worn surfaces		UMA_0182_A (2007 – 2008)

Table 5. Possible Prehistoric finds reported through the BMAPA/English Heritage Protocol for Reporting Discoveries of Archaeological Interest

5.1.26 The handaxes recovered from Area 240 (Hanson_0133_A) are of particular interest and have been the subject of extensive study since their discovery (Wessex Archaeology 2009a; 2009b, 2010a, 2010). Between December 2007 and February 2008 75 Palaeolithic artefacts, including hand axes, flakes and cores, and a number of bones (including woolly mammoth, bison, horse and reindeer) were discovered by Mr Jan Meulmeester in stockpiles of gravel at the SBV Flushing Wharf. Based on the dates of these finds and through consultation with (HAML) it was established that the artefacts and faunal remains were dredged from a discrete locale within marine aggregate licence Area 240, and their provenance is judged to be secure (**Figure 9**). Initial inspection of the artefacts indicated that they were sourced from three environments: those found in a primary context, those originating from an eroding surface and those derived from the seafloor (Hans Peeters, pers. com.). This indicates a complex, rather than simple find site and suggests the dredger impacted a range of deposits containing artefacts, rather than one single deposit. The lithics are currently being assessed at the University of Leiden (Dr Dimitri Loecker) and the faunal remains are being assessed by Dr Jan Glimmerveen.

5.1.27 As part of further work carried out in the area (Wessex Archaeology 2010a) further flints and faunal remains were recovered from clamshell grab samples. In total, fifteen flint flakes and ten pieces of bone were recovered from the clamshell grab samples (**Figure 9**). The recovered flint consisted entirely of flint flakes. Although it is difficult to distinguish humanly produced flint flakes from those that occur naturally, of the 15 flakes recovered all are of probable anthropogenic origin, but eight are more obviously genuine artefacts.

5.1.28 The known prehistoric sites are integrated into the following sections.

General Geological Setting

5.1.29 The shallow geology of East Anglia comprises a highly complex and varied sequence of unconsolidated sediments reflecting deposition in differing environments and climatic conditions. During the early Pleistocene sediments were deposited in warm and cold marine conditions, followed by later glacial and interglacials to the present day (Cameron *et al.* 1992). These Quaternary sediments overlie Tertiary deposits throughout the offshore MAREA Study Area.

5.1.30 Throughout the MAREA Study Area the bedrock (Tertiary sediments) comprises London Clay Formation, a Lower Eocene sediment unit comprising the thickest and most widespread of the mudstone formations (Allen and Sturdy 1980:2; Cameron *et al*.1992). This deposit is approximately 150m thick in the Thames Estuary region and 76m thick north of the MAREA Study Area. The London Clay Formation consists of stiff dark or bluish grey clayey silts, silty clays and silts (Cameron *et al*. 1992:97) and dates to c. 53 - 51 Ma.

5.1.31 The London Clay Formation is overlain by the Red Crag Formation. The offshore Red Crag Formation probably correlates with the early onshore deposits (Moorlock *et al*. 2000) of the Red Crag Formation.

5.1.32 Lower and Middle Pleistocene sediments, deposited prior to the Anglian Glaciation, comprise mainly shallow marine sands, gravels, silts and clays with occasional terrestrial sediments, and river gravels and sands, occasionally containing organic remains (Rose 2008). The river systems were typically large relative to present-day river systems.

5.1.33 Offshore, Pleistocene sediments overlie the Red Crag Formation deposits and comprise Lower Pleistocene Westkapelle Ground Formation (*c.* 2.43-2 Ma), which in turn is unconformably overlain by the Smith's Knoll Formation (*c*.2 – 1.65 Ma).

5.1.34 The Westkapelle Ground Formation comprises clays, muddy sands and the sands deposited in pro-delta and delta-front environments (Cameron *et al*. 1992:105). The delta-front sediments outcrop within the western part of the MAREA Study Area, where its upper levels have been removed by erosion. Further supply of sediments from Britain produced the overlying Smiths Knoll Formation which forms a delta front facies situated directly to the east of the Westkapelle Ground Formation delta front. Remnants of this Formation are situated in the east of the MAREA Study Area.

5.1.35 The base of the Westkapelle Ground Formation correlates with the base of the upper part of the onshore Red Crag Formation (Cameron *et al*. 1992; Moorlock *et al*. 2000).

5.1.36 The Yarmouth Roads Formation overlies the Westkapelle Ground and Smiths Knoll Formations, particularly in the central and northern sections of the MAREA Study Area. The Yarmouth Roads Formation correlates with the onshore Cromer Forest-bed Formation, Kesgrave Group and Bytham Sands and gravels (Moorlock *et al*. 2000), observed onshore, associated with large river systems cutting into the underlying crag deposits.

5.1.37 The Yarmouth Roads Formation comprise sediments deposited as part of a complex delta-top sequence forming part of the Ur-Frisia delta plain, consisting of sands with pebbles (including chalk), abundant plant debris and peat clasts (Cameron *et al*. 1992:107).

5.1.38 The Egmond Ground Formation is observed sub-cropping the Holocene sediments in the northeast of the MAREA Study Area. This formation was originally charted as the younger Eem Formation (British Geological Survey 1984; 1991) and then re-interpreted as Egmond Ground Formation (Cameron *et al.* 1992). The Egmond Ground Formation was deposited during the latter stages of the Hoxnian interglacial as the re-establishment of a shallow sea prevailed caused by rising sea levels and continued tectonic subsidence following the decay of the Anglian ice sheet. The Formation comprises fine-grained, sparsely shelly marine sands with clay interbeds.

5.1.39 The youngest of the Pleistocene sediments documented in the MAREA Study Area belong to the Brown Bank Formation deposited in the Late Ipswichian / Early Devensian (110,000 - 75,000 BP). This formation was deposited during the marine regression at the onset of the glacial stage. Generally, sediments comprise brackish-marine grey-brown silts which are extensively bioturbated with a thin layer of shelly gravelly sand towards the base (Cameron *et al*. 1992:113; 1989:125). In the eastern area of the MAREA Study Area the deposits were deposited in outer estuarine or lagoonal environments. Further to the west the Brown Bank Formation may comprise more fluviatile current-bedded silt and finely laminated clays filling late Ipswichian/ Early Devensian channels, up to 20m deep (British Geological Survey 1984; 1991). Onshore, the Brown Bank Formation may be equivalent, at least in part, to the sands and gravels of the Yare Valley Formation (Arthurton *et al*. 1994).

5.1.40 Post-Devensian sediments are likely to be limited to nearshore areas in the MAREA Study Area. Remnant deposits of inter-tidal mudflat deposits are documented in the south of the area (Moorlock *et al.* 2000) and remnants of peat and other fluvial deposits of this age are documented offshore Great Yarmouth (Arthurton *et al*. 1994).

5.1.41 The general seabed topography of the area is variable throughout the MAREA Study Area. Water depths vary from the coast to a maximum depth of around 70m in the east of the MAREA Study Area. The northern part of the MAREA Study Area is dominated by a series of large sandbanks, predominantly orientated parallel to the coastline (northwest to southeast). These features are up to 30m high. Elsewhere in the MAREA Study Area there is a general deepening from the coast to the east with a deep channel observed in the southeast of the MAREA Study Area.

Geoarchaeological Assessment

5.1.42 The geotechnical assessment identified 6 sedimentary units:

- Unit 6: Recent sediment
- Unit 5: Intertidal / saltmarsh peats and clays
- Unit 4: Brackish/lagoonal/shallow marine restricted clays, sands and gravels
- Unit 3: Shallow marine sands and gravels
- Unit 2: Pleistocene sands and gravels
- Unit 1: Pliocene sands

5.1.43 The Pliocene sands of Unit 1 are predominantly observed in the south of the MAREA Study Area associated with the Red Crag and Westkapelle Formations.

5.1.44 Pleistocene sands and gravels (Unit 2) are observed throughout the central and northern areas and are associated with the Yarmouth Roads Formation.

5.1.45 Unit 3 sediments are observed in the northeast of the MAREA Study Area and are predominantly associated with the Egmond Ground Formation. Shallow marine sands and gravels are also associated with basal infill deposits of channel features within the MAREA Study Area.

5.1.46 Unit 4 sediments are associated with the Brown Bank deposits in the MAREA Study Area, particularly the upper infill sediments of channels associated with this formation. Infill sediments associated with channels also include glaciofluvial and fluvial sediments.

5.1.47 Unit 5 is observed in vibrocores situated in the nearshore regions of the MAREA Study Area and include fine-grained sediments, peats and other organic matter associated with early Holocene deposition prior to the onset of the last transgression.

5.1.48 Unit 6 represents the most recent seabed sediment and comprises sand. Notably in aggregate areas this unit is often disturbed. Also, a layer of recent sediment is not observed in all the reviewed vibrocores, indicating older sediments present at the seabed.

5.1.49 The geotechnical interpretation allowed sediment units to be ascribed to stratigraphic units, as described above. These were then used in identifying features of archaeological interest, as detailed in **Section 5.2**.

Palaeo-geographic Assessment

5.1.50 This palaeo-geographic assessment comprises a review of the geophysical and geotechnical data in conjunction with the known geology with the aim of identifying features with archaeological potential within the offshore MAREA Study Area, namely indicators of past land surfaces (Wessex Archaeology 2008c).

5.1.51 Stone artefacts have long been found in sediments associated with river channels, either in sand and gravel layers or associated fine-grained sediments and peats (e.g. Wymer 1999). The presence and survival of these artefacts are closely linked to the environmental processes that caused the associated deposits to be formed.

5.1.52 Within the East Coast region terrestrial archaeological finds have been documented along the course of the Rivers Yare, Wensum and Waverney (Wymer 1999). These refer to single, isolated finds along the valley and comprise predominantly hand axes and stone flakes and are considered to be Lower Palaeolithic, being predominantly found in re-worked fluvial or glacial sediments rather than in an *in situ* context (Wymer 1985). Although it should be noted that at Pakefield and Happisburgh *in situ* artefacts have been recovered from fluvial and estuarine sediments (Parfitt 2008; Parfitt *et al*. 2010).

5.1.53 Peats are indicative of the remains of previous land surfaces, in which prehistoric objects and structures can be found. The preserved vegetation, together with other organic remains such as insects and the microscopic remains of pollen, enable archaeologists to build up a detailed picture of the environment that was once present. The waterlogged and anaerobic conditions under which peat is formed result in the peat having a high preservation potential for both non-degradable and degradable (*i.e*. wood) artefacts, with the potential for *in situ* preservation. Remnants of fine-grained sediment units such as silts, clays and sand can cover artefacts and also prove to be important.

5.1.54 As part of the palaeogeographic assessment in the MAREA Study Area the geophysical (sub-bottom profiler and MBES) data were analysed for evidence of a number of specific features of archaeological interest. Definitions of these features are detailed in **Table 6**.

5.1.55 Only cut and fill features thought to be of archaeological interest have been interpreted. In the nearshore area numerous cut features are observed associated with the edges of modern channels such as the Holm Channel and Barley Picle. In these instances the cut features are associated with the development of these banks since the last inundation and as such are of no interest regarding the prehistory of the MAREA Study Area.

Feature type	Description
Channel	Channel cuts and associated infill deposits. May indicate extensions of present-day terrestrial system or now unconnected channels. May include both fluvial and estuarine environments. Can be described as filled, underfilled and unfilled. Archaeological potential for *in situ* and secondary context artefacts. Infill deposits may also be of palaeo-environmental interest.
Gravel terrace Bank	Features associated with the edge of channel features, or within channel features. Archaeological potential for *in situ* and secondary context artefacts
Cut and fill	As channel features. Cut and fill is used as a descriptor when the feature of interest can not be traced over distance. Generally used for isolated features. Can be described as simple (one phase of fill) or complex (multiple phases of infill)
Depression Fine-grained unit	Small isolated infilled feature which may include remnant features formed by erosion or be associated with inter-tidal deposits. Potential for *in situ* and secondary context artefacts. Infill deposits may also be of palaeo-environmental interest.
Peat Organic matter	Indicator of former terrestrial land surface. Potential for *in situ* and secondary context artefacts. Deposits are of palaeo-environmental interest. Generally associated with other features such as channels or cut and fill features.
Gas blanking	Gas blanking masks the seismic reflectors and is caused by the presence of shallow gas. Shallow gas may indicate the presence of organic matter/peat at a particular layer caused by microbial activity. Shallow gas can also be sourced from depth migrating to the surface along migration pathways. Discrimination is made during the assessment and only shallow gas thought to be associated with the presence of organic matter is recorded. Generally associated with channel infills, cut and fill features and erosion surfaces.
Strong reflector	May indicate either hard ground layer or layer containing organic matter.
Erosion surfaces	These tend to be broad scale features associated with erosion during transgression and regression. May include ravinement surfaces (transgressive erosion surface resulting from nearshore marine and shoreline erosion associated with a sea level rise)

Table 6: Features of potential prehistoric archaeological interest

5.1.56 Only features thought to have formed during the period of occupation have been interpreted, *i.e*. from *c.* 970,000 to the last transgression.

5.1.57 A total of 171 features of archaeological interest were identified: 143 features were identified in the EC REC sub-bottom profiler data; 15 features identified in the TEDA dataset and 13 identified in the Seabed Prehistory: Great Yarmouth datasets. The features were divided into groups (1 – 5) for ease of discussion (**Figure 10**). When defining the groups the following were taken into account: the potential age of the feature and associated deposits, feature type and geographic location. Descriptions of all features are detailed in **Appendix VA**.

5.1.58 Feature prefixed with “T_” relate to features interpreted for TEDA (Wessex Archaeology 2010) and “GY_” relate to the Seabed Prehistory: Great Yarmouth prospection lines dataset (Wessex Archaeology 2008a). Detailed descriptions of these features are provided in **Appendix VB** and **C**, respectively.

5.1.59 **Table 7** correlates the groups with the stratigraphy of the MAREA Study Area.

	Pre-Devensian (c. 970,000 – 110,000 BP)	Devensian to LGM (110,000 – 18,000 BP)	Post-LGM and Early Holocene (18,000 – 6,000BP)
Group 1	Possible preservation of sediments of archaeological interest Possible preservation of Pre-Devensian channels and deposits		
Group 2		Channel features and floodplain deposits (Brown Bank Formation) associated with known faunal and flint finds	
Group 3		Features predominantly associated with Brown Bank Formation, particularly channel infill deposits, outer estuarine/lagoonal deposits	
Group 4			Early Holocene channel deposits (predominantly fine-grained deposits and peat/ organic matter)
Group 5			Early Holocene intertidal deposits (fine-grained sediments with organic matter)

Table 7: Correlation between stratigraphy and archaeological features of interest

5.1.60 The identified features were characterised by group and feature type, as summarised in **Table 8**. **Table 8** includes all 171 features. Each group of features is discussed in detail below.

Feature	No. features identified					
	Group 1	Group 2	Group 3	Group 4	Group 5	Total
Complex cut and fill		7	19	1		27
Simple cut and fill	5	15	53	11	12	96
Bank		5	9	3		17
Depression		2	7	3	4	16
Gas blanking			1			1
Erosion surface			5			5
Fine-grained unit			5		1	6
Strong reflector		2				2
Seabed anomaly	1					1
Total	**6**	**31**	**99**	**18**	**17**	**171**

Table 8: Summary of identified features of potential prehistoric archaeological interest

5.1.61 The features identified during the palaeo-geographic assessment are discussed further in **Section 5.2**.

5.2 PRE-DEVENSIAN (970,000-110,000 BP)

Overview

5.2.1 The initial hominin occupation and subsequent settlement of Britain and north-west Europe has taken place against the backdrop of the Quaternary period (1 million years ago-present), characterised by the onset and recurrence of a series of glacial and interglacial cycles. Over 60 cold-warm cycles have been identified in the Quaternary, corresponding with fluctuations in the proportions in deep-sea sediments and ice-core records of the Oxygen isotopes O^{16} and O^{18} (Wenban-Smith 2002:3). During the late Early and early Middle Pleistocene, East Anglia lay within the coastal margins of a shallow marine ebayment fed by three major river systems (the Thames, Bytham and Ancaster rivers) which drained eastwards across southern and central Britain and into the North Sea (Rose *et al*. 2001).

5.2.2 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 are associated with fluctuating glacial and interglacial conditions arising from changes in global climate. There are large gaps in our knowledge of the relative sea level history of the southern North Sea and the configuration of the coastline at any one time. Within the MAREA Study Area, the palaeoriver, the Bytham, flowed from the Midlands across East Anglia some 500,000 year ago, running eastwards into what is now the North Sea. This river and its floodplain was probably one of the most important routes of colonisation for Britain's first human inhabitants.

5.2.3 **Appendix IV** provides an approximate indication of relative sea level variations in the southern North Sea during the last *c*.970,000 years, in relation to MIS stages and approximate dates. Major archaeological periods and significant archaeological discoveries and events are shown to illustrate the relationship between these periods and the relative sea level stands.

5.2.4 The lower sea levels that occurred during glacial periods meant that for long periods during the last *c*.970,000 years, areas of the southern North Sea have been exposed as dry land. As such, the MAREA Study Area was suitable for hominin exploitation at various times in the past. With reference to **Appendix IV**, it is likely, however, that portions of the MAREA Study Area were inhabitable for at least parts of this period.

5.2.5 The Anglian and Wolstonian glaciations and associated transgressions and regressions had significant implications for the environment within the MAREA Study Area and along the coasts of Norfolk and Suffolk. The pre-Anglian landscape of the MAREA Study Area – including the path of the Bytham river system – was extensively modified by the Anglian Glaciation. The Bytham River ceased to exist when the landscape in which it flowed was overridden by lowland glaciation during the Anglian stage of MIS 12, and was replaced by glacial terrain, with all areas of pre-existing terrain either eroded or buried (Rose 2008). Notwithstanding, the identification by the Outer Thames Estuary REC of a pre-Anglian (Cromerian Complex) channel in an area interpreted as lying beneath the Anglian ice margin (Emu *et al*. 2009) implies that not all pre-existing landscape features -or archaeological deposits- were completely destroyed and scattered by the ice sheet (Flemming 2002:6).

5.2.6 Throughout the Wolstonian and Devensian glaciations, the MAREA Study Area would have been outside of the limits of the ice front. As a result, the river terrace formations preserved within the buried Bytham sediments represent an important record of the pre-Anglian Pleistocene in Britain, with a carbonate soil at Pakefield revealing structures and isotope signatures that indicates a Mediterranean-style climate (Candy *et al.* 2006).

Pre-Anglian

5.2.7 The earliest date for hominin presence in Britain has been attributed to possibly as early as the end of MIS 25 (*c.* 970,000 - 936,000 BP (Parfitt *et al.* 2010) based on the excavation of an assemblage of 78 flints (flakes, cores and tools) and faunal remains at Happisburgh (Site 3) on the north Norfolk coast. This further pre-dates the occupation of Britain from the previous estimate of *c.* 720,000BP based on the discovery of a coastal site at Pakefield, near Lowestoft, Suffolk (Parfitt *et al.* 2005)

5.2.8 During this period (MIS 25 – 13) there were at least eight temperate phases. With the exception of MIS 16 and MIS 14, which are thought to represent colder phases (Wymer and Robins 2006: 464-466), this period has been described as having a warm climate, similar to that of the present day Mediterranean. The temperate phases are likely to have been favourable for hominin activity. Sea level varied, falling to approximately 90m below its current level during MIS 16. Consequently, there are periods within this period between the extremes of sea level and climate when the MAREA Study Area would have supported human inhabitation.

5.2.9 The evidence from Pakefield comprises flint artefacts found within the Cromer Forest-bed Formation (Parfitt *et al.* 2005:1008), an extensive deposit of organic mud attributed to MIS 17-19, which overlays part of the Wroxham Crag Formation. These sediments have been exposed within the sea cliffs from Weybourne to Southwold (West 1996). In the north of the MAREA Study Area, a quarry in Norfolk has revealed Cromer Forest-bed Formation sediments appearing to infill a channel that cuts into the Neogene Crag Basin, and overlain by sediments known as the Ingham Formation, or the Bytham sands and gravels (AHOB 2006). The Ingham Formation comprises cross-bedded gravelly sand sediments (Rose *et al.* 2001:10) which were deposited by the pre-Anglian Bytham River. The presence of microdebitage within the Pakefield assemblage indicates that flint knapping was undertaken at the site, with the material used sourced locally from the banks of the channel (Parfitt 2008).

5.2.10 At Happisburgh on the north-west Norfolk coast, Lower Palaeolithic/Cromerian deposits within the Cromer Forest-bed Formation are considered to be associated with the Ancaster palaeoriver, which was overlain/infilled by the Happisburgh Formation, deposited during the Happisburgh glaciation, thought to date to MIS 16. The Happisburgh glaciation was the first Middle Pleistocene glaciation of lowland eastern England and the adjacent margins of the North Sea Basin (Lee *et al.* 2004). The Ancaster River drained from northern England across The Wash and transported sediments to northern East Anglia and the southern North Sea delta, with flint tools found within its floodplain and estuarine deposits. Evidence for early human activity at Happisburgh consists of handaxes, flint flakes and butchered bone (Parfitt *et al.* 2005; Preece and Parfitt 2008), and along with evidence from Pakefield, challenges previously accepted dates for the earliest evidence of hominin activity in Britain, shifting dates back by 200,000 years to *c.*700,000 BP.

5.2.11 The Cromer Forest-bed sediments, associated with the fluviatile deposition of the Ancaster and Bytham river systems, have yielded a rich fauna of elephants, deer and other large mammals, suggesting that food sources would be available for early hominins (Parfitt *et al.* 2005; Wymer 1999:129). Clayey silts from the Ingham Formation at High Lodge, Mildenhall, have produced a pollen assemblage indicating woodland with juniper, herbs and heath plants (Austin 1997:8). Fossils, plant and beetle remains from Pakefield indicate that the floodplain there would have provided a resource-rich environment for early humans, along with flint-rich river gravels providing raw materials for tool manufacture (Parfitt *et al.* 2005).

5.2.12 The Bytham River was once one of the largest rivers in Britain, and during the Lower Palaeolithic would have been a major river valley, providing an attractive route utilised by the first humans to colonise Britain. A large proportion of known human occupation sites dating to the Cromerian Complex, before the onslaught of the Anglian glaciation, have been discovered along the length of the palaeoriver, including Waverley Wood near Coventry, and High Lodge, West Dereham, Feltwell, Brandon, Hengrave and Lakenheath in East Anglia. Furthermore, stone artefacts discovered within the Ingham Formation at Warren Hill at Mildenhall is one of the richest sites for Lower Palaeolithic hand axes in Britain (Wymer 1999:130).

5.2.13 The Cromer Forest-bed Formation and associated Bytham River sands and gravels are partially equivalent of the Yarmouth Roads Formation offshore. The Yarmouth Roads Formation is of Praetiglian to Cromerian age (approximately 2.3MA – 480,000BP). The age of the formation within the MAREA Study Area is difficult to assess: environmental data from vibrocores 8km off the coast of Lowestoft suggest a Praetiglian to Tiglian age (1.9 to 2.4 Ma) (Cameron *et al*. 1992). However, sediments to the north of the MAREA Study Area are of Cromerian Complex age 790,000 – 480,000 BP) (Cameron *et al*. 1992:107) and pollen analysis of a core in the Dutch Sector indicates that the deposition of the sediments at a similar latitude occurred during the Cromerian III Interglacial, around 720,000 to 690,000 BP (Zagwijn 1983). Deposition of this formation occurred through to the end of the Cromerian Complex with a basin-wide marine transgression progressing south to around 52° latitude by 400,000 BP. It was during this transgression phase that the Cromer Forest-bed Formation was deposited. There may be remnants offshore of these sediments, although it has been suggested that the uppermost parts of the Yarmouth Roads Formation have probably been eroded (Cameron *et al*. 1992:108).

5.2.14 It is possible that Lower Palaeolithic material may be preserved *in situ* within late Cromerian Yarmouth Road deposits. The potential might be greatest where later Yarmouth Roads Formation deposits are associated with features (river valleys, shorelines etc.) cut into earlier Pleistocene or pre-Pleistocene formations.

5.2.15 A total of six features were identified as pre-Anglian during the palaeo-environmental assessment (**Group 1**). Potential preservation of deposits of this age may be associated with the Cross Sands Anomaly (**7000**) identified in the MAREA Study Area. Further cut and fill features (**7002** – **7005**) may provide evidence of the remnants of channels possibly dating to the Pre-Anglian. As such, there is potential for possible derived artefacts of this age, offshore.

5.2.16 The seabed anomaly (**7000**) is a feature referred to as the Cross Sands Anomaly and is listed by the UKHO (UKHO 10774) as a live obstruction described as a probable geological feature. The feature is situated approximately 6.5km from the coast to the north of Great Yarmouth (**Figure 12**). The feature measures 200m x 70m x 15m and is orientated WNW-ESE. An obvious edge is observed on the western side; on the eastern side feature penetrates sandbank (Middle Cross Sands) protruding into Barley Picle channel. The height above average seabed is 4.5m, but is situated in large scour 10.4m deep, 600m long by 250m wide. **VC1**, situated 60m northeast of the feature, comprises 1.56m probable shallow marine gravels and sands. The upper 0.3m is oxidised which is a possible indication of lowered sea level. The lower sandier (0.63 to 1.56m) section represents a slightly lower energy marine environment to that above.

5.2.17 The true nature of the feature is unknown. One theory is that the feature is a chalk raft deposited during the Anglian Glaciation. Chalk rafts can be seen on the north Norfolk coast (Burke *et al*. 2009) and are defined as dislocated slabs of bedrock and/or unconsolidated sedimentary strata that have been transported from their original position by glacial action. On the northeast coast of Norfolk the chalk rafts are exposed within the Middle Pleistocene glaciogenic sediments that are exposed in the cliffs capped by periglacial sand and gravel.

5.2.18 Although a chalk raft, in itself, is not of particular archaeological interest the presence of this feature offshore may indicate preservation of underlying sediments that could be of archaeological interest.

5.2.19 The location of the Cross Sands Anomaly is approximately 6.5km offshore. During the Early Holocene the coastline was approximately 5.5km east of its present-day shoreline and formed the boundary between the terrestrial upland area and the North Sea plain (Arthurton *et al.* 1994: 83). It is possible that the chalk raft formed part of the cliffline at one point and has subsequently been eroded away leaving the feature exposed. As such, the feature may preserve Early Pleistocene sediments in a similar way that the cliffs, until recently, have preserved the sediments containing artefacts and faunal remains at sites such as Happisburgh and Pakefield.

5.2.20 Feature **7001** is situated approximately 3.5km from the present day coastline and is an isolated simple cut and fill feature. The feature is interpreted as a cut into the underlying Westkapelle Ground Formation and infilled with up to 4m of fine-grained sediment possibly Yarmouth Roads Formation. If this infill does indeed comprise Yarmouth Roads Formation there may be some potential for Lower Palaeolithic artefacts or palaeo-environmental material. It is possible that the infill is in fact younger and may be associated with offshore extensions from present-day rivers.

5.2.21 Features **7002 – 7005** are interpreted as simple cut and fill features and may be evidence of the remnants of a more extensive channel feature. **7002** and **7003** are similar in form. Both are cuts marked by strong, undulating basal reflectors and infilled by a series of strong reflectors, probable coarse-grained sediments. **7004** is situated to the northwest of **7003**. **7004** is also a simple cut and fill feature. However, a distinct incised cut is observed at the base of the feature. A similar feature is observed in **7005.** It is possible that these cuts were caused by glacial action rather than fluvial action. The nature and age of fill of these features is unknown and difficult to determine. Also, the relationship between **7003** and **7005** is difficult to determine other than they are in the proximity of each other. If these features are glacially formed then it is possible that the fill represents remnants of the Swarte Bank Formation (Cameron *et al*. 1992:112).

5.2.22 Swarte Bank Formation in fills a fan-like array of valleys cut into Pleistocene and earlier strata. The valleys are generally considered to have been formed by subglacial meltwater under pressure and are filled with stiff, grey diamictons overlain by glaciofuvial sand or glaciolacustrine muds, overlain sporadically by marine interglacial sediments. Swarte Bank Formation is considered to be of late Anglian to, locally, earliest Hoxnian age. If the infill is Swarte Bank Formation the fill is unlikely to contain any artefacts. However, if the fill is older (Pre-Anglian) then there is potential for Lower Palaeolithic artefacts associated with these features.

5.2.23 A deep channel was identified to the south of this area in the prospection line data acquired as part of the Seabed Prehistory: Great Yarmouth project (Wessex Archaeology, 2008h). **GY_7013 (Figure 11)** is observed as a symmetrical cut feature observed between 7.3 and 18.3m sub-seabed. This fill is composed of 2 phases of fill. The deepest fill layer shows reflectors draping the cut overlain by secondary fill, the base of which is observed at around 10.5m sub-seabed. This cut and fill is unconformably overlain by a unit of strong reflectors interpreted as Brown Bank Formation. Infill is likely to comprise Early to Mid Pleistocene sediments (Yarmouth Roads Formation or younger).

Anglian

5.2.24 The Anglian glacial phase (478,000-423-000 BP; MIS 12) was the most extensive of the glaciations, with ice sheets reaching as far south as the north Cornwall coast and the Thames Valley (Wymer 1999:17). The trapping of water within the extensive Anglian ice sheets resulted in a fall in sea level thought to be the lowest recorded around the British Isles and estimated at 130m below the present level.

5.2.25 During this phase the MAREA Study Area would have been covered with ice, which extended south into modern-day Essex, with the extent of the Anglian ice sheet thought to run in a line from Brentwood, through Billericay to a point a little west of Colchester (Allen and Sturdy 1980:2). Although it has been suggested that the limits of the Anglian Glaciation are further south (Emu *et al*. 2009).

5.2.26 Extensive remodelling of the landscape took place, with old river courses such as the Bytham River ceasing to exist. The Thames and its tributaries were diverted southwards and a large ice-dammed lake developed in the southern North Sea directly to the south of the ice front, into which the Thames and other major European rivers, such as the Rhine, flowed (Gibbard 1988).

5.2.27 Onshore deposits from this period along the Norfolk and Suffolk coasts are till deposits belonging to the Corton and Lowestoft Till Formations. No Anglian till formations are known to be preserved offshore, as they are thought to have been eroded by the subsequent sea level rise during the Hoxnian interglacial. However, if the Cross Sands Anomaly (**7000**) is a chalk raft then this would be associated with Anglian till deposits, and as such there may be remnants of Anglian material offshore.

Hoxnian

5.2.28 The Hoxnian interglacial (423,000-380,000 BP; MIS 11) was a temperate phase, which followed the Anglian Glacial period. During the interglacial, Britain is likely to have become a peninsula of north-western Europe and remained so until the Aveley Interglacial (*c*.245,000 BP). During the Hoxnian interglacial, the meltwater from the Anglian icesheet ran down the Thames-Medway channel, increasing its size and causing it to divert once again southwards in a course approximating the current position of the Thames Estuary (Brigland 1994: 295).

5.2.29 Sediments of possible Hoxnian age were observed in a section during the construction of sea defences at Caister-on-Sea. The sediments comprise channel fill sands cut into Lowestoft Till Formation. These sands were overlain by sands and gravels of the Devensian Yare Valley Formation (Arthurton *et al*. 1994).

5.2.30 Elsewhere to the west of the MAREA Study Area, further Hoxnian deposits have been noted, such as the lake deposits at Hoxne (West 1956), after which the

Hoxnian is named, and which included a number of Lower Palaeolithic artefacts (Wymer 1999:156-159). Other lake-edge locales include Barnham and Elveden, both near Thetford, Suffolk, to the west of the MAREA Study Area. Nearby at West Stow, a Lower Palaeolithic 'home-base' site has been discovered, comprising flint artefacts of Acheulian character, as well as numerous charred bones and flints, indicating the repeated use of fire. Discrete areas of burning have been interpreted as hearths, with the spatial distribution of flints suggesting fireside knapping (Preece *et al*. 2006). The archaeological evidence suggests that the site repeatedly served as an area of focused activities throughout the interglacial, with fossil evidence suggesting occupation was within a closed deciduous forest in a fully temperate climate (Preece *et al.* 2006).

5.2.31 Within the onshore extent of the MAREA Study Area, two sites listed by the NMR contain references to Acheulian flakes, which is the main Lower Palaeolithic flake tool industry dating to the middle of the Hoxnian Interglacial (Darvill 1987:31). An Acheulian handaxe was found on the shore 6km to the south-east of Happisburgh, whilst a second axe was found with frost damage, and not *in situ*, at Oulton Broad, 4km inland from Lowestoft. No sites with specifically Acheulian material were recorded within the Norfolk HER, although there were seven sites attributed to the Lower Palaeolithic, all of which comprised handaxes, which were mostly concentrated along the coast between Happisburgh and Hemsby. In Suffolk five sites with Acheulian material were recorded in the HER, all handaxes, and by contrast all were inland in an area between Beccles and Brampton.

5.2.32 The discovery of three early human skull fragments at Swanscombe in north-west Kent known as the 'Swanscombe Skull', provides direct evidence of a hominin presence within the wider region. The 'Swanscombe Skull', which was found alongside flint artefacts, has been assigned to the *Homo heidelbergensis* species (Bridgland 1994:13).

5.2.33 The distribution of known sites both within the onshore extent of the MAREA Study Area and within the wider region suggests that river valleys and lakeside situations were favoured for settlement during this period (Darvill 1987:31). It is also likely that coastal and estuarine environments would have equally been exploited by humans during the Hoxnian. Early humans would have made use of the full range of resources that such fluvial environments provide, such as a greater diversity of animal, plant and lithic resources, as well as many being major routeways through the landscape (Ashton *et al.* 2006). By exploiting river valleys, early humans were able to make use of their plentiful resources, whilst the valleys themselves operated as open corridors through the otherwise dense forest, having good accessibility and being easily navigable, as well as being prominent landscape features which were simple to relocate.

5.2.34 Offshore, the Egmond Ground Formation sediments are of Hoxnian age (Cameron *et al*. 1992) and represent a transgression sequence associated with the development of a shallow sea to the east of the river channels described above. It is considered that there may also be potential for artefacts to be covered by these transgressive sediments and where Egmond Ground Formation forms the infill to channel deposits there is the possibility of derived artefacts.

5.2.35 Features **7095** and **7101**, identified during the palaeo-geographic assessment, are distinct deep cut features infilled with a series of strong sub-parallel reflectors interpreted as Egmond Ground Formation. However, **VC24** situated within **7101** indicates that the upper 4.3m of this fill comprises organic silts and clays overlying fine-medium grained sands. These sediments are indicative of the Devensian Brown Bank Formation sediments (**Section 5.3**).

Wolstonian

5.2.36 The Wolstonian (380,000-130,000 BP; MIS 10-16) comprised three cold stages (MIS 10, 8 and 6) interspersed with two temperate phases (MIS 9 and 7). The extent of the ice sheets during the cold stages are a matter of ongoing discussion. It has been tentatively suggested that the ice margin ran across Lincolnshire and the Midlands (Wymer 1999:18), with its limits extending from the Wash eastwards and then north before heading south and west. Another view suggests British ice sheets joined with the Scandinavian ice across the northern North Sea, leaving the sea floor south of an approximate line from Southwold to Scheveningen outside the limits of the ice front (Flemming 2002:8). The MAREA Study Area would thus have either been partially covered by an ice sheet during the Wolstonian, with the southern part of the offshore area (Licence areas 496 and 430) free of ice, or else the entire area may have been exposed. Sea levels are estimated to have been up to approximately 120m below their current level during Wolstonian cold stages, which means that parts, if not all, of the MAREA Study Area would have been uncovered. Climatic conditions would have provided a landscape of bare ground and heath (Allen and Sturdy 1980:3) that was largely suitable for human activity within this part of the MAREA Study Area. British faunas from this period are dominated by cold species such as mammoths, woolly rhino, reindeer and arctic fox (Wessex Archaeology 2009a).

5.2.37 Gibbard (2007) has proposed that the Wolstonian ice sheet dammed a lake in the southern North Sea, with the lake water level remaining close to the present sea level, with the major rivers of the Rhine and Meuse forced to flow to the southwest into this ice-marginal lake. If this is the case, parts of the MAREA Study Area may not have been covered by an ice sheet, but may instead have been situated on the western edge of this glacial lake, with a landscape of vegetational mosaic of cold tundra and open steppe (Barton 2005: 26).

5.2.38 Within the Wolstonian, two temperate phases have been identified - the Purfleet interglacial (339,000-303,000 BP; MIS 9) and the Aveley interglacial (245,000-186,000 BP; MIS 7). It is thought that the sea level was at similar levels to today, and that during these times Britain was an island. Analysis of deposits assigned to the Purfleet interglacial indicates a range of habitats including riparian, woodland and grassland environments with climatic conditions that are thought to be warmer than the present day (Bridgland *et al.* 1995:178).

5.2.39 Traditionally the onset of the Avelely interglacial is associated with the transition from the Lower to the Middle Palaeolithic (c.300,000-40,000 BP), which sees a change in tool technologies, largely with the first appearance of Mousterian (Levallois) techniques. Within the MAREA Study Area there is one possible Levallois or late Acheulian handaxe found on the surface of a cliff talus near Dunwich to the south of Southwold. In Norfolk a Levallois flake was found on the beach at Lessingham, 4km along the coast from Happisburgh.

5.2.40 At the end of the Aveley Interglacial there followed a further Wolstonian glacial period (MIS 6), in which it is suggested that Britain was uninhabited from *c*.180,000 years ago until c.40,000 years ago, which marks the transition to the Upper Palaeolithic period (c.40,000-10,000 BP) and the first appearance in Britain of modern humans.

5.2.41 There is no documented evidence of Wolstonian age sediments in the offshore region. However, a bank feature comprised of sand and gravel situated in dredging Area 254 was dated by Optically Stimulated Luminescence (OSL) to be Wolstonian in age. This bank deposit was associated with a channel feature, possibly the extension of the Palaeo-Yare possibly cut towards the end of the Anglian Glaciaton (Wessex Archaeology 2008h). This channel feature and its associated archaeological potential are discussed further in **Section 5.3**.

Ipswichian

5.2.42 For the purposes of this report the Ipswichian Interglacial is referred to as dating to *c*.130,000-110,000 BP, MIS 5e only. Certain authors integrate MIS 5 a-d with the interglacial and mark the start of the Devensian Glaciation at MIS 4 (75,000-60,000 BP), as it is at this point in the faunal record that animals are cold adapted (Currant and Jacobi 1997). However, more generally, MIS 5d is referenced as the onset of the Devensian after the maximum stage of the interglacial (Wymer 1999; Kukla *et al.* 2002).

5.2.43 The onset of MIS 5e was marked by an abrupt climatic transition from the end of the Wolstonian. The climate was similar to that of today, possibly a bit warmer with hot summers and mild winters (Barton 2005). The southern North Sea was submerged during this time, with the sea level 5-6m higher than it is today.

5.2.44 There is little evidence of Ipswichian glacial sediments remaining in the MAREA Study Area. Given the rise in sea level during this time much of the coastal area would have been inundated. At Great Yarmouth and its surrounding areas, of the Pleistocene stages following the Anglian, only the Devensian sediments are considered to be widespread (Arthurton *et al.* 1994). To the south in the Lowestoft area there are Ipswichian deposits at Wortwell, interpreted as having been deposited in a low energy fluvial backwater within the Waverney Valley (Moorlock *et al.* 2000: 68).

5.2.45 Britain remained an island during the Ipswichian, with the climate thought to be for much of the time as warm as our current climate (Wymer 1999:33). Faunal remains dating to this period discovered at sites such as Bobbitshole near Ipswich indicate a climate suitable for large mammals such as lions, hippopotami, straight-tusked elephants, rhinoceri, giant deer, red deer, fallow deer, aurochs and bison within floodplains (Wymer 1999:33). Evidence from Essex suggests vegetation comprising predominantly mixed oak forests (Allen and Sturdy 1980:3) within the general vicinity of the MAREA Study Area.

5.2.46 During the Ipswichian, it is suggested that Middle Palaeolithic hominins known on the Continent were absent here in Britain (Wymer 1999:33; Ashton and Lewis 2002). This absence is enigmatic, given the favourable climate and availability of large mammal fauna. Two sites listed by the NMR and regional HERs in the onshore extent of the MAREA Study Area contain references to Levallois flakes, a technique of flintworking dating back to the Wolstonian period but also employed throughout the Middle Palaeolithic, encompassing the Ipswichian, by some Mousterian communities (Darvill 1987:33). Both sites relate to individual findspots, which have been found in coastal locations, but which may have once been fluvial floodplains. If hominins were proved to be present in the Ipswichian, then there is potential for archaeological material to be present along submerged river valleys in the offshore extent of the MAREA Study Area.

5.2.47 Offshore there are no documented evidence of sediments of Ipswichian date until the end of the Ipswichian with the deposition of the Brown Bank Formation (discussed in detail in **Section 5.3**). However, fine-grained sediments of possible Ipswichian date have been identified in dredging Area 254 overlying Wolstonian gravel deposits (Wessex Archaeology 2008h).

5.2.48 If finds, securely dated to this period were found, they would be of great importance.

5.3 DEVENSIAN TO LGM (110,000BP – 18,000 BP)

5.3.1 The Devensian glaciation (110,000-13,500 BP) was the last glacial stage to occur before the present climatic amelioration. The Devensian maximum, when the glaciation was at its greatest extent, occurred *c.*18,000 BP, during the Upper Palaeolithic. At the height of the Devensian, the water locked up in ice sheets caused a lowering of sea level to approximately 120m below its current level. This phase is known as the Dimlington Stadial, named after the type site just north of Easington in south-east Holderness. With the southern edge of the ice sheet extending in a line from the Severn to the Wash (Flemming 2002:7) the MAREA Study Area would have been outside the limits of the ice but within a peri-glacial zone during this phase.

5.3.2 During MIS 5a-d (*c.*110,000-70,000 BP) there was a general deterioration in climate characterised by interstadials (Upton Warren and Chelford, 5c and 5a) and stadials (5d and 5b). Periglacial conditions prevailed during the stadials, but pollen indicates this did not limit tree growth altogether (Barton 2005).

5.3.3 The Devensian is represented by the deposition of cold-climate gravel, whilst offshore the sediments from the early Devensian are ascribed to the Brown Bank Formation. This formation was deposited during the marine regression at the onset of the glacial stage. In the eastern area of the MAREA Study Area the deposits were deposited in outer estuarine or lagoonal environments. Further to the west the Brown Bank Formation may comprise more fluviatile filling late Ipswichian/ early Devensian channels. Onshore the Brown Bank Formation may be equivalent to the sands and gravels of the Yare Valley Formation (Arthurton *et al*. 1994).

5.3.4 MIS 4 (*c.*70,000-60,000 BP) marked the onset of very cold conditions in Europe, with the advancement of the Scandanavian ice sheet, and although most of southern Britain would have remained ice free, it seems that this land was uninhabited until at least 60,000 BP, at the start of MIS 3.

5.3.5 MIS 3 (c.60,000-25,000 BP), the late Middle Palaeolithic, is typified by a sharply oscillating climate in which short cooling episodes and milder climatic events are recorded. In Britain, cool dry conditions encourage the development of rich arid grasslands (mammoth steppe) which supported large mammals such as mammoth, woolly rhino, lion, bear, etc. The migration of these animals probably also coincided with the arrival of the Late Neanderthals, whilst from around 31,000 BP anatomically modern humans are first recorded as inhabiting the British Isles (Barton 2005: 28).

5.3.6 It is likely that from 22,000 BP Britain was again unoccupied. This immediately preceded the Dimlington Stadial (*c.*20,000-13,500 BP, MIS 2) which marks the climax of the Devensian Glacial period and its maximum ice limit in most areas. The ice was not extensive enough to join the Scandanavian ice sheet across the North Sea Basin. Instead, the lowered sea level left a wide plain affected by permafrost over much of the southern and central North Sea (Woodcock and Strachan 2000).

5.3.7 Having reached its maximum at approximately *c.*18,000 BP, the ice sheet of the Dimlington Stadial retreated. The MAREA Study Area remained exposed as dry land, but is not thought to have been re-colonised until the mid-Upper Palaeolithic, around 12,500 BP, during the Windermere Interstadial.

Archaeological Potential of the MAREA Study Area

5.3.8 The UK's terrestrial archaeological record suggests that Britain was uninhabited from *c.*180,000-60,000 BP. However, the possibility of a human presence throughout the Devensian prior to the glacial maximum (*c.*110,000-40,000 BP) should not be disregarded within the MAREA Study Area. Although the Late Middle Palaeolithic period is marked by the onset of the Devensian glacial, it is unlikely that the initial cooling stages of the glaciation would immediately rule out a hominin presence within the MAREA Study Area.

5.3.9 The first evidence for the presence of modern humans (*Homo sapiens*) in Britain dates to the Early Upper Palaeolithic (*c.*40,000-30,000 BP), which at the time was connected to the European mainland as a result of the fall in sea level. The MAREA Study Area would have been on the margins of the ice front during this phase, exposing it as a peri-glacial landscape. This, together with the availability of protein-rich foods within the rivers valleys that ran through the region suggests that the MAREA Study Area would have provided a landscape suitable for human exploitation during the early stages of this glacial phase. Despite this, the Early Upper Palaeolithic is very poorly represented across the wider region of the MAREA Study Area. This may be due to a low population density in East Anglia during this period, although it has been suggested that the dearth of Early Upper Palaeolithic may be largely due to the lack of cave sites which have proved to be so important for the preservation of Upper Palaeolithic sites in other areas of Britain (Austin 1997:9). It is also reasonable to assume that many Early Upper Palaeolithic sites within the wider region of the MAREA Study Area now lie submerged offshore.

5.3.10 The known Upper Palaeolithic material in the region consists of stray artefacts, although the potential exists for the favourable preservation of finds within the alluvial deposits of the river valleys and under fen deposits (Austin 1997:9). Where such material is found, it is likely to be indicative of occasional hunting forays as the peri-glacial landscape within the MAREA Study Area would not have been conducive to any long-term or sustained human occupation (Wymer 1985:11). As the glacial maximum approached, the conditions became too cold to be favourable for human exploitation, rendering the MAREA Study Area region uninhabitable between *c.*22,000-13,000 BP.

5.3.11 Between 2005 and 2010 (at the time of writing) there have been 30 reported finds of prehistoric material reported as part of the BMAPA protocol within the aggregate dredging areas offshore East Anglia (**Table 5**). Finds have ranged from in excess of 28 handaxes, fossilised animal bones and areas of preserved peat deposits, one of which (in Area 360) was dated to earlier than 47,000 BP.

5.3.12 Mammoth bones have been reported from Areas 361, 296 and 240, which may date from the Wolstonian (*c.*380,000) through to late Devensian/Upper Palaeolithic. Other large mammal bones have also been reported, e.g. elephant from Area 360, deer from Area 319, 361, and 254, and possible hippopotamus from Area 251.

5.3.13 Recent archaeological finds in the southern North Sea therefore clearly indicate that archaeological deposits of the Devensian and pre-Devensian period can survive offshore.

5.3.14 Some 28 hand axes, plus flakes, cores and faunal remains, have been dredged from dredging Area 240 and were reported through the BMAPA/EH protocol (Hanson_0133_A). These have been tentatively associated with sediments deposited during the early stages of the Devensian glacial. As the hand axes do not appear to have been subject to a high level of abrasion, it has been further suggested that they were dredged from a deposit in which they lay *in situ,* demonstrating the possibility of other such finds to be present within their primary context offshore within the MAREA Study Area. Further evidence of flints and faunal remains were recovered from the same area (Wessex Archaeology 2010a).

5.3.15 A possible flint artefact was identified during onboard processing of a clamshell sample at station CG6 (**Figure 13**) recovered during the EC REC groundtruthing survey. The sediment sample from which the flint was recovered was described as clean gravelly sand with occasional flint/quartz cobbles/pebbles on top. This flint was recovered from within the area from which the flint artefacts (Hanson_0133_A) were dredged.

5.3.16 The artefact is a broken secondary flake (**Plates 1** and **2**). The surviving dimensions of the piece are approximately 60mm by 43mm by 9mm, although a transverse break means that the piece was originally considerably longer. Although formal retouch is absent, both lateral margins have been used. The right margin has light edge damage towards the distal end; the proximal two thirds, however, show evidence of more robust use. The left margin is almost entirely cortical, but one short section comes to a cortex-free point, which appears to have been used as a piercing tool. The butt is facetted, and the platform edge has been prepared.

5.3.17 Flake debitage is difficult to date, but these traits are suggestive of a potentially Late Glacial date. However, such a flake could also result from hand axe preparation, and thus may be linked with the previous discoveries. One facet on the dorsal surface has a light patina; otherwise the piece is unpatinated and in very good condition, showing no signs of rolling, staining or damage congruent with its having been redeposited or having undergone any disturbance subsequent to its original loss/discard.

5.3.18 These flints and faunal remains are associated with the floodplain deposits of a channel feature observed in dredging Areas 254, 240, 228 and 251 (**Figure 13**).

5.3.19 The northern edge of the channel is observed as gently shoaling, rather than being a steep cut as observed to the south of the feature. The sediment infilling this buried channel varied in composition and is indicative of a changing flow regime with periods of high-energy and low-energy sediment deposition. The high-energy depositional sediments comprise sands and gravels and are observed on the sub-bottom profiler as units of strong reflectors. Fine-grained sediment units, indicative of lower-energy depositional environments are observed as seismically transparent units and are observed infilling broad shallow depressions or forming small bank structures up to 3m high. The vibrocore data indicate that the channel infill sediments comprise outer estuarine/shallow marine sands and gravels overlain by glaciofluvial gravel, which is in turn overlain by estuarine alluvium of clayey sand deposits (Wessex Archaeology 2010b). There is also some evidence of oxidation which may be a result of weathering and exposure to oxygen and the formation of a gley type soil (Wessex Archaeology 2009a).

5.3.20 The floodplain of this channel is extensive and comprises sands and gravels, probably deposited in an outer estuarine environment (Wessex Archaeology 2010b).

5.3.21 The age of the channel cut-and-fill deposits is, at present, unknown, but the channel may have been cut as early as the Late Anglian Glacial (*c.* 430,000 BP) (Arthurton *et al.* 1994) or during the Late Ipswichian/Early Devensian (Cameron *et al*. 1992). Studies carried out in Area 254 (Wessex Archaeology 2008) indicate that the coarse-grained fill may have been deposited during the Wolstonian (*c.* 300,000 – 130,000 BP) with the finer-grained sediments deposited at the onset of the Ipswichian Interglacial (*c.* 130,000 – 110,000 BP). The seismic response in the geophysics data is similar to that described as Brown Bank Formation (110,000 - 75,000 BP) but it is considered likely that the infilling of any channel features would have continued beyond this date throughout the Devensian, where conditions, and sea level changes, allowed. The extent of the Brown Bank Formation (after British Geological Survey 1984; 1991) is illustrated in **Figure 13**.

5.3.22 The gravel deposits identified by Bellamy (1998) within dredging Area 254, directly adjacent to the north of Area 240 were tentatively identified as analogous to the terrestrial Yare Valley Formation, as identified by Arthurton *et al*. (1994). If so, then this channel may form an extension or a tributary to the Palaeo-Yare as identified onshore.

5.3.23 A total of 22 features (**7006** – **7022**, **GY_7007** – **7009**, **GY_7012**) were identified during the palaeo-geographic assessment associated with this channel and floodplain (**Group 2**). Specific features are discussed below.

5.3.24 Features **7006**, **7007** and **7008** delimit the edge of the channel feature. **7006** and **7007** (**Figure 14**) delimit the northern and southern edges of the channel; **7008** marks the western and eastern limits. The maximum depth of the channel is observed at 13m sub-seabed to the south of the feature (**7008**). Several phases of fill comprising coarse-grained and fine-grained sediment fills are associated with this channel (**Figure 13**). There is also some evidence of possible high organic content within the fill (**7017**).

5.3.25 **7009** and **7010** are situated in Area 240 and are two distinct small cut and fill features comprising finer-grained fill associated with the infill within the channel. Features **7011** – **7017** are situated in Area 254. **7011** – **7014** and **GY_7012** are interpreted as fine grained units within bank structures lying within and on the edges of the channel. Similar features have previously been identified in Area 254 (Wessex Archaeology 2008a).

5.3.26 **7019** and **7020** are situated to the south of the channel. It is possible that they form the southern limit of the channel. However, there is not enough evidence to extend the channel feature this far south. **VC6** indicates sediments similar to the infill sediments of the channel and is considered to be deposited in the same conditions during a similar time period.

5.3.27 **7018** is situated to the west of the channel in Area 240 and is a shallow depression cut into coarse sand and gravel. Based on previous work in the area (Wessex Archaeology 2009a) it is likely that this fill comprises fine sands and clays deposited in an estuarine or nearshore environment.

5.3.28 A second channel is observed cutting this channel in the northwest corner of Area 240. This channel and features associated with it have been grouped (**Group 4**) and are discussed in **Section 5.4**.

5.3.29 Given the number of artefacts and faunal remains associated with the floodplains of this channel and that the channel sediments are associated, at least in part, with the

Brown Bank Formation, it is considered possible that artefacts may be associated with further deposits of the Brown Bank Formation within the MAREA, in particular associated with the margins and channels infilled with these sediments. Although there is a general paucity of finds in Britain for this period, it is possible that the infilling of any channel cut during this period continued to flow and fill long into the Late Devensian.

5.3.30 Within the MAREA there are a further 3 distinct large-scale channel features associated with the Brown Bank Formation and these flow into an outer estuarine/lagoonal environment (British Geological Survey 1991; 1984. **Figure 15**). A total of 101 features (**Group 3**) were identified during the palaeo-environmental assessment associated with the Brown Bank Formation (**7024 – 7114**, **7119**, **T_7035 – 7037**, **T_7092 – 7096**). Only archaeological features associated with this unit are detailed, rather than charting the entire coverage of Brown Bank Formation.

5.3.31 There are four channel features infilled with Brown Bank Formation as detailed by the BGS (**Figure 15**). The westernmost channel (channel 1) is associated with **Group 2** and is discussed above.

5.3.32 Channel 2 is the northernmost Brown Bank channel and is situated to the north of the aggregate areas.

5.3.33 Features **7024 – 7027** are complex cut and fill features probably associated with this channel with the upper sediments comprising sandy clays deposited in a shallow marine restricted environment (**VCR6**). **VCR9** is situated at the eastern limit of **7026** and indicates that the fill at the edges of the feature comprise shallow marine deposits indicating deposition during changes in sea level (during periods of regression or transgression). The basal cut of features **7028 - 7030** may represent a continuation of this feature, although due to the line spacing it is difficult to say this with confidence. Further features within the proximity to this potential channel are a small simple cut and fill feature (**7031**) within the channel deposits (a fine-grained unit cutting into Brown Bank deposits), and two remnants of fine-grained units (**7032** and **7033**), probably associated with the channel feature.

5.3.34 Channel 3 is observed in the south and comprises a main channel with tributaries (**Figure 15**). Features **7034 – 7053** are associated with this channel. Features associated with this channel include complex cut and fill features (**7035**, **7036, 7041, 7044 and 7046**), simple cut and fill features (**7038**, **7040, 7042, 7047, T_7035, T_7096**) and bank features (**7034 and 7039**).

5.3.35 The large bank (**7034**) is probably composed of gravel and forms the upper sediments of an infilled cut. It is interpreted as a relict feature that may have been modified by present day sea currents rather than a recent feature deposited under present day hydrological conditions. Depending on the age of this bank and its depositional nature there may be some archaeological potential. There may also be archaeological potential associated with the edge of the underlying cut feature. **7036** marks the southern limit to the feature; the northern limit is not delimited and is observed to continue to deepen to the north into the outer regions of the channel.

5.3.36 **7040** is observed towards the eastern limit of a complex cut and fill feature (**7041**). The western limit of **7041** indicates that the extent of the channel may be further west than that indicated by the BGS (British Geological Survey 1984; 1991).

5.3.37 Both the upper fill of the cut and fill features and the bank features generally comprise recent sediments overlying sandy silt and sandy clay deposited in a restricted shallow marine or lagoonal environment (**VC10**, **VC30**, **VC3** and **VC11**). It is possible that the deeper fills observed in the geophysics data may have been deposited in a more estuarine or fluvial environment.

5.3.38 **7043, 7048 – 7051** are associated with the westernmost tributary and comprise a complex cut and fill feature (**7049**) which delimits the eastern and western edges of the channel, simple cut and fill features (**7048** and **7050, 7043**) which delimit the northwestern, southeastern and northern limits of the channel, and a bank feature (**7051)** formed on the edge of the western limit of the channel. The upper fill of these features comprises silty clays and sand deposited in a shallow marine restricted environment (**VC4** and **VCR8**) with organic material becoming increasingly sandy with depth overlying possible shallow marine sands interpreted as a bank deposit of Brown Bank sediments overlying older marine sands, probable Westkapelle Ground Formation (**VC23**).

5.3.39 **7052 – 7054** are situated in the outer limits of the channel. **7052** and **7054** are two east-west orientated sections of a complex cut and fill with numerous phases of fill and evidence of gas blanking indicative of the presence of organic matter within the cut. **7053** is the north-south orientated section of the same feature. The upper fill comprises organic sediment deposited in a low energy shallow marine (restricted environment) overlain by sands deposited in a more high energy environment (**VC25**). **7055** is a small simple cut and fill feature within the outer limits to this channel.

5.3.40 Channel 4 is the easternmost of the Brown Bank Formation channels. Features **7056** to **7059** are associated with this feature and are all interpreted as cut and fill features with an infill of Brown Bank Formation. **VC27** is situated on the southern edge of **7057** (**Figure 16**) and indicates shallow marine restricted deposition, similar to the upper fill of the other features associated with these channels, as described above.

5.3.41 **7060 – 7062** are situated in the outer limits of Channel 4 and are simple cut and fill features infilled with probable Brown Bank Formation.

5.3.42 Two outlying remnants of Brown Bank Formation are charted by the BGS (**Figure 15**). The easternmost outlier (**7063** – **7065**) comprises a cut and bank feature, whereby the infill of the cut is formed into a bank. Similarly, the western outlier (**7066** – **7068**) is also a cut and bank feature. **VC16** indicates sandy gravelly clay (shallow marine sediment) overlying clays of a shallow marine restricted/lagoonal deposit. It is likely that these banked fill structure were deposited during the Early Devensian and have subsequently been re-modelled under the present-day current regime. If these features were deposited and developed as part of a channel system there may be some archaeological potential associated with the features.

5.3.43 Features **7069** – **7094** are associated with the outer estuarine/lagoonal deposits of the Brown Bank Formation.

5.3.44 These features include depressions (**7069**, **7074**) infilled with fine-grained sediments and fine-grained units (**7079**) which are interpreted as fills of Brown Bank Formation, or a finer-grained fill within the Brown Bank Formation. A vibrocore situated close to **7079** indicates that this fine grained unit comprises silty sands and organic matter (Andrews Survey 2003).

5.3.45 There are 3 complex cut and fill features (**7075, 7076** and **7094**). **7076** is the largest feature of these and comprises a distinct cut with four phases of fill (**Figure 17**).

7075 and **7076** both mark the edge of the Brown Bank Formation cutting into underlying Egmond Ground Formation deposits. **7094** features a cut into the underlying Yarmouth Roads Formation.

5.3.46 Features **7082 – 7084**, **7086** and **7087** are all erosion features. **7085** is a fine-grained unit associated with these erosion surfaces. The nature of these erosion surfaces is unknown and as such the archaeological potential of these features is unknown. However, in Area 401/402, to the west of these features, a series of north - south orientated features were identified and interpreted as deposits possibly representing beach bar progression (Wessex Archaeology 2008b). It is possible that the erosion features are associated with beach progression that has subsequently been eroded leaving a series of erosion surfaces. If these features are associated with beach progression deposits then there is limited potential for archaeology material.

5.3.47 The remaining features are simple cut and fill features. **7073**, **7078** and **7092** are simple cut and fill features and mark the edges of the Brown Bank Formation cutting into underlying sediments. The remaining features either represent cuts and fills within the Brown Bank Formation or marking isolated channels at the base of the Brown Bank Formation.

5.3.48 The remaining features associated with Group 3 are those situated outside of the areas defined as Brown Bank Formation (**7095 – 7114**).

5.3.49 **7095 – 7103** are situated in the northeast of the MAREA Study Area and comprise simple cuts and fills (**7095**, **7097** and **7101 – 7103**), fine-grained units (**7096**), depressions (**7098** and **7100**) and gas blanking (**7099**). **7095** and **7101** are distinct deep cut features infilled with a series of strong sub-parallel reflectors interpreted as Egmond Ground Formation. However, the upper fill of these features comprises organic silts and clays overlying fine-medium grained sands **(VC24)** indicative of Brown Bank Formation.

5.3.50 **7096 – 7100**, **7102** and **7103** are all shallow features within this Egmond Ground Formation fill. The infill sediments associated with these feature may be Brown Bank Formation sediments or similar. **7098** and **7099** both show evidence of gas blanking further indicating the presence of organic matter within the upper fill of these features.

5.3.51 **7104** and **7105** represent a bank structure which is clearly seen on both the SBP and MBES data. The bank is primarily composed of a series of strong chaotic reflectors indicating coarse sediment. **VC7** indicates that the upper sediments are interbedded sands and clays overlain by recent sediments. An oxidation layer is observed at the top of the interbedded sands and clays indicative of a post-depositional fall in relative sea level. It is considered that this bank feature is a relict feature rather than formed by present day processes.

5.3.52 **7106 – 7108, T_7092 – T_7095, T_7036** and **T7037**are simple cut and fill features situated in the south of the MAREA Study Area. It is possible that these features represent isolated remnants of the Brown Bank Formation or similar Pleistocene sediments cutting into pre-Pleistocene sediments. Depending on the timing of the cut and fill of these features there may be the possibility for the presence of archaeological material.

5.3.53 **7109** is a deeper channel cut and fill feature, to a maximum depth of 18m sub-seabed infilled with unknown sediments. **7110 – 7113** are all shallower features (within the upper 8m) and contain fills of various sediment types. It is possible these features represent remants of Brown Bank Formation.

5.3.54 **7114** is situated in Application Area 454 and is a simple cut and fill feature. An obvious cut is observed to the north with a gentle shoaling of the cut observed to the south of the feature. The infill is variable but is similar in character to other channels interpreted as containing Brown Bank Formation sediments. Also, the feature is situated to the southwest of a charted area of Brown Bank Formation and may be a continuation.

5.3.55 The Brown Bank Formation is extensive throughout the MAREA Study Area. However, by identifying specific features associated with this formation, namely evidence of channel features and other remnant land surfaces, this highlights areas were there is a greater potential for the occurrence and preservation within the MAREA Study Area.

5.4 POST LGM AND EARLY HOLOCENE (18,000-6,000 BP)

5.4.1 As the glaciers began their retreat, sea level began to rise from a eustatic low of *c.*120m below present day levels during the glacial maximum (Cameron *et al*. 1992).

5.4.2 At approximately 12,000 BP, during the Windermere Interstadial (13,500-11,000 BP) Britain was re-colonised by humans for the last time. Following the end of the Dimlington Stadial, the Windermere Interstadial provided a warmer climate and a landscape containing a mixture of light birch woodland, grassy meadow and areas of wetland vegetation within the MAREA Study Area region, favourable for human occupation and exploitation.

5.4.3 During the following stadial phase, known as the Loch Lomond Stadial (11,000-10,000 BP), glaciers formed once again in the Scottish Highlands and colder conditions returned until the climate finally ameliorated with the onset of the Holocene period, approximately *c.*10,000 BP.

5.4.4 By 10,000 years ago the regional sea levels were approximately 65m below present day level. The seabed within the MAREA Study Area lies at depths up to *c.*70m and as such would just start to be encroached at *c.*10,000 BP.

5.4.5 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 forest environment within the general vicinity of the MAREA Study Area (Allen and Sturdy 1980:4).

5.4.6 During the Early Boreal (c.9500BP) the deeper eastern section of the MAREA Study Area would have been situated on the western edge of a deep water channel flowing into the Dover Strait. By the Late Boreal (*c.* 7200 BP) this deep water channel would have widened and inundation of the MAREA Study Area continued. Between 8700 and 4500 BP local sea level rose by between 22 and 26m, the change being marked by the intrusion of tidal influence much further inland up the valleys (Moorlock *et al.* 2000).

5.4.7 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).

5.4.8 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 7000 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.

Archaeological Potential of the MAREA Study Area

5.4.9 It was not until *c.*13,500 BP, during the Late Upper Palaeolithic, that the warming stages of the Windermere Interstadial (13,500-11,000 BP) provided a climate which was conducive to human re-occupation and exploitation of Britain. It was during this period that Britain is thought to have been slowly re-colonised by modern humans from the Continent, and areas of the southern North Sea and the MAREA Study Area may have been populated by human communities. The discoveries of butchered or worked animal bones trawled from Dogger Bank certainly support this contention (Coles 1998:60). Furthermore flint and bone artefacts have also been trawled up around Brown Ridge and Dogger Bank (Louwe Koojmans 1970; Verhart 1995; Flemming 2002), indicating the likely presence of archaeological sites on the seabed in these areas.

5.4.10 Within the onshore extent of the MAREA Study Area, only the Norfolk HER lists any sites specifically dated to the Upper Palaeolithic, which comprises 5 findspots of material. A flint blade was recovered during fieldwalking 2.5km west of Happisburgh, whilst Upper Palaeolithic material was recorded in two separate locations along the River Thurne near Hemsby following a metal detecting survey. Upper Palaeolithic flint as well as some Mesolithic material was found near Hopton-on-Sea, whilst three Upper Palaeolithic flint blades were found along the River Waveney west of Beccles. Offshore, 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).

5.4.11 Although secure, datable evidence for the Late Upper Palaeolithic in the MAREA Study Area region is scarce, this dearth of evidence should not be taken to imply a lack of human activity in the area during this period. 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 vicinity of the MAREA Study Area.

5.4.12 The eventual end of the ice age at c.10,000 BP was presaged by at least two short-lived returns to cold conditions, including the Loch Lomond Stadial (11,000-10,000 BP), which may have interrupted human occupation, leading to the lack of continuity in the British archaeological record for the transition from the final Upper Palaeolithic to the Mesolithic (Wenban-Smith 2002).

5.4.13 The advent of the Mesolithic (*c.*10,000-5500 BP) was probably not a change of population, but a change of adaption to a new means of hunting and the new, wooded and watery post-glacial environment (*ibid.*).

5.4.14 Early Mesolithic sites and find spots are often found adjacent to wetlands and estuaries (Oxford Archaeology 2007:11), indicating a preference by these Mesolithic communities for areas in which they could exploit the marine resources available in such environments. In the Early Mesolithic period, the MAREA Study Area would have comprised an undulating lowland drained by a complex of Pleistocene river systems. This extensive lowland would have been attractive for human occupation, not only providing access to both terrestrial and marine resources, but also enabling these early Mesolithic communities to exploit the herds of red deer and other such mammals which migrated into Britain from the Continent as the climate ameliorated (Sumbler *et al.* 1996:136).

5.4.15 East Anglia is quite rich in Mesolithic sites, yielding a more widespread distribution of known remains than for the Upper Palaeolithic (Austin 1997:9). However, these comprise predominantly surface finds, with very few sites containing material in primary contexts (Austin 1997:9).

5.4.16 Terrestrial data for Mesolithic sites recorded in the NMR and regional HERs (**Figure 2**) indicates a total of 50 sites with dated Mesolithic material within the onshore part of the MAREA Study Area, once duplications have been removed.

5.4.17 In Norfolk there are 26 sites with Mesolithic material which range from flint knives and blades, axeheads, and tools to undiagnostic worked flints on multi-period sites. There are some sites along the coast, such as the adze found on the beach at Caister-on-Sea, but the majority of sites are isolated findspots located inland, or material which is present on multi-period sites, which also include finds from the Neolithic through to the medieval period. No great patterning is apparent, nor are there any sites with secure Mesolithic contexts or other associated Mesolithic features.

5.4.18 In Suffolk there are 24 sites with Mesolithic material comprising largely scatters of worked flint material from multi-period sites, as well as examples of tranchet axeheads and two maceheads. At Walberswick Beach, south of Southwold, sub-rectangular rafts of well-humidified peat were found on the high tide mark, clearly eroded from close off-shore outcrops, and comparable to deposits on Southwold town marshes. 500m to the south of this peat the NMR records a Mesolithic perforated antler mattock, which may have been used for digging up roots and tubers. Elsewhere within Suffolk, the distribution of Mesolithic sites are more readily identifiable within river valleys, in particular the apparent clustering of sites near Kessingland which appear to follow the current Hundred River and Latymere Dam, once a sea inlet and Kessingland's harbour.

5.4.19 By the Late Mesolithic period, brackish conditions would have begun to occur within the river estuaries of the MAREA Study Area and the low-lying ground would have been subject to periodic flooding and the generation of marshland (Wessex Archaeology 2003:17). Mesolithic occupation sites within the offshore MAREA Study Area during the Late Mesolithic period are unlikely as the rising sea level would have progressively forced people further inland. However, Mesolithic communities will have continued to exploit the marine resources within the marshland of the MAREA Study Area, until its full inundation *c.*7,500-7,000 BP.

5.4.20 Although the coastline would have been further to the east in the Mesolithic period, the steady rise in sea level at this time may have subjected these areas to periodic flooding and the consequent generation of marsh land, providing a landscape preferable to Mesolithic communities for exploitation. Various terrestrial sites, such as those along the River Thurne and at Kessingland, and the peat recorded at Walberswick Beach, highlight the potential for further sites dating to this period in wetland areas which now lie submerged within the offshore MAREA Study Area. The Mesolithic sites and findspots along this stretch of the coastline are relatively few in relation to the suggested volume of human activity in the region, and as such should be viewed as a bare minimum baseline of activity.

5.4.21 The palaeo-geographic assessment identified two groups of features that have archaeological potential. **Group 4** features (are interpreted as post-glacial features associated with the Early Holocene and comprises 21 features (**7115 – 7118**, **7120 –7128, GY_7001** – **GY_7006**, **GY_7010** and **GY_7011**) (**Figure 18**).

5.4.22 The regional bathymetry of the area indicates a broad, shallow meandering channel (**Figure 18**). Based on its morphology it appears to widen to the south, indicating its likely flow direction. The width of the channel varies from *c.* 350m to in excess of 2.5km to the south.

5.4.23 These features, with the exception of **7125** and **7126** are observed as cut and fill features or infilled depressions with a maximum fill of 6.8m (**7122**).

5.4.24 Many of the features (**7116** – **7118**, **7120, 7123** and **7124**) are associated with very strong, bright reflectors which are indicative of a high peat or organic matter content. **VC18** is situated on the northern shoulder of feature **7123** and the seismic data indicates strong, bright reflectors at the vibrocore location (**Figure 19**). **VC18** indicates deposition of shallow marine sediments overlain by estuarine alluvium/restricted shallow marine sediments. The upper metre of the vibrocore comprises fine to medium sand with patches of organic material overlain by black silty clay. The remaining features indicate a variable fill likely composed of sands and gravels, rather than fine-grained fill. Similar features were also identified in prospection lines acquired as part of the Seabed Prehistory: Great Yarmouth project (Wessex Archaeology, 2008a) and are illustrated in **Figure 18 (GY_7001** – **GY_7006**).

5.4.25 Features **7125** and **7126** are bank structures within the limits of the channel. Both banks are 3.4m high and comprise a unit of chaotic fill, interpreted as coarse-grained sediments. The bathymetry data indicates that the banks form small plateaus and are interpreted as remnant bank deposits within the confines of the channel.

5.4.26 The northern part of the channel feature is situated in Area 240 and has been the subject of detailed study (Wessex Archaeology 2009a; 2009b; 2010a; 2010). The geophysics data from Area 240 exhibits channel infill deposits composed of strong, bright reflectors similar to those seen in the EC REC dataset. Vibrocore data within Area 240 indicates an infill of a transgressive sequence of intertidal/saltmarch peat and organic matter overlain by estuarine sediments and then shallow marine sediments. The distribution of these sediments is illustrated in **Figure 18**. Feature **7115**, **7127** and **7128** coincide with the unit identified in Area 240.

5.4.27 Independent dating of a vibrocore containing a peat layer from deposits within this channel was undertaken by English Heritage. The results of radiocarbon dating of the top and bottom of the peat layer dates the peat between 10,470+/-35 BP (10,710 – 10,280 cal. BC, SUERC-11978) and 8370+/-25 (7530 – 7350 cal. BC, SUERC 11975) (Hazell, in prep.) at depths of 30.80mbOD and 30.05mbOD, respectively.

5.4.28 A peat sample was dredged in November 2009 from a 1.4km track on the western limits of Area 251 (**Figure 18**) and reported through the BMAPA/EH protocol (Cemex_0296). The water-logged plant remains within the peat indicate deposition in an ox-bow lake or similar cut-off chute. 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 2010d).

5.4.29 At the location where the peat was dredged there is no indication in the EC REC geophysics data of a channel infill deposit although small localised areas where the seabed reflector is slightly stronger and brighter are observed. However, generally the seabed is disturbed, probably due to dredging activities and this may be masking any response that you would normally observed from the presence of peat.

5.4.30 Although not directly associated with the channel, as observed on the bathymetry data, feature **7129** is situated in the mouth of the Palaeo-Yare in an area that has previously been interpreted as the Breydon Formation by the BGS (Arthurton *et al*. 1994). Feature **7129** is a shallow cut and fill feature. The geophysics indicates that the fill is comprised of fine-grained sediments. Although **7129** is not as extensive as that interpreted by the BGS (British Geological Survey 1984; 1991), it is possible that this infill may be a remnant of the Breydon Formation.

5.4.31 Onshore, the confluence of the Rivers Bure and Yare at Great Yarmouth has resulted in a large complex of alluvium, peat and Fen silts adjacent to the coast (Geological Survey of Great Britain, Sheet 12). Peat of freshwater and brackish origins is a major component in the valleys of the River Yare and overlies the older Yare Valley Formation gravels (Arthurton *et al.* 1994:72).

5.4.32 These post-glacial peats are identified as the Breydon Formation, a fill of the buried valley system underlying present-day marshland. The formation is dominated by silt and clay. Associated with the formation are three peat layers: the basal, middle and upper peat. Of these peat layers the basal peat is the one of interest with regards to offshore area; the middle and upper peat were deposited onshore after the inundation of the MAREA Study Area (Boomer and Godwin 1993; Arthurton *et al.*1994). The basal peat is recorded to have formed *c.* 7580+/- 90 BP at a depth of around 23m below OD and is up to 2m thick (Arthurton *et al.* 1994:77).

5.4.33 Although the radiocarbon dates recorded in Area 240 are slightly older and deeper than those documented by Arthurton *et al*. (1994:77), it is possible that these sediments may be an offshore continuation of the Breydon Formation. Certainly, the peats identified in the channel were formed in similar conditions and within the same timeframe as those observed onshore.

5.4.34 Features **7130 - 7132** are situated to the west of the channel and comprise shallow depressions (**7130** and **7131**) or cut features (**7132**) infilled with up to 4.3m transparent reflectors, indicating fine-grained sediments, overlain by large sandwaves (up to 6.5m high). **GY_7010** and **GY_7011** are small features identified by their very strong seismic response and are interpreted as possible remnants of fine-grained sediments containing possible organic matter/peat. These are interpreted as possible remnants of intertidal sediments or associated with the former channels of the River Waveney.

5.4.35 **Group 5** features (**7133 – 7142**, **T_7038 – 7040**, **T_7089 – 7091** and **T_7097**) are interpreted as probable intertidal wetland deposits relating to the pre-transgression and are observed to the south of the MAREA Study Area (**Figure 20**).

5.4.36 Features **7133**, **7135 – 7137** are interpreted as infilled depressions and **7138**, **7139**, **7140 - 7142** are interpreted as shallow, cut and fill features. The geophysics indicates that the fill is variable and comprises probable fine-grained sediments (**7135** and **7136**) and possible organic matter/peat (**7137 – 7142**). **7138** is illustrated in **Figure 21**. Similar cut and fill features were identified in the TEDA Study Area (; Wessex Archaeology 2010).

5.4.37 Feature **7134** comprises the southernmost edge of a cut up to 7.4m sub-seabed. The northern edge of the cut is not discernible but possible coincides with the northern edge of feature **7135**.

5.4.38 **VC28**, situated in the area (**Figure 20**) indicates up to 1.73m shallow marine deposits comprising sand with silty clay inclusions overlain by sand, which in turn is overlain by sand and fine silty organics. The top of the sand unit exhibits evidence of oxidation indicating a possible lowering of sea level post deposition and prior to deposition of the upper unit. Towards the base of the core the silty clay inclusions include possible organics that have not been fully degraded, indicating a possible young depositional sequence. The geophysics data at the location of **VC28** indicates an upper unit up to 3m sub-seabed of relatively strong parallel/sub-parallel reflectors, although no specific archaeological feature has been recorded at this location.

5.4.39 Based on the geophysical and geotechnical evidence it is possible that these shallow features may be remnants of early Holocene tidal flat deposits comparable to those documented by Moorlock *et al.* (2000). Reedswamp and fen vegetation would have developed in the outer regions of former river valleys forming wide floodplains. These sediments would have become more intertidal and marine as increased inundation occurred. Although these deposits were probably more widespread overlying Pleistocene and older sand and gravel sediments, remnants of it are discontinuous, probably due to erosion during the last transgression (Moorlock *et al.* 2000).

5.4.40 The presence of these Early Holocene land surfaces offshore indicate that complete removal of these sediments and features did not occur during the last transgression. Mesolithic communities may have exploited these inter-tidal areas until its full inundation *c.*7,500-7,000 BP, and as such, there is considerable potential in these areas for the presence of archaeological material.

6 MARITIME ARCHAEOLOGY

6.1 INTRODUCTION

6.1.1 Maritime sites can be defined as broadly comprising either 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 the MAREA Study Area.

6.1.2 The evidence for coastal and maritime activity within the vicinity of the MAREA Study Area will be discussed with regards to the composite time line for shipwrecks around England, produced by Wessex Archaeology (2008d). 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.

- **Class A: 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.
- **Class B: 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.
- **Class C: 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.
- **Class D: 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.
- **Class E: 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.

6.1.3 Of the vessels which passed through the MAREA Study Area, 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 of the MAREA Study Area 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).

6.2 MARITIME GEOPHYSICAL ASSESSMENT

6.2.1 This section summarises the known maritime resource. For the purposes of this report, the maritime resource is considered to comprise of known charted wrecks and anomalies of potential archaeological interest. Anomalies of potential archaeological interest were identified as part of the archaeological interpretation of the geophysical data. Where possible, the geophysical data has been collated with the charted wreck and obstruction data in order to indicate the presence or absence of known wreck sites.

6.2.2 The sidescan sonar, bathymetric and magnetometer surveys revealed a total of 534 anomalies thought to be of potential archaeological interest. Not all anomalies of potential archaeological interest were located within the MAREA Study Area (**Figure 22**) as the data coverage extended outside of this. These sites were cross-referenced with the UKHO charted wreck and obstruction data (provided by SeaZone) and NMR data and were divided upon the basis of the following interpretation (**Table 8**):

Interpretation	Number of Anomalies
Anthropogenic origin of archaeological interest (A1)	54
Uncertain origin of possible archaeological interest (A2)	92
Uncertain origin of possible archaeological interest, located by magnetic response only (A2 – Magnetic only)	315
Historic record of possible archaeological interest with no corresponding geophysical anomaly (A3)	73
Total	**534**

Table 8: Number of anomalies of potential maritime archaeological interest

6.2.3 The anomalies observed in the geophysical datasets were also classified by probable type (**Appendix VI**), which further aids in assigning archaeological potential and importance to the anomalies (**Table 9**):

Anomaly Classification	Number of Anomalies
Wreck	54
Debris	27
Dark Reflector	24
Bright Reflector	9
Seafloor Disturbance	14
Mound	18
Magnetic	315
Wreck (not observed on geophysical data)	73
Total	**534**

Table 9: Number of seabed anomalies by classification

6.2.4 The UKHO data holds 816 records within the MAREA Study Area, of which 124 are within the coverage of the survey data. Therefore, 692 wrecks or obstructions have not been included in this discussion as their positions are outside of the survey extents (**Figures 5** and **6**). Only those UKHO records within the geophysical survey are discussed in this section and listed within **Appendix VI**. The UKHO data for the entire MAREA Study Area are discussed in **Section 6.3**.

6.2.5 A total of 54 anomalies were discriminated as A1 during the archaeological interpretation of the geophysical data. Of these wreck sites, 51 corresponded to known wreck or obstruction locations recorded in the data provided by the UKHO and NMR. Examples of known wreck sites are provided in **Figures 23 - 31**.

6.2.6 The extent of the wreck and the related debris may also be apparent within the geophysical data, as seen in **7212** (**Figure 23**). Of the 54 sites discriminated as wrecks, 24 have apparent scour associated with the site. Examples of scour can be seen in **Figures 23 – 31**. Scour indicates a strong present-day current regime which can have an impact on the survival and visibility of the site, as discussed in **Section 8**.

6.2.7 A possible wreck may display detailed structure which would support its classification. An example of detailed structure as observed through the sidescan sonar data set is **7227** (**Figure 24**). This is not always the case and some wrecks may appear more amorphous, as seen in **7215** (**Figure 25**).

6.2.8 Three wrecks were observed within the survey data that have been previously unrecorded by the UKHO or NMR. Anomaly **7212** is a wreck site was observed in bathymetric, sidescan sonar and magnetometer data sets (**Figure 23**). The wreck has dimensions of 62.5 x 12.5 x 10.8m and is orientated northeast-soutwest and is situated within a large sandwave. It is clearly upstanding with a height of 5.5m above the general height of seabed. The magnetometer response for this wreck was 1212 nT.

6.2.9 Anomaly **7211** is situated approximately 1.6km to the east of **7212** and is also previously uncharted. The wreck is orientated east-west with dimensions 26.2 x 8 x 3.7m and is situated in scour to south up to 0.5m deep. The wreck is generally well-defined and sits proud of the seabed, however, the wreck is possibly partially buried to north. The wreck is situated in an area of sandwaves and megaripples. A magnetometer response of 689nT is associated with the wreck.

6.2.10 Anomaly **7254** is observed in the southwest of the MA REA Study Area. The wreck has dimensions 30.7 x 21.6 x 3.7m and is orientated northwest-southeast. There is no debris associated with the wreck. Some sediment build-up is observed towards the northern limit of the wreck, indicating partial burial.

6.2.11 There are 407 sites discriminated as A2. These anomalies are interpreted as anthropogenic in origin and of possible archaeological interest. However, it is possible that these anomalies may prove to be natural or modern and the anomalies would require further investigation to establish their true nature.

6.2.12 Of the anomalies classed as A2, 27 are interpreted as debris. Two of these are located at UKHO recorded positions (**7202** and **7208**) for probable debris. The remaining are isolated anomalies all of which exhibit height. Of the 27 instances of debris, four are interpreted as small (dimensions less than 5m); the remainder are all large features. Examples of debris observed within the sidescan sonar data are illustrated in **Figure 32**.

6.2.13 A total of 24 dark and 9 bright reflectors have been recorded, which have the potential to be of anthropogenic origin. Further investigation would be required for further discrimination of these anomalies. Examples of dark and bright reflectors observed within the sidescan sonar data are illustrated in **Figure 32**.

6.2.14 Within the data, 14 anomalies have been classified as seafloor disturbances. These are defined as an area where the seabed has possibly been anthropologically disturbed, or may indicate a buried feature. Examples of seafloor disturbances within the sidescan sonar data are illustrated in **Figure 32**.

6.2.15 A total of 18 mounds were identified in the geophysics data. A mound can be described as a mounded feature with height that is not considered a natural feature. Mounds may form over wrecks or other debris, either on the seafloor or partially buried, but they do not show any structure indicating their contents.

6.2.16 Two identified mounds have corresponding UKHO records. Anomaly **7221** was observed on the edge of the multibeam data measuring 8 x 4 x 0.7m with no apparent scour or debris. The feature is orientated east-west and appears quite mound-like which suggests that it may be at least partially buried if a feature of anthropological origin. The mound is situated approximately 10m south of UKHO 10850, which is described as a small item of debris or possible well-head (2 x 2 x 2.5m). The mound possibly represents the burial of this feature.

6.2.17 Feature **7275** is a rounded mound (39 x 18 x 1m) and lies approximately 10m north of UKHO 11244 which is recorded as debris covering an area of 5 x 5 x 1.9m. Nothing was observed in the geophysical data at the UKHO position and it is possible that the mound represents the burial of this area of debris. The remainder of the mounds are isolated features with no correlation with any recorded features.

6.2.18 A total of 315 anomalies classified as A2 are observed within the magnetometer data only. The responses range from 5 nT to 4478 nT and 21 of these responses are over 100nT. Magnetic anomalies are most likely to be of anthropological origin, but without further evidence, their origin cannot be discerned.

6.2.19 Within the geophysical data coverage 73 recorded wrecks were not observed during the assessment of the geophysical data. This can be due to positional reasons, i.e. the positional accuracy recorded in the UKHO records indicates that the wreck may be associated with a sinking position rather than a known wreck position. Also, some wreck positions are maintained within the database, even though they have not been observed at these locations in subsequent surveys (classified as 'dead' by the UKHO) either due to positional inaccuracies or because the wrecks are possibly buried. Furthermore, some recorded wrecks which may have been observed in the geophysical data in past surveys may now be fully buried and have no surface expression. Given the strong currents and numbers of sandwaves and megaripples in the MAREA Study Area, it is likely that at least some of the recorded wrecks are now buried.

6.2.20 Of the UKHO locations that have not been observed, five of these locations may have related magnetometer responses. As there are no surface expressions of these five magnetometer anomalies observed in other data sets, they may represent isolated debris or buried ferrous material, rather than the recorded wreck. A magnetometer response may not give an accurate position, as the data is collected only along the survey line. The responding anomaly may be offset from the survey line, which may decrease the level of response.

6.2.21 **Table 10** displays the number of anomalies discriminated within the limits of the geophysical survey, broken down by classification, for the Dredging Licence, Prospection and Application areas situated within the MAREA Study Area.

Anomaly Classification	Licensed Area	Prospection Area	Application Area
Wreck	6	1	1
Debris	3		1
Dark Reflector			
Bright Reflector	1		
Seafloor Disturbance	1		1
Mound	4		
Magnetic	41	1	12
Wreck (not observed)	5		1
Total	**61**	**2**	**16**

Table 10: Number of seabed anomalies by classification within Licensed, Prospection and Application Areas

6.2.22 In addition to the sites identified within the MAREA Study Area from the East Coast REC geophysical data, a number of charted and uncharted wrecks, along with other anthropogenic features, have been identified in previous Wessex Archaeological Reports. These are listed below:

Great Yarmouth Area 254 (Wessex Archaeology 2002)	Archaeological Assessment Technical report of the potential impact of archaeological remains from proposed sand and gravel extraction off Great Yarmouth. A total of 20 anomalies were identified from the elements of the side-scan data that lay within the MAREA Study Area. 9 are thought to correspond to at least 5 charted wrecks. The other remaining anomalies are believed not to represent wreck sites.
Yarmouth Dredging Area 401/2 (Wessex Archaeology 2004)	Desk-based assessment in preparation for a licensing renewal application for the aggregate extraction Area 401/2. Altogether 9 anomalies were discovered, seven of which corresponded to charted wreck sites.
Southern North Sea Aggregate Licence Area 430 (Wessex Archaeology 2006)	Archaeological Assessment Technical report for the renewal of dredging licence Area 430. No sidescan sonar anomalies were found in any of the datasets, which suggests the potential for further modern wrecks is low, with the potential for the presence of small debris objects likely to be moderate, particularly from trawling related activities.
Area 202: Cross Sands (Wessex Archaeology 2007)	Archaeological interpretation of geophysical data. A total of 8 geophysical anomalies were 6 of which correspond to charted wreck sites.
Area 401/2 (Wessex Archaeology 2008b)	Assessment of geophysical data for the heritage impact monitoring process implemented for aggregate extraction within Area 401/2. The geophysical survey discovered 14 anomalies all attributed to potential anthropogenic origin.
Area 202 (Wessex Archaeology 2008c)	This report was also prepared for the Archaeological assessment of a geophysical survey data. The results of which identified two anomalies, interpreted as patches of dark reflectors, both of which are believed to be of anthropogenic origin.

6.3 RECORDED WRECKS

6.3.1 Based on the charted sites listed by SeaZone and the recorded losses listed by the NMR, the baseline data has been used to provide a broad understanding of the nature and density of maritime activity within the MAREA Study Area. It is not within the scope of this report to discuss each record contained within the SeaZone and NMR data on an individual basis.

SeaZone

6.3.2 A total of 816 charted sites were listed in the SeaZone data within the MAREA Study Area. Using the 'Feature' attribute listed within the SeaZone data these records were subdivided into those classified as wrecks and obstructions. An 'obstruction' is defined by SeaZone as 'an object on the seabed of known or unknown source that is neither a wreck nor infrastructure that may hinder safe passage or other activity'. Despite this definition, through an assessment of the SeaZone obstructions for the MAREA Study Area, it became apparent that some contained references to shipwreck material.

6.3.3 A further query based on the 'Label' attribute listed within the SeaZone data, which defined these records into known wrecks, obstruction, foul and those with no label at all. In doing this it was hoped that a clear distinction would be made between the percentage of known wrecks and obstructions of any other kind. When considering those sites with no 'SZlabel' there are 27 with a brief description in the 'Type of Obstruction' field that could be considered of a maritime nature, but have little in the way of definitive evidence. The results of these queries are shown in **Table 12** below. A total of 3 aircraft sites were listed within the SeaZone data. These sites are considered in **Section 7** and are thus omitted from **Table 12**.

SeaZone Label	Number of Sites
No SZlabel	229
Named Wreck	375
Obstructions and Foul	209
Total	813

Table 12: SeaZone charted vessels and unspecified sites

6.3.4 In order to provide a broad overview of the density and nature of maritime activity within the MAREA Study Area as implied by the SeaZone data, a number of queries were conducted based on the date of the charted wrecks and obstructions. The composite time line for shipwrecks around England, produced by Wessex Archaeology (2008d), was used as a framework in which to attribute a class to the wrecks based on the dates of these charted sites (see **Section 6.1**). **Table 13** below represents the results of the queries conducted on the SeaZone data based on these date ranges classified within this composite time line. These sites are illustrated in **Figure 29** and also include aircraft wreck sites.

Class	Date	Wrecks	Unspecified	Total
A	<1508	0	0	0
B	1509-1815	1	0	1
C	1816-1913	11	2	13
D	1914-1945	248	33	281
E	>1946	51	17	68
	Unknown	243	210	453

Class	Date	Wrecks	Unspecified	Total
	Total	**554**	**262**	**816**

Table 13: SeaZone wrecks and unspecified sites queried by date range

6.3.5 When comparing the number of sites from each period as a whole there is certainly a far clearer record of those charted wrecks from 1914 onwards. Interestingly the period of 1816 to 1913 is comparatively low in charted wreck sites, and under closer scrutiny the data further illustrates a distinct lean to the latter half of the period (the earliest wreck being from this grouping sinking in 1868) (**6.6.15**, **Figure 34**). The only recorded site earlier than this is that of the suspected HMS *Royal James* (**UKHO10793**) lost in 1672.

6.3.6 Overall, the wreck sites are dispersed fairly randomly throughout the MAREA Study Area, although some distinct areas of concentration have been noted throughout different periods (see **6.7.7**) (**Figure 34**). The highest density of wreck sites occur central to the MAREA Study Area within 10km of the east coast shoreline, from Caister-on-Sea in the North to Southwold in the South, with large numbers of losses at the approaches to Lowestoft and Great Yarmouth (**6.7.3** and **6.7.8**). It is also apparent from the SeaZone data that unclassified wrecks and obstructions dominate this area. However, known wrecks from the period 1914 to 1945 are well represented which is also true of wrecks sites within and in close proximity of the East Coast Licensed Dredging Areas.

6.3.7 To the north-eastern extent of the MAREA Study Area the series of shallow long narrow gravelly sandbanks that run from northwest to southeast are the resting places for a large quantity of wrecks from World War II within this particular area. Predominantly they area situated between two major natural hazards, to the east of Winterton Ridges and Hearty Knoll and to the west of Smiths Knoll (see **6.7.8** and **Figure 35**).

6.3.8 To the south of the MAREA Study Area, a smaller concentration of wreck sites appears to correlate to the natural hazard of Aldeburgh Napes, in close proximity to Licence Dredging Area 496. This is not surprising, as it is expected that a great number of vessels were lost after foundering on the extensive shallow sand banks such as these which characterise the surface geology of the MAREA Study Area.

Shipping Casualties

6.3.9 A total of 3056 recorded losses were listed in the NMR within the MAREA Study Area. It is important to note that the positions of recorded losses are often vague and inaccurate and also only represent those loses which were actually recorded.

6.3.10 The recorded losses were sorted into two categories defined as ‘wrecks’ and ‘aircraft’. A total of 58 aircraft were listed in the NMR data and are considered in **Section 7**. A further query classified the wrecks into the date range discussed above (**Section 6.1**). The results of these queries are presented into **Table 14** below and illustrated in **Figure 31**.

Class	Date	Shipping Casualties
A	<1508	30

Class	Date	Shipping Casualties
B	1509-1815	1052
C	1816-1913	1368
D	1914-1945 including aircraft	468
E	>1946	1
	Unknown	137
	Total	**3056**

Table 14: NMR shipping casualties queried by date range

Discussion

6.3.11 The charted sites and shipping casualties should not be regarded as directly representative of the wreck sites that lie on the seabed within the MAREA Study Area. Prior to the advent of the Lloyds of London List of shipping casualties in 1741, there was no central record of ship losses and as such the record of shipping casualties is biased towards wrecking incidents which occurred from the mid 18th century onwards. It must also be taken into account that the shipping casualties refer to wrecking incidents for which there are no known positions other than a description of the general area and may consequently lie outside the MAREA Study Area.

6.3.12 There are some interesting distribution patterns discernible within the data, which may possibly be due to a number of differing factors. Documented casualties within the NMR dating to before 1508 all lie extremely close to the shoreline, which may be a result of bad weather, navigational problems, or of a bias in the reporting based on survivors making it to the shore or being picked up or if the vessel was seen in distress from the shore.

6.3.13 Losses attributed to the period between 1509 and 1815 present a similar focus toward the East Coast shore line. Additionally there are some recorded losses to the north in close proximity to natural hazards such as Hammond Knoll, Winterton Ridge, Smiths Knoll, Winterton Shoal and North Cross Sand. Interestingly these ships were lost prior to the northern region of the MAREA Study Area being sufficiently charted. The positional data assigned to the wrecks for these periods should be viewed with caution, and there is often a clustering of a large number of wrecks to the same grid reference due to a lack of more accurate information regarding their sinking.

6.3.14 The outline of losses for the period between 1816 and 1913 displays a similar pattern, with losses on the Southern North Sea sandbanks, with the majority situated on the approaches to Lowestoft and Great Yarmouth.

6.3.15 The period between 1914 and 1945 presents a far greater concentration across the MAREA Study Area, with particular focus toward the East Coast shoreline. Many of these casualties are attributable to Britain being at war, with ships of all kinds targeted by the German navy. There is also a notable increase in the number of losses indicated within and in the vicinity of licence dredging areas, totalling 95 wrecks. The NMR data from this period is seemingly more accurate as there appears to be fewer wrecks assigned the same grid reference. This is most likely due to a number of differing factors, such as better knowledge of navigation and recording methods of radio, with accurate techniques for spotting vessels in difficulty and organised recue operations. The survivability of such modern wrecks is also a greater aspect to the accuracy of 20th century records.

6.4 COASTAL AND SEAFARING ACTIVITY: PRE-1508

Early Prehistoric (Palaeolithic – Mesolithic)

6.4.1 There is no evidence for Palaeolithic watercraft pre-dating the Devensian glacial maximum (*c.* 40,000-18,000 BP) in the UK. This lack of evidence should not, however, be taken to indicate a lack of maritime activity during this period around the UK, as the resources and technology required to construct small craft would certainly have been available to these early communities. Examples from elsewhere in the world suggest that early modern humans were engaged in maritime activities, with the suggestion that the colonization of Australia c.40,000 BP involved island-hopping in or on primitive watercraft (Lourandos 1997).

6.4.2 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 type of craft used for these voyages and how extensively they were used is unknown. However, vessels for which there is archaeological evidence from the Mesolithic are logboats. 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.*7190-6340 BC (McGrail 2004:173) and another from Lough Neagh in the north of Ireland, radiocarbon dated to *c.* 5300 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.

6.4.3 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 in the archaeological record. 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)

6.4.4 By the early Neolithic (*c.*4,000 BC) the MAREA Study Area would have been predominantly submerged and its coastline would have attained a form approaching that of today. In providing a landscape rich in resources for hunting, fishing and shellfish collecting, evidence suggests small scale activity on the north Suffolk coast (Bradley *et al.* 1997:156). There is relatively more common Neolithic evidence represented to the north and far to the south of the MAREA Study Area within the coastal and outer estuarine environments of Suffolk and Essex (Wilkinson and Murphy 1995 and Bradley *et al.* 1997:156).

6.4.5 Logboats provide the only archaeological evidence in the UK directly relating to watercraft during the Neolithic period. Watercraft may have facilitated the transportation of goods by water throughout the Neolithic. The discovery of porcellanite stone axes from Ireland on the UK mainland and the Western Isles of Scotland certainly implies trade and transport of goods was possible by sea during this period (Breen and Forsythe 2004:32).

6.4.6 The available archaeological evidence for the later Neolithic period suggests a less than active human occupation within coastal and shallow estuarine areas of the MAREA Study Area (Hegarty and Newsome 2004: 23-27). As marine contexts are generally regarded to offer better conditions for the preservation of organic material than that of terrestrial contexts, there is the potential for the remains of Neolithic watercraft to be present within the offshore extent of the MAREA Study Area, although the discovery of such material would be exceptionally rare. However, the lack of archaeological evidence could be due to the poor survival of larger Neolithic sites rather than representative of a *de facto* low level of human activity (Wilkinson and Murphy 1995:71). Therefore small scale discoveries are still possible.

6.4.7 The technological advances of the late Bronze Age and early Iron Age of Europe brought with it greater human interaction, resulting in the transference of materials, belief, concept, traditions and ideas, either reciprocal or forced (Agbe-Davies and 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).

6.4.8 The growth in social organisation brought an increase in the scale of seafaring and although dugout logboats were still used, evidence suggests that hide boats were also being constructed in the UK during this period. Other forms of Bronze Age watercraft include flat-bottomed sewn plank boats, a more advanced form of early water transport, suitable for a variety of functions and a range of environments.

6.4.9 Some of the earliest examples of Bronze Age watercraft in Northern Europe have been found on the east coast of Britain. Discoveries to the north of the MAREA Study Area on the Humber Estuary, notably the Kilnsea fragment dating to 1,870-1,670 BC (Van de Noort *et al.* 1999) and the Ferriby boats 1, 2 and 3 built between *c.*2000-1,700 BC, suggest types of craft suitable for riverine, estuarine and possibly even sea-going use (Lillie 2005). To the south of the MAREA Study Area a Bronze Age vessel found at Dover represents a similar society confident in its technology and organised in its planning (Clark 2004: 210). This discovery is believed to be typical of large vessels that existed on the east coast of Britain at this time and is certainly thought to have been seaworthy (Clark 2004: 210; Crumlin-Pedersen 2006).

6.4.10 It is possible that trading activities took place within the general vicinity of the MAREA Study Area 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. 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, Dover, certainly suggests maritime trade across the southern North Sea during this period (Fenwick and Gale 1998:26). This is further enhanced by the examples of 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).

6.4.11 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 (Martin 1999b: 38), as evidenced by the two bowl barrows positioned on the banks of the River Meare. Evidence for Bronze Age barrows situated on the coastal sandlings (light soil comprising: sands, gravel and local till) represents a community connected to marine and esturine areas for reasons more significant than simply transport and subsitence (Hegarty & Newsome 2004: 31). This may suggest the potential for discovering archaeological material being greater than originally thought within the MAREA Study Area.

6.4.12 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)

6.4.13 While sites dating to the Late Bronze Age/Early Iron Age transition appear to be concentrated along the principle river valleys in Suffolk and Essex (Bryant 1997:24), there is only limited evidence for settlement along the coast during the Iron Age. The remains of wooden structures facilitating access to and from the salt marshes indicate a continued exploitation in the coastal pasture during the Iron Age. Salt production comprised an important element of this exploitation, as evidenced by the Red Hills in Essex to the south of the MAREA Study Area, one of the more common types of sites thought to represent the waste resulting from Late Iron Age and Roman salt working (Wilkinson and Murphy 1995:166). While the Suffolk coastal zone does not contain as large an area of reclaimed saltmarsh as seen in its neighbouring county of Essex, a number of possible Red Hill sites have been noted, indicative of at least some level of salt working industry within the county during this period (Hegarty and Newsome 2004:56). Salt-making evidence has also been discovered around the River Alde (Bradley *et al.* 1997:159).

6.4.14 It is clear that from at least the Iron Age onwards seagoing vessels passed through the southern North Sea. Trading ports investigated at Mount Battern in Plymouth and Hengistbury in Dorset, and Roman accounts of the *Veneti* people based in Brittany suggest that England's Iron Age populations were using sea-going sailing ships (Wessex Archaeology 2009:53). Despite this, 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 vicinity of the MAREA Study Area. 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* from Northern France and Belgium (Cunliffe 1975: 75-88).

6.4.15 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 they were not completely subdued until around AD 61 after an almost successful war led by Boudicca restored independence for the East Anglia tribe (Cunliffe 1975: 122).

6.4.16 Direct maritime archaeological evidence from this period is also 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). Dating to the 2nd century AD, the Blackfriars ship is a fascinating find that may originally have been able to carrying capacity of 63.7 tonnes (McGrail 2004: 201). With a heavy, strong and flat-bottomed construction it possibly represents an example of the type of ship Caesar enviously described as being perfectly suited to the shallows and stormy seas of the area (Steffy 1994: 100). The New Guy's House find was of a similar period as that of Blackfriars I but was a versatile river barge with a possible cargo hold for 7 tonnes (Marsden 1994:97). The County Hall ship was another interesting discovery from the late 4th century AD. Built locally from oak with a traditional construction more typical of that of the Mediterranean, this maritime find further exemplifies the varying ability of craftsman, and the performance and function of vessels of this time.

6.4.17 Although the major point of import was London far to the south of the MAREA Study Area, there is evidence that ports on the Suffolk and Norfolk coasts and rivers were developed in the Romano-British period, essentially to protect the exposed eastern reaches of Roman-occupied Britain. The military establishment made extensive use of the MAREA Study Area's coastal waters for transporting goods from garrison to garrison (Rippon 2008: 86). 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. Evidence from an excavation in the 1950s suggested a cavalry occupying the fort (made up of a defensive wall and rampart) from the early 3rd century to late 4th century (Darling and Gurney 1993). 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).

6.4.18 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 (Johnson 1983). 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)

6.4.19 Although the archaeological evidence for early Anglo-Saxon settlement is poorly understood, there are notable examples of their seafaring capabilities during this period within and around the MAREA Study Area. Saxon settlers introduced the Scandinavian-style clinker-built vessels during the Early Medieval period (410-1066 AD). The first notable example within the MAREA Study Area was a wooden boat discovered in an old watercourse near Ashby Dell in 1830, thought by Bruce-Mitford to be from the 4th or 5th century (NMR MON: 1244923). It was believed that the approximate length of the vessel was 15.5m with a beam of 2.45m. The entire vessel was held together by lashings and treenails. It was powered by 14 oars, and there was no provision for a sail. Comparison has been made with the double ended five strake sided Nydam 2 ship from Jutland of around AD 310 to AD 350.

6.4.20 With the further inland settlement of the Saxon communities a network of trade and migration routes existed in the Southern North Sea, with a number of important ports or landing places along the East Anglia coast. According to the Anglo-Saxon Chronicle, the Saxon leader Cerdic landed at the shore close to Great Yarmouth in AD 495 (Online Medieval and Classical Library 2004) and Dunwich (Dumnoc) is listed as a port in the Anglo-Saxon Chronicle for 636 (Comfort 1994:5).

6.4.21 The Anglo-Saxon burial mounds of Sutton Hoo discovered on a promontory overlooking the River Deben in Suffolk, not only represents the type of Northern European shipbuilding practices in use during this period, but provides evidence along with the Snape boat burial site of the perceived social or cultural importance of ships and seafaring to those living within the vicinity of the MAREA Study Area at this time (Bruce-Mitford 1972; Evans 1994).

6.4.22 Although the Sutton Hoo vessel was constructed to sit low in the water so oars could function, and was probably not suited to the open sea in difficult conditions, there was nonetheless evidence of continental influences. Amongst the grave goods, 37 minted coins were discovered from 37 different locations across northern and southern France and western Germany (Bruce-Mitford 1972: 56-57). The Kvalsund Ship of AD 700 found in western Norway has been compared closely to that of Sutton Hoo. Although Sutton Hoo does not reflect an ocean-going cargo vessel it does represent that shipbuilders were developing sailable hulls by the early 8th century.

6.4.23 Viking raids on the eastern British coast began in the 8th century, leading to an obscure period in English History (Abrams and Parsons 2004: 423). It is documented that in AD 870 Vikings killed the East Anglian King Edmund (later to be venerated as a saint) and began to settle in East Anglia (Rogerson 1998). The North Sea would have acted as a communication, trade and migration route to the Scandinavian home countries. In addition coastal trade would have continued.

6.4.24 Within the MAREA Study Area two oaken rudders, thought to date from AD 850 to AD 950 were discovered. The smaller was found in a fishing net in 1981 near Eastern Bavents and the larger washed up on a beach just north of Southwold pier in 1986. They are thought to originate from Anglo-Saxon vessels or a Viking fleet. Both had holes to accommodate tiller bars, establishing their original placement as 'steering-board' side rudders due to the shape of the stern. Hewn from large oak trees, both were over four metres long.

6.4.25 At around this time it is also possible that a more distinctive tradition transformed from the Scandinavian 'longship' style (Goodburn 1986, 1994). The Graveney Boat, discovered in a marsh in north Kent, was built for the coastal estuarine environments, with Saxon clinker-built, Nordic oak working and Romano-Celtic affinities (Mcgrail 2004: 218-220). In 1990 a boat was discovered at Buss Creek, near Southwold in the very south of the MAREA Study Area, the entry to which is through the Blyth River. The timbers built for a clinker vessel had an approximate length of between 9.1m to 12.2m and produced radiocarbon dates of AD 890 to AD 970 (Bacon 1996: 18-22). It is possible these timbers represent a vessel similar to that of the Graveney boat, with cross cultural traditions, capable of small scale cargo carrying in calm open water.

6.4.26 The latter part of the medieval period was just as turbulent but witnessed greater advances in communication, technical ability and the growth of ambition. The strategic geographical benefit of the east coast region in relation to sea resources and the neighbouring continental economies was also enhanced. Documented evidence from 11th to 15th centuries, although still relatively sparse, does provide a valuable picture for the scale and diversity of trade that took place within the MAREA Study Area and the surrounding pattern of exchange of commodities.

6.4.27 By the beginning of the period of Norman rule many East Anglian ports had developed into busy trading centres, with Norfolk and Suffolk establishing larger fleets than any other region of England at this time (Williams 1988: 257). With prosperity came the necessity to protect assets and investment. Town seals of these medieval ports provide important information about technological modifications made to ships for fighting at sea and the wider social environment as a whole. Dunwich was one of the most notable sea ports of medieval England and its seal illustrated a fighting top square and central to the mast in the late 12th century. The walled town of Great Yarmouth also depicted armed merchant vessels in the 13th and 14th century (Hutchinson 1994: 153).

6.4.28 This area of the English coast also provided shipbuilding expertise and was to play a major role in the development of shipbuilding traditions during this period. One of the earliest documented three masted 'carvel' ships built in England was by Sir John Howard of Dunwich in Suffolk (Friel 1983: 134). Edward II also ordered 26 towns to build 20 galleys including Newcastle, York, Dunwich, Ipswich, and London (Hutchinson 1994: 23).

6.4.29 The NMR documents losses of vessels voyaging during the 13th, 14th and 15th centuries within and across the MAREA Study Area. Losses include the *La Nicholas* stranded at Kirkley on passage from Sluis in the Netherlands to Berwick-upon-Tweed in 1352 (NMR Mon No.: 913642) (Larn 1997), as well as the French cargo vessel *La Grace De Dieu,* also wrecked near Kirkley in 1362 on passage from Great Yarmouth to Bayonne in Southern France with a cargo of herring. It is possible such deep drafted vessels were cogs or ships of similar size such as hulcs, and possibly similar to the large clinker built vessel of AD 1445 found on the west bank of the River Usk in Newport, south Wales, discovered in 2002.

6.4.30 Baltic cordage was supplied to England through Great Yarmouth at the market of Lothingland selling nets and rope (Salzman 1931: 136). At the 11th and 12th century fishing settlement of Fuller's Hill, 19 species of marine fish were identified, as were 45 fish hooks, 9 of which measured between 5cm and 12cm in length, plus knives, whetstones and arrowheads illustrating the diverse fishing grounds (Wheeler and Jones 1976: 212).

6.4.31 The most notable market was that of preserved fish during the 13th, 14th and 15th centuries in Norfolk and Suffolk, as fish was an important facet to the medieval diet with many monastic houses sending ships there (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; Heath 1969: 60). These fleets acted in convoy throughout the 15th century reaching a peak in the early 16th century (Marcus 1954: 296).

6.4.32 Great Yarmouth in particular had become one of the major herring markets in Europe and Mediterranean states during this period (Hutchinson 1994: 129). In 1338 Edward II obtained 400 Lasts (a unit for measuring twenty four 100lb barrels of gunpowder) of herring (equivalent to half a million fish) from Great Yarmouth to supply his troops for the eventual Battle of Arnemuiden during the Hundred Years War (Cutting 1955: 35), made famous for the first use of naval artillery in battle. The church forbade meat for more than two days a week, plus during the six weeks for Lent (Saul 1981: 33), making fish a very necessary commodity.

6.4.33 Similarly, in Suffolk fish bones are exceedingly common in medieval urban deposits (Murphy 1997:64) and many coastal settlements such as Southwold and Aldeburgh established fishing industries in the late medieval period, particularly with the development of the Icelandic fisheries (Oxford Archaeology 2007:12). The progression into the northern extents of the North Sea provided towns suffering from depopulation and phases of deposition within their harbours to booster difficult economic circumstances (Comfort 1994). The city of Dunwich was to bare the brunt of further natural disasters in the form of six phases of coastal erosion from the 13th century to the 20th century (A 2008. As a casualty of such recurrent events that would see the thriving identity of Dunwich extinguished, it has been a dramatic example of the forces at work on the east coast of England.

6.4.34 By the late medieval period, purpose-built warships were constructed and the shipbuilding practices for both warships and merchant vessels were 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 four masts and extra rigging (Wessex Archaeology 2009: 55). 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).

6.5 COASTAL AND SEAFARING ACTIVITY: 1509 - 1815

6.5.1 Events that took place during this period would see the mercantile communities of northern Europe make substantial economic endeavours to encompass a new transoceanic network link between the North Sea and the East and West Indies. Such a link 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.

6.5.2 The distinction between men-of-war and ocean going merchantman became increasingly difficult to identify as the massive political and economic interests at stake during this turbulent period increased at a massive rate (Barbour 1930: 261). An example of the difficulty of interpreting archaeological remains from the early part of this period are illustrated by the protected wreck site of Dunwich Bank within the MAREA Study Area to the far south. With up to six ordnance observed in diving operations from the 1990s onwards and no timber visible, the main focus of the dispersed site represents a wreck from the 16th/17th century with initial parallels to that of the designated warship HMS *Colossus* (Wessex Archaeology 2010e). However, the nature of shipping at this time does not rule out the possibility of the wreck being that of an armed merchantman.

6.5.3 By the late 16th century East Anglia was a centre of such prosperity, driving and thriving coastal and foreign trade, and in the process making a substantial contribution to the wealth of England. The geographical extent of this prosperity ranged from the Baltic Sea to the Iberian peninsular and beyond (Williams 1988: 70), with a strong connection to the Netherlands exchanging corn fish and new types of cloth, particularly for wool, fish and leather. East Anglian ports situated on the east coast were connected to the coast by navigable rivers which provided trade into the interior and coastal and international trade was extensive.

6.5.4 During the 17th century, two significant naval battles took place within the MAREA Study Area. The battle of Lowestoft was the opening engagement of the Second Anglo-Dutch war in 1665. Altogether, 20 Dutch ships and two English vessels were lost in the course of the battle, among these the Dutch flagship *Eendracht* which exploded. The Battle of Sole Bay (Southwold Bay) in June 1672 was the first engagement of the Third (and final) Anglo-Dutch war. The Dutch lost three ships, while the combined English and French fleet suffered the loss of four ships including the *Royal James*, wreck within the MAREA Study Area that potentially may be protected under the Protection of Wreck Act. An English first rate ship of the line that foundered after being attacked by cannon and fireship, the *Royal James* is suspected to be situated approximately 6km due east from Southwold harbour, although it has not been conclusively identified. With none of the lost warships from either battle having been located, it is not inconceivable that their wreckage might be found within the MAREA Study Area. These battles were mapped with buffers based on historical documentary sources in the course of an ALSF funded project, England's Shipping (Wessex Archaeology 2004).

6.5.5 Since 2005 a joint initiative by BMAPA (British Marine Aggregate Producers Association) and English Heritage established a single protocol applicable for finds in all dredging areas, vessels and wharfs (BMAPA and English Heritage 2005). This has provided important information as to the whereabouts of potential maritime sites. By way of example, a total of 14 cannonballs have been discovered in the last five years in dredging Areas 430, 240, 242, and 296. It is possible that the majority of these finds are linked to the Battle of Lowestoft and the Battle of Sole Bay.

6.5.6 In terms of trade and shipping the MAREA Study Area would have continued to be utilised and traversed by a wide range of sailing vessels on a regular basis. 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).

6.5.7 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).

6.5.8 With regards to the post-medieval period, the MAREA Study Area is considered to be a zone of concentrated civilian and military use, for which there is a possibility for finding associated evidence within the MAREA Study Area. Archaeological material within the MAREA Study Area for this period is considered to predominantly comprise of wreck material, a significant proportion of that being toward the late 18th century and early 19th century, and which have already been documented. Material from the earlier Tudor period would be of a rare discovery and therefore would be of greater significance.

6.6 COASTAL AND SEAFARING ACTIVITY: 1815 – 1913

6.6.1 The Industrial Revolution was without doubt the most fundamental effect upon the use of the landscape and the coastal communications network. The Broads of Norfolk and Suffolk were at the forefront of this transformation, becoming a patchwork of model farms, necessitating effective and efficient communication links for transporting the products of agriculture. Local industries sprung up to supply the demand for growth, and the materials for ironworks, lime works (for building and fertilising) and brickworks. Much of this had to be transported by sea until a reliable railway had been developed by the 1860s (Gould 1999: 73).

6.6.2 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.

6.6.3 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 fundamentally due to the restraint of cemented cultural traditions and the uneven economic spread of such progression.

6.6.4 Although the use of iron in shipbuilding can be dated back until at least the late 18th century, it did not displace wood as the primary construction material in shipbuilding until the 1860s and 1870s (Graham 1957: 77 and Ville 1993:52). Initially, iron was used to supplement structural elements in shipbuilding, although it was later used for angular joints or knees and the framing of vessels. Further advances in hull construction took place with the introduction of steel in shipbuilding practices. Steel was used periodically for ship construction from the late 1850s but did not supersede iron generally until the introduction of the Bessemer and Siemens processes in 1885 (Greenhill 1993:89; Ville 1993:52). The use of metal in shipbuilding enabled the construction of more durable vessels with a larger stowage capacity (Ville 1993:73).

6.6.5 The advent of the steamboat, initially using paddle wheels and equipped with single cylinder engines and low pressure boilers, brought a new type of traffic to the MAREA Study Area. Although sail was still the dominate means of transport at sea at the beginning of the 19th century, the first Atlantic crossing in May 1819 of the *Savannah* paddle steamer (with collapsible paddle wheels) certainly encouraged support for the technology. Steamships were quickly put to use for coastal voyages and shorter cross-Channel passages, and by the 1820s steamboat transport formed an extensive network around the British Isles (Pearsall 1985:195). The only downside was that paddle steamers were high in coal consumption, thus limiting their range and competitiveness, and as such they were largely confined to the passenger trade where reliable quick passages were more important than cost (MacRae and Waine 1990:11).

6.6.6 Paddle steamers are poorly represented in the NMR. Only one is recorded within the MAREA Study Area, the *Prince Frederick* (**NMR UID 1239644**). It foundered after grounding on Corton Sand (south of Great Yarmouth), while en route from Kingston-upon-Hull to London with cargo and passengers in 1835. Of composite metal and wood construction, she was a steam-driven vessel. Another separate vessel is recorded in SeaZone in the MAREA Study Area, named *Seagull* (**UKHO10550**, **7215**, **Figure 25**). Built in 1848 in Belfast as a 2 masted steam paddle schooner, it was owned at the time of loss by Coates & Young, Belfast. It had one boiler, a compound expansion engine, and single shaft, and was struck by SS *Swan* and foundered whilst on passage from Hull to Rotterdam with a cargo of raw cotton.

6.6.7 Paddle steamers were gradually superseded by screw (propeller) driven vessels, which provided an alternative and more efficient means of propulsion, the introduction of which began in the 1830s. However, it was not until the development of the compound engine in 1854 that vessels equipped with screw propulsion could truly compete with the sail or paddle.

6.6.8 A notable example of the screw driven vessel is the steam screw barque *Xanthe* of some 689 tonnes, built in 1862 in Hull. It sank after a collision in December 1869 (**UKHO10660**, **7217**, **Figure 26**) and is situated approximately 1.5km to the west of the *Seagull*. Further advances in the 1880s saw the construction of high pressure steel boilers at competitive costs and the consequent application of the triple expansion engine, leading to the production of vessels which could be operated with a much greater efficiency and was more economical than a sailing vessel.

6.6.9 Prior to 1842 there was no direct rail service between Edinburgh and London. As the demand for raw materials and fabricated goods increased the railway network from north to south of the United Kingdom became more reliable and provided further economic stimulus with the continent. 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).

6.6.10 With the general trend toward steam taking hold of shipping lanes across the North Sea there still remained coastal communities persisting with traditional ways of propulsion. This period of steam dominance coincided with the development of sailing smacks 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 is reflected in the casualty losses in the MAREA Study Area, accounting for approximately 16% of all vessels with a known function within the SeaZone data provided.

6.6.11 In the late 19th and early 20th century, the Yarmouth/Lowestoft autumn herring fishery was by far the biggest fishery on the East Coast. Huge shoals of ‘silver darlings’ would gather in the southern North Sea. A vast fleet of East Anglian and visiting Scottish fishing boats would reap the harvest.

6.6.12 The dominance of Great Yarmouth as a port in the region continued as it played a major role in the Icelandic cod fishing fleets during the mid 17th and 18th century, with whaling vessels heading course for the Arctic. This continued into the 19th century, with the well established herring stock exported on mass to the Mediterranean and with an expanding market to Northern Europe in the 20th century. Coastal and estuarine craft included barges, coasters and other vessels linking the Broads to the coast, Lowestoft’s Parkeston Quay in particular was to emerge as an important centre during the 19th century (Gould 1999: 74).

6.6.13 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 coming 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.

6.6.14 As the 19th century came to an end the Royal Navy was certainly outdated. Despite the Admiralty's prestige and experience an increasing threat was posed by Germany with the opening of the Kiel Canal in 1895 and the passing of Navy Laws in 1898 and 1900. By the beginning of the 20th century it became clear that an arms race would ensue, the focus of which would be the battleship. 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).

6.6.15 The centralised recording of ship losses was greatly improved by the late post-medieval period, and as such, the available record of losses is both more complete and accurate. The incorporation of metal elements within vessel designs from the mid 18th century onwards also means that wrecks are often more evident on the seabed than their predecessors as their upstanding components are apparent to bathymetric and geophysical survey, and they generate strong magnetic anomalies. Refer to Table 8 above illustrating sites with magnetometer readings, and Table 9 both in section 6.2 Maritime Geophysical Assessment showing the number of wrecks, debris and mounds found on the geophysical Survey in September and October 2008.

6.7 COASTAL AND SEAFARING ACTIVITY: 1914 - PRESENT

6.7.1 Surprisingly, after a decade of preparation, the Royal Navy would undertake only four major sea encounters in the North Sea, the Battle of Jutland in May 1916 being the most notable battleship confrontation, with the German battleships refusing to engage with the British Grand Fleet and there blockade in the high seas again. A far more successful strategy of the German Navy developed around a U-Boat campaign which aimed at bringing Britain's merchant fleet to its knees with unrestricted attacks from September 1915 onwards. 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 (IWM Website 2010 and Hewitt 2008:17).

6.7.2 The East coastal trade route facilitated the transport of cargos from the 'Great North Coalfield' passing close to and directly through the MAREA Study Area, and was still the main supply line to London, which accounted for the single largest consumption for fuel in England (Hewitt 2008:7). To protect the maritime trade upon which Britain relied, World War I saw the introduction of coastal convoys, whereby steaming merchant vessels were escorted in groups by minesweepers (Steffen 2005: 802).

6.7.3 Although the U-boat was extremely effective it was also the use of mines which would make a dramatic impact to shipping losses during World War I, with a total of 1 million tons of Allied Merchant shipping sunk (Steffen 2005: 802). Within the MAREA Study Area as a whole some 64 losses were attributed to mines during the World War I, with a general trend in close proximity to the coast between Southwold and Lowestoft. There was possibly a wider German strategic attack on Lowestoft (a centre for minesweepers and minelayers), since the failed Bombardment on the 24th of April 1916 (see **Figure 35**). The wreck of the SS *Southford* (**UKHO10349**, **7248**, **Figure 30**) situated 10km east of Southwold is one such vessel that struck a mine in this area of high World War I losses.

6.7.4 The overall scale of the German mine laying strategy off the East Coast of England initially puzzled the Royal Navy, as there was little evidence of the number of Armed Merchant Cruisers (AMC's) necessary to cause such losses. However, when the coaster *Cottingham* accidentally rammed an underwater obstruction on the 2nd July 1915 the secret German strategy became clear. A Royal Navy diver was sent in to investigate and discovered a 3 foot opening on the hull of the *UC-2* (**UKHO10473**, **7719**), a Type SM UC 1 minelayer submarine of the German Imperial Navy previously unknown to the Royal Navy. The German minelayer had been on transit to Lowestoft from Zeebrugge as part of 15 vessel operation to disrupt the British Cargo carrying network (Messimer 2002).

6.7.5 These convoys were also utilised in the World War II in an attempt to transform the east coastal trade route into an indestructible highway (Hewitt 2008:17, 23). During the World War II, large numbers of steam trawlers and drifters were bought or hired by the Admiralty to supplement the Royal Navy's dwindling resources. Dozens of these small vessels were lost because of enemy action, some sunk by torpedoes or gunfire from submarines, with the additional threat of German motor torpedo boats, known as E-Boats 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 from 1939 to 1941 (Larn and Larn, 1997).

6.7.6 The main convoy route during the World War II was that of FS/FN, a passage between Methil, Fife and Southend-on-Sea in the Thames from 1939 onwards. Which passed through the MAREA Study Area. During the war the seaside resort of Southend-on-Sea would witness over 2,000 convoy vessels arrive and depart.

6.7.7 Three such Merchant Vessels utilised and lost during the Second World War were surveyed using geophysics by Wessex Archaeology. They Include the SS *Stad Alkmaar* (**UKHO10992**, **7227**, **Figure 24**), the SS *Cormead* (**UKHO11031**, **7228**, **Figure 28**), a cargo steamer built in 1939 by the Burntisland Shipbuilding and Engineering Company, and the SS *Rye* (**UKHO10544**, **7229**).

6.7.8 In interpreting the SeaZone data there is a clear variation between the situated merchant shipping losses of World War I and those of World War II. The coastal regions of Suffolk between Hopton and Southwold illustrate the significant majority of WWI losses (especially in the near shore vicinity of Kessingland to Southwold), possibly due to the German Naval strategy of deploying mines and U-boats toward the major ports such as Great Yarmouth, Lowestoft and Soutwold. The recorded losses of World War II are far less concentrated and appear to be further offshore, with sixteen situated within the accumulated east coast dredging areas. Another substantial cluster of thirteen to the north of the MAREA Study Area are positioned between the lengthy sand waves of Winterton Ridge and Smiths Knoll (**Figure 35**). Such a large coverage of losses may suggest a much larger area of passage for the Merchant Navy, with greater numbers within convoys with deeper drafts and larger escort vessels.

6.7.9 The apparent variation in World War I and World War II merchant shipping losses within the MAREA Study Area may be a result of the different technological capabilities possible at the time and the strategies used. These apparent trends may also be a slight indication as to the likelihood of possibly World War I and World War II merchant vessels lost within the licence dredging areas.

6.7.10 This area of coast was also well fortified in the World Wars with artillery recorded in 1941 at Southwold, Dunwich, Minsmere, Sizewell and Aldeburgh (Foynes 1994). A number of monuments dating to this period survive including gun sites, hideouts, anti-tank cubes, pillboxes, anti-aircraft batteries and gun emplacements (Hegarty and Newsome 2007). However, they are at risk to similar natural processes that swept away Dunwich Greyfriars, with the entire coastline in which they we fixed completely gone (*ibid* 2007: 92).

6.7.11 Maritime activity within the MAREA Study Area region throughout the post-war era is multi-faceted. Providing an arena for military, commerce and leisure activities and an environment capable for overseas, coastal and inland voyages, a diverse array of boats and ships continued to enter the archaeological record after 1945, such as the *Marsworth* (**UKHO10547**, **7220**, **Figure 27**). And although ships and boats are less numerous than in preceding years, the overall volume of seafaring activity continues to be very high (Wessex Archaeology 2009:61). Due to the intensity of activity within the MAREA Study Area during this period, the potential exists for the presence of currently uncharted wreck sites.

6.8 MARITIME ARCHAEOLOGY: SUMMARY

6.8.1 From the above it is clear that there is the potential for the remains of vessels which date from at least the Mesolithic period to the present day within the MAREA Study Area. The density of marine traffic which has passed through the MAREA Study Area since the Mesolithic is immense. Furthermore, by its close proximity to the northern Continent and its position as a direct passage for shipping traffic passing from the North of Britain to London, there is the likelihood of significant wreckage still to be discovered within the MAREA Study Area, sunk either by accident or by war. Encompassing such a major stretch of the English coastline, the MAREA Study Area has witnessed some of the most fundamental movements of British History. With this quantity of shipping activity within the region, the potential for the remains of vessels within the MAREA Study Area is clearly very high.

6.8.2 This potential is further enhanced by the nature of the seabed topography within the MAREA Study Area and the areas recorded as notable shipping hazards. The highly mobile and numerous sandbanks which characterise the shallow geology of the region have the ability to swallow shipwrecks of considerable size. These sandbanks also often provide favourable preservation for shipwrecks. Although in some cases the remains of vessels would not survive due to post-depositional processes and the impact of modern vessels sweeping them, the debris field of a wrecking incident may also be sealed within the sandbanks.

6.8.3 Consideration must also be given to the potential for isolated finds that may have come to be on the seabed having been lost or discarded overboard. Such finds may not only be useful in defining the preferred sea routes within the MAREA Study Area throughout the centuries, but may also provide evidence for other maritime activities, such as overseas commerce and naval warfare. A number of finds reported through the English Heritage/British Marine Aggregate Producers Association Protocol for Reporting Finds of archaeological interest (http://www.wessexarch.co.uk/projects/marine/bmapa/index.html) highlight the importance of isolated finds. Since the start of the Protocol in 2005, a number of cannon balls have been found in material dredged from licence area 430, approximately 25km south-east of Southwold on the Suffolk coast. Following an assessment of their calibre, it became apparent that these cannon balls may derive from the 17th century and this may be associated with the two naval battles of the Anglo-Dutch Wars which took place in this vicinity; the Battle of Lowestoft 1665 and the battle of Sole Bay 1672. Their discovery is thus not only important in relating to this significant episode of Britain's maritime history, but also in being indicative of the density of maritime activity within the region during the post-medieval period.

7 AVIATION ARCHAEOLOGY

7.1 INTRODUCTION

7.1.1 Since the advent of powered human flight in the early 20th century, thousands of military and civilian aircraft have been lost around the UK, and aircraft losses at sea span the entire period of aviation history, from the introduction of flight to the post-WWII period. However, although records of aircraft losses at sea are extensive, data regarding their location is limited.

7.1.2 A guidance note published by English Heritage (EH) entitled *Military Aircraft Crash Sites* (English Heritage 2002) outlined a case for recognising the importance of aircraft crash sites, specifically with regards to existing and planned development proposals which may have an impact on such sites. The guidance note argues that aircraft crash sites not only have significance for remembrance and commemoration, but they also have an implicit cultural value as historic artefacts, providing information on the aircraft itself and also the circumstances of its loss (English Heritage 2002:2).

7.1.3 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 the MAREA 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.

7.2 AVIATION ARCHAEOLOGY PRE-1939

7.2.1 Fixed wing aviation first began in the early 1900s in the UK, with the first fixed wing flight across the English Channel in 1909 (http://www.rafmuseum.org.uk/milestones-of-flight/british_civil/1909.cfm). The county of Norfolk has had a long and close association with aviation. During the First World War, Boulton & Paul started manufacturing airplanes in Norwich in 1915, flying them from Mousehold Heath. Narborough was the biggest aerodrome in the country, and Pulham was a major airship base. The Royal Navy Air Service (RNAS) also had airfields around the coast as a defence against Zeppelin raids.

7.2.2 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 RNAS, founded in July 1914, to patrol the east coast of Britain and provide airborne defence and anti-submarine duties (Brown *et al.* 1995:31; 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).

7.2.3 The Royal Naval Air Station at South Denes, Great Yarmouth opened in 1913, and had a number of satellite airfields called Night Landing Grounds around the coast, including those at Bacton and Burgh Castle. The Royal Flying Corps had an airfield at Marham, but also controlled landing grounds at Earsham, Freethorpe and Saxthorpe. During World War I, the perceived threat from Zeppelin attacks following successful raids on London caused more of a psychological than actual impact, but resulted in 12 British squadrons being mobilised for home defence.

7.2.4 The Royal Flying Corps and the RNAS provided further defence against air raids, and there were a series of Home Defence airfields protecting London (Crowe 2008:37). The increasing threat posed by Zeppelin airships and, from 1917, Gotha bombing planes flying across the North Sea to London and targets on the East Coast was met by the establishment of 16 squadrons of fighter aircraft, 480 anti-aircraft guns and 706 searchlights with a centralised control system around Britain (English Heritage 2000; Lake and Francis 1998:13).

7.2.5 During World War I, the potential of airpower as an independent sector of the armed forces became increasingly clear (Lake and Francis 1998:13). The patrols of the RNAS had pioneered the role of airpower from purely reconnaissance motives to an increasingly strategic role, and by April 1918 the Royal Air Force (RAF) had been established as an independent force (English Heritage 2000a; Lake and Francis 1998:13).

7.2.6 The regular use of aircraft over the battlefields of the Western Front by the end of World War I prompted the mass-production of fixed wing aircraft in large numbers for the first time. This increasing use of aircraft during World War I also spurred technological advances which saw the development of more powerful engines, allowing aircraft to reach speeds up to 130mph (Wessex Archaeology 2009:64). This increased power not only enabled aircraft to travel more than twice the speed of pre-war aircraft, but it also made larger aircraft possible (Wessex Archaeology 2009:65).

7.2.7 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.

7.2.8 By the end of World War I it had become apparent that increasing effort would have to be put into defending Britain's airspace at the expense of guarding the coastline (Brown *et al.* 1995:31). After the collapse of the Geneva disarmament talks in 1933, the British government engaged in a massive programme of rearmament and more than 100 permanent airbases were built throughout Britain during the inter-war years (English Heritage 2000; Lake and Francis 1998:13).

7.2.9 There was a rapid progress in the field of aviation during the interwar years. Technological innovation during this period meant that the low-powered wood and cloth biplanes had been replaced by high-powered monoplanes made of aluminium (Wessex Archaeology 2009:65).

7.2.10 With the construction of aircraft designed to carry passengers and cargo, commercial civil aviation significantly increased during the 1920s and 1930s and various cross-channel services to a number of European and worldwide destinations had been established (Wessex Archaeology 2008:16). The Department of Transport's Air Accident Investigation Branch (AAIB) records 20 civil aircraft losses at sea between 1920 and 1939, though this is not regarded as being a comprehensive record (Wessex Archaeology 2009:65).

7.2.11 Pre-1939 aircraft crash sites at sea are likely to be relatively rare, and the lightweight construction of the earlier airframes means they are less likely to survive within the marine environment unless buried within seabed sediments. Any early air crash sites from this period are, however, likely to be very important.

7.3 AVIATION ARCHAEOLOGY: 1939-1945

7.3.1 By the World War II an advance in aeroplane technology enabled flights over water to take place with a much lower level of risk and airpower became increasingly important at a strategic and operational level.

7.3.2 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 2008:16). Hostile aircraft activity was particularly concentrated off the east and south coasts of the UK throughout World War II.

7.3.3 East Anglia's long, sweeping, flat landscape was a significant focus for aircraft activity during World War II, and became England's airfield during the war. In 1934 there were only four active air bases in the region, but by 1939 there were 15, and 5 satellite landing grounds, as a result of an 'expansion' initiative. By 1945 there were as many as 107 bases in use by the RAF and the United States Air Force (USAF) (Williamson 2006: 77). Suffolk and Norfolk were 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.

7.3.4 From the 7th September 1940, the Blitz saw the sustained bombing of Britain, with Great Yarmouth suffering more bombing than any other coastal town in the country. The aircraft losses which occurred during this period were considerable. Losses in British aircraft destroyed or written-off due to battle damage amounted to 1,140, and RAF fighter pilots are recorded to have destroyed at least 1,733 German aircraft (Bowyer 2003:79). With so much aircraft activity focussed in East Anglia and off its coast it is likely that a number of these losses took place in the MAREA Study Area.

7.3.5 The loss of aircraft from both sides was immense in World War II. It has been estimated that an average of 5 aircraft crashed every day between 1939 and 1945 somewhere in the British Isles (Bédoyère 2001:8) and many of these casualties would have occurred offshore. Despite this, the known aircraft crash sites which have been identified are few.

7.3.6 In response to the apparent discrepancies between the known and potential aircraft crash sites, Wessex Archaeology was funded by English Heritage through the Aggregates Levy Sustainability Fund to undertake a scoping study entitled *Aircraft Crash Sites at Sea* (Wessex Archaeology 2008). The study aimed to identify current gaps in data and understanding relating to aircraft crash sites at sea.

7.3.7 One of the most complete sources of information reviewed by Wessex Archaeology during the scoping study for the World War II and post-war period was provided by published aviation researcher Ross McNeill. McNeill has recorded 11,090 RAF aircraft losses in the North Atlantic, North Sea, English Channel, Irish Sea and Biscay areas between 1939 and 1990, the majority of which occurred during World War II (Wessex Archaeology 2008:18). Of these aircraft crash sites, 217 are thought to be located off the coast of Norfolk, while another 73 are thought to be off the coast of Suffolk. Although Wessex Archaeology cannot verify the accuracy of the data supplied by McNeill, it was collated through a systematic study based on both primary and secondary sources and suggests a high volume of potential aircraft crash sites within the MAREA Study Area.

7.3.8 A further survey of crash sites in England carried out by English Heritage, in consultation with the Ministry of Defence (MoD) as part of the Monuments Protection Programme (MPP), revealed that World War II losses tended to cluster along the southern and eastern margins of England. For example, some 1,000 losses of World War II aircraft were estimated off the coast of Suffolk (English Heritage 2000; English Heritage 2002:5).

7.3.9 A review of maps showing the location of World War II Air/Sea Rescue Operations suggest that over 130 recorded Air/Sea Rescue Operations took place within the MAREA Study Area (**Figure 36**). There seems a fairly large disparity, between the Air/Sea Recue Operations and the estimated losses illustrated above. However, this may be due to limited reconnaissance of the Coastal Commands Air/Sea units. Although the mapped location of these operations is not necessarily reliable, the locations provide a useful guide to the general distribution and potential density of aircraft crash sites within the MAREA Study Area. A review of these operations alongside the recorded aircraft crash sites within the NMR highlights the disparity between the known and potential resource with regards to aviation archaeology.

7.3.10 There are 57 of the 58 recorded aircraft crash sites listed within the NMR for the MAREA Study Area from World War II. There are 4 locations within or close to the licensed dredging zones which record between them the loss of 27 aircraft (see **Figure 37** and **7.6.5** for further details). The location within Area 454 has 9 aircraft associated with it, whilst the location just to the north of Area 328B has 16 aircraft assigned to it.

7.3.11 Further evidence of the comprehensive nature and dispersal of aviation archaeology from World War II within the MAREA Study Area has been highlighted by the recorded finds from the BMAPA protocol since 2005 (BMAPA and English Heritage 2005). Eleven such discoveries have been recorded in total throughout the licence dredging areas within the MAREA Study Area. They include a large quantity of aluminium wreckage from World War II, some of which is identifiable with a particular make of aircraft. Area 430 especially illustrates the potential resource of dredgers in enhancing the known cultural heritage for the region. With a pedal from either a P-51 Mustang or a B-25 Mitchell Bomber from the U.S Air Force discovered in 2005. And a human bone, from the right upper arm is thought to be of a German Airman, possibly associated to a Heinkel He 111 or Junkers Ju 88 that may have gone down during the Battle of Britain around August 1940 (Wessex Archaeology 2007b).

7.3.12 Commercial aircraft are also likely to have been lost in this period. Although only two aircraft losses were recorded by the AAIB from 1939-1945, this figure seems unlikely and is possibly a factor of the acknowledged incompleteness of the AAIB records (Wessex Archaeology 2008).

7.4 AVIATION ARCHAEOLOGY: 1945 - PRESENT

7.4.1 Following World War II and until the early 1990s, military aviation activity was dominated by the Cold War. In response to threats posed by the Cold War, military aircraft research, design and development was further increased, much development of which was also applied to commercial aircraft (Wessex Archaeology 2009:67).

7.4.2 Technological innovation during this period saw the refinement of the jet engine, which enabled the production of jet aircraft which catered for both military and commercial pursuits. The jet aircraft was much faster than its propeller-powered predecessors and was able to attain a much greater altitude, providing maximum efficiency over long distances (Jarrett 2000).

7.4.3 Throughout the periods prior to 1945, military activity provided the dominant impetus for aircraft design and development. However, following World War II there was a steady and rapid rise in commercial flights. Initially ex-military aircraft were used to transport people and cargo, with aircraft such as the American B-29 and the British Lancaster converted into commercial aircraft (Wessex Archaeology 2009:68). The first purpose-built commercial jet airliner was the de Havilland Comet, which first flew in 1949 and entered service for the British Overseas Airways Corporation (BOAC) in 1952, between London and Johannesburg. Flight soon became an available means of travel within and around the UK for most people, and the volume of airliner activity across the MAREA Study Area is considerable.

7.4.4 Despite the volume of aviation activity across the UK, there have been very few major losses. The 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).

7.5 AVIATION ARCHAEOLOGY: SUMMARY

7.5.1 Although aircraft losses are predominantly concentrated within the period between 1939 and 1945, there is the potential for aircraft crash sites which span the entire period of aviation history.

7.5.2 With the potential resource for aircraft crash sites large, and the number of known crash sites relatively small, the potential exists for the presence of a large number of unknown crash sites on the seabed within the MAREA Study Area. In providing favourable preservation, the seabed environment further enhances this potential, making the discovery of fairly intact aircraft on the seabed far more likely than for those discovered on land.

7.5.3 Despite this, due to the often ephemeral nature of their remains, aircraft crash sites are not easily distinguishable in standard geophysical survey. Furthermore, the remains of military aircraft which are found receive blanket protection under the Protection of Military Remains Act 1986, whereby no disturbance of a military aircraft wreck is permitted without a licence from the MoD.

7.5.4 Consequently, the potential for the remains of aircraft – especially military aircraft – to be present within the MAREA Study Area must be borne in mind during the assessment of any area ahead of seabed development.

7.6 KNOWN AIRCRAFT CRASH SITES

SeaZone

7.6.1 Of the 816 charted sites listed in the SeaZone data within the MAREA Study Area, only 3 contained references to aircraft crash sites. All 3 records appear to be post 1946 in date. The sites are illustrated in **Figure 38**.

7.6.2 These 3 records contain some basic information as to the type of aircraft and its registered nationality. The first is that of a Royal Air Force Buccaneer (also known as the Blackburn Buccaneer, as it was originally produced by Blackburn Aircraft). It is believed to have crashed on the 29th July 1975 and is situated 4km offshore south of Kessingland Beach. Buccaneers were built in the late 1950s as a mid wing, twin engine monoplane with a tandum seated crew. It entered service in 1962 with the Fleet Air Arm and it was not until 1968 that they were adopted by the RAF, acquiring 46 in total from Blackburn's successor Hawker Siddeley. However, there had been crashes involving variations of the Buccaneer. One in particular, the Buccaneer S.1 had a turbine failure in mid air, after which the fleet of S.1 was grounded for good (Boot 1990).

7.6.3 The second recorded loss was that of an American Voodoo aircraft, of which there were many variations. Built by the massive air firm McDonnell, they were originally designed as bomber escorts for long-range missions, essentially for Cold War action, but were later modified as a Fighter Bomber capable of carrying a single nuclear weapon. This particular aircraft crashed in August 1961 less than a kilometre from the beach south of Dunwich near East Bridge.

7.6.4 The last aircraft is that of a Piper Comanche, used for pleasure and training, this crash site has been recorded 31km off the coast of Aldeburgh and is in the extreme south of the MAREA Study Area.

Recorded Losses

7.6.5 Of the 234 World War I sites and 537 World War II sites listed in the NMR within the MAREA Study Area, a total of 58 contained references to aircraft crash sites. These sites are illustrated in **Figure 37**. Of these aircraft losses, all but one has been identified as being lost during WWII. Of this total 17 are believed to be of German origin, with five Dorniers, seven Junkers, two Heinkels (one shot down off Lowestoft), two Messerschmitts and a single Folke Wulf. Four of these (one Dornier, one Heinkel, and two Junkers) have been recorded in licence dredging Area 454.

7.6.6 Of the British losses, 38 have been recorded. These included 24 Bombers, of heavy, light and ordinary design, 3 Fighter bombers lost in 1943, 13 Fighters (with three Spitfires: MK VB EP298, MK VB EP969 and MK WI PLA887) and a Reconnaissance Aircraft. Four of these losses have been identified as occurring within licence dredging Area 454 and a Wellington Bomber recorded as lost in licence dredging Area 251.

7.6.7 However, these are generic locations, and are indicative of general aircraft losses as opposed to specific identifiable locations. However, any aircraft wreckage subsequently discovered would be immediately protected under the PMRA.

7.6.8 Three unidentified aircraft were also identified within the MAREA Study Area inland, two of which have been excavated.

8 SITE SURVIVAL AND VISIBILITY

8.1 INTRODUCTION

8.1.1 In order to identify the impacts of existing and future dredging operations on the known and potential archaeological resource, the preservation of archaeological material and deposits within the MAREA Study Area is a prime consideration. Archaeological sites and material may be covered by metres of sediments which protect them or their preservation may be compromised by exposure. They may also be subject to human disturbance as a result of marine and seabed activities such as aggregate dredging.

8.2 PREHISTORIC ARCHAEOLOGY

8.2.1 The potential for prehistoric archaeological sites within the MAREA Study Area has already been discussed in this report (**Sections 5.4, 5.5 and 5.6**). However, the degree to which archaeological material can be expected to survive is a key consideration in the assessment of the submerged prehistoric archaeological potential within the MAREA Study Area. Since the earliest evidence for the occupation of the British mainland in *c.*970,000 BP, artefacts may have been deposited in sediments on the Continental shelf whenever the glacial ice sheets caused the floor of the North Sea to be dry and beyond the limits of the ice (Flemming 2006:6).

8.2.2 The critical period of survival for prehistoric archaeological material is the time when the surf zone starts to impact on the site, and the ensuing few hundred years as the sea level rises over the site (Flemming 2006:12). Favourable factors for the survival of prehistoric archaeological material *in situ* in the southern North Sea, outlined by Flemming (2006:12), are as follows:

- Very low beach gradient and offshore gradient so that wave action is attenuated and is constructional in the surf zone;
- Minimum fetch so that wave amplitude is minimum, wavelength is short, and wave action on the seabed is minimum;
- Original deposit to be embedded in peat or packed lagoonal deposits to give resistance and cohesion during marine transgression. Drowned forests and peat are good indicator environments;
- Where deposits are in a cave or rock shelter, roof falls, accumulated debris, concretions, breccia, conglomerate formation, indurated wind-blown sand, all help to secure archaeological strata;
- Local topography contains indentations, re-entrants, bays, rivers, estuaries, beach-bars, lagoons, near-shore islands, or other localised shelter from dominant wind fetch and currents at the time of transgression of the surf zone.

8.2.3 The factors listed above are those which promote the survival of the prehistoric archaeological resource *in situ.* The visibility of the archaeological resource is determined by further factors, outlined by Flemming (2006:13) and listed below:

- Low net modern sediment accumulation rate so that the artefacts are not too deeply buried;
- No fields of sand waves or megaripples over the site;
- A slight change in oceanographic conditions so that the site is being gently eroded to expose deposits, permitting their discovery.

8.2.4 There are a number of prospective locations within the MAREA Study Area that may be considered to have favourable site survival and visibility for prehistoric archaeological material. Recorded sites of retrieved prehistoric artefacts in the North Sea are predominantly discovered in some form of depression or low ground, where scour has removed the overlying mobile marine sands (Flemming 2006:18). The depressions and gulleys between the sandbank of the coast particularly to the northern and eastern areas of the MAREA Study Area may provide an environment potentially favourable for prehistoric site survival and visibility.

8.2.5 Prehistoric site survival is also expected to occur within the relict channels (predominantly associated with estuarine sediments) and lagoonal deposits of the Brown Bank Formation within the MAREA Study Area. The majority of features of potential archaeological interest were associated with these types of sediments. The hand axes recovered from Area 240 also indicate that there is the potential for survival, which may be exposed during dredging operations.

8.2.6 The potential also exists for the survival of palaeoenvironmental remains within peat or alluvial deposits. These are mostly associated with nearshore/coastal areas, but as identified in the geophysics data, channel deposits and peats are also located in some current aggregate areas.

8.2.7 The visibility of such remains may be considered in terms of the methods adopted by geophysical and geotechnical surveys in order to identify such deposits, outlined in **Section 5.4**.

8.2.8 Although this report is primarily concerned with marine and offshore areas, the coastal areas adjacent to the MAREA Study Area have a high potential for the survival and visibility of the prehistoric archaeological resource. There is the potential for artefacts to erode out of modern coastlines, such as that in Happisburgh and Pakefield, where the present-day coastline is continuously being extensively eroded revealing underlying depoits containing the earliest evidence of occupation in Britain. Coastal sediments adjacent to the MAREA Study Area, comprising mudflats, marshes and wetlands, also have a high potential for prehistoric site survival and visibility.

8.3 MARITIME ARCHAEOLOGY

8.3.1 The ALSF *Navigational Hazards* project (Bournemouth University 2007) attempted to identify areas where a high potential for ship loss coincided with a high potential for preservation of archaeological materials. These areas were referred to as Areas of Maritime Archaeological Potential (AMAPs), and it is with reference to these that the survival and visibility of maritime sites within the MAREA Study Area will be considered.

8.3.2 The results of the *Navigational Hazards* project showed a general higher potential for the loss and preservation of vessels on approaches to estuaries inshore and shallow fine-grained sandbanks offshore (Bournemouth University 2007:33). The nearshore sandbanks off the East Coast were highlighted as an AMAPs in which these trends coincided.

8.3.3 The coastal character of the MAREA Study Area is that of an exposed coast with numerous offshore sandbanks which run parallel to one another in a northwest-southeast direction in the north of the MAREA Study Area and more north–south orientated in the south of the MAREA Study Area. The sandbanks mostly lie at a moderate depth of between 10-20m, causing little risk to smaller vessels, but representing a considerable risk to larger vessels, particularly in bad weather. (Bournemouth University 2007:37).

8.3.4 The survival of shipwrecks or maritime structures depends largely on whether they come to lie on or within the seabed sediments (Gregory 2006:8). Structures which lie exposed within the seawater are at risk of being deteriorated by wood boring or saprotophic organisms (Gregory 2006:8). Those which are engulfed or covered by sediments experience a much slower rate of deterioration due to the absence of dissolved oxygen (Gregory 2006:8).

8.3.5 The sediment types which contain a higher proportion of finer grained sediments and a lower proportion of coarser grains offer the best preservation for archaeological material on the seabed (Gregory 2006:14-15). This is partly due to the fact that such sediments tend to have lower bearing capabilities and thus engulf archaeological material more readily (Gregory 2006:15). Finer grained sediments are also quite mobile and will more easily cover archaeological material, although the obvious drawback of this is that such sediments may be more easily transported away from a site leaving it exposed (Gregory 2006:15). The penetration of oxygen is much lower in finer grained deposits such as sand which also contributes to the preservation of archaeological material (Riedl and Ott 1982).

8.3.6 The seabed within the MAREA Study Area is predominantly characterised by sands and gravels between the sandbanks. The predominance of fine grained sediments suggests that the MAREA Study Area thus has a high potential for the preservation of archaeological material, although this may be counteracted to a degree by the mobile nature of the sandbanks (Bournemouth University 2007:37).

8.3.7 The visibility of the maritime archaeological resource predominantly relies on the ability for individual sites to be identified in geophysical and hydrographical surveys, particularly with regards to side scan sonar and magnetometer surveys. The visibility of such sites thus depends on the survival of individual wreck sites and their related material on the seabed, the degree to which they are buried beneath sediment and their construction material.

8.4 AVIATION ARCHAEOLOGY

8.4.1 With regards to aircraft crash sites within the MAREA Study Area, site survival and visibility is determined largely by the cause of loss of the aircraft. With a few exceptions, aircraft come to be on the seabed as a result of an in-flight accident or enemy action. Those aircraft which are on the seabed as a result of controlled ditching are likely to be much better preserved than those which exploded in mid-air or hit the water at speed, which are likely to be highly fragmented and widely dispersed.

8.4.2 The factors which determine the survival of an aircraft crash site are not yet fully understood. It is, however, recognised that marine environments generally offer favourable conditions for the preservation of artefacts, enhancing the potential for the survival of aircraft crash sites on the seabed.

8.4.3 The seabed sediments within the MAREA Study Area as discussed in **Section 8.3** with regards to the survival of the maritime resource would similarly promote the survival of aircraft crash sites. As with wreck sites, the visibility of aircraft crash sites predominantly relies on their ability to be identified by geophysical survey.

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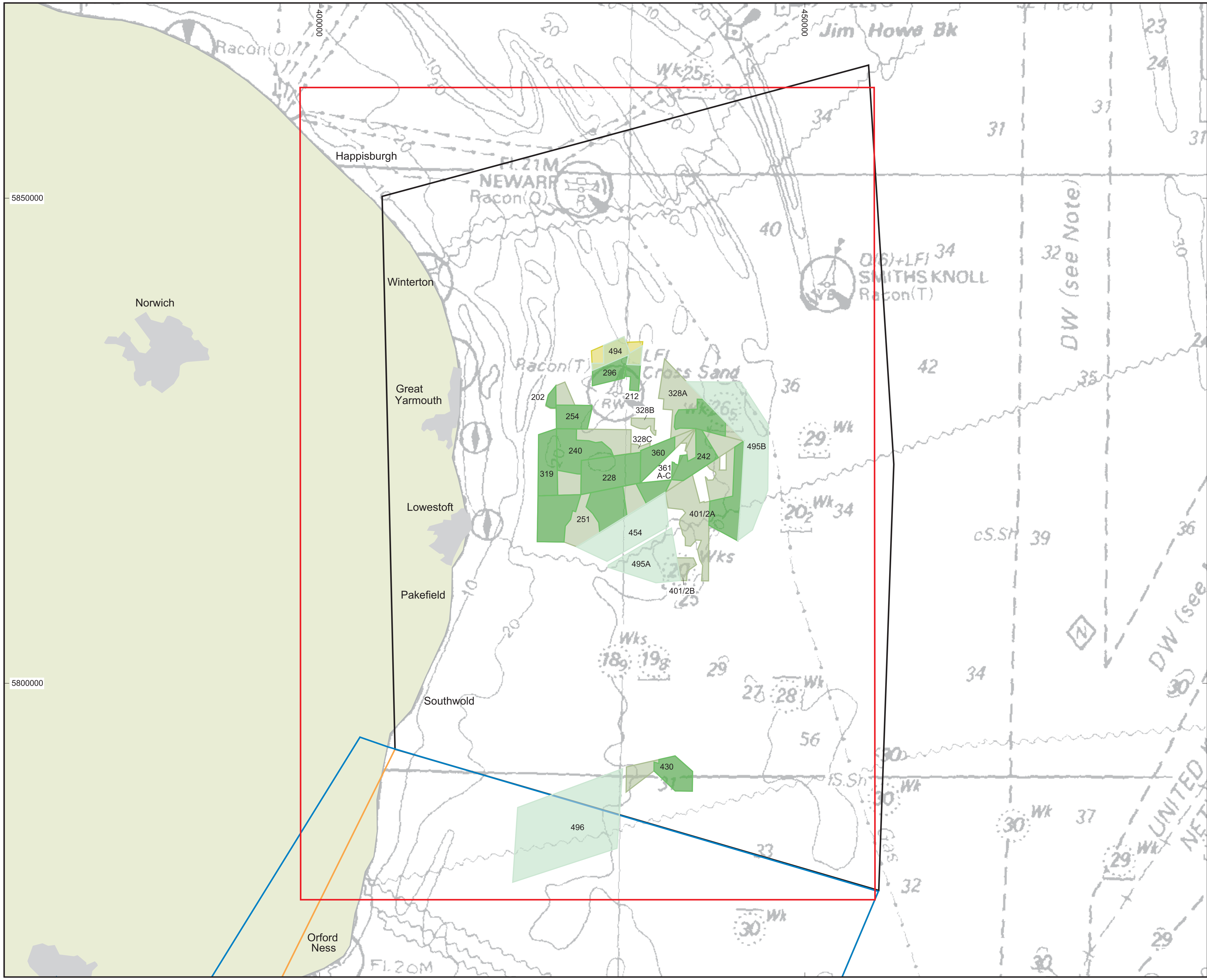

Study Area
East Coast REC Study Area
TEDA Study Area
Thames REC Study Area
Active Dredging Area
Licenced Dredging Area
Dredging Licence Application Area
Prospecting Licence Area

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Drawing projection UTM WGS84 z31N
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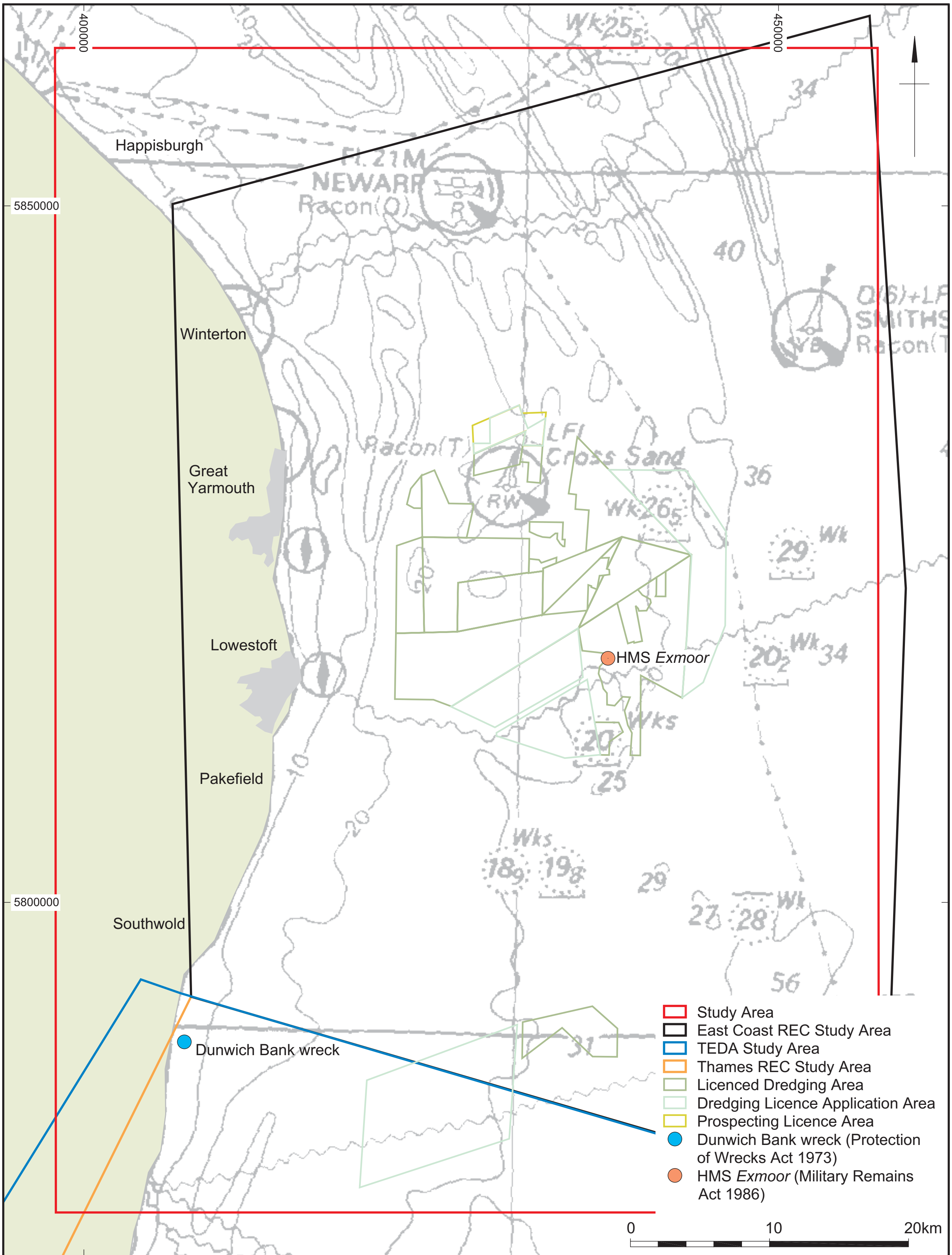
MAREA Study Area location map

Figure 1



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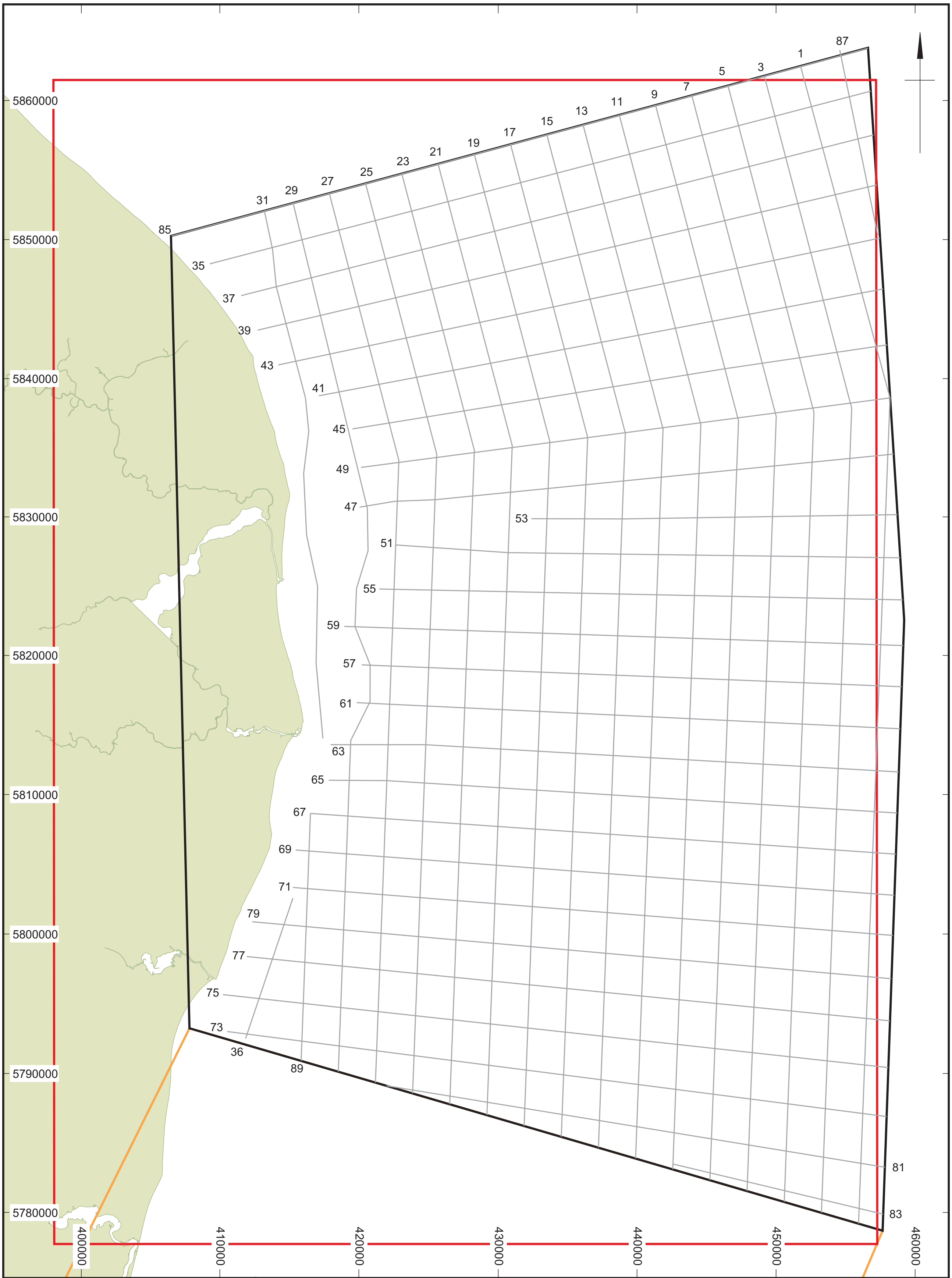
Maritime historic environment protected sites

Figure 2



- Study Area
- East Coast REC Study Area
- Thames REC Study Area
- Geophysics line plan

0 10km

Wessex Archaeology

Drawing projection: UTM WGS84 z31N

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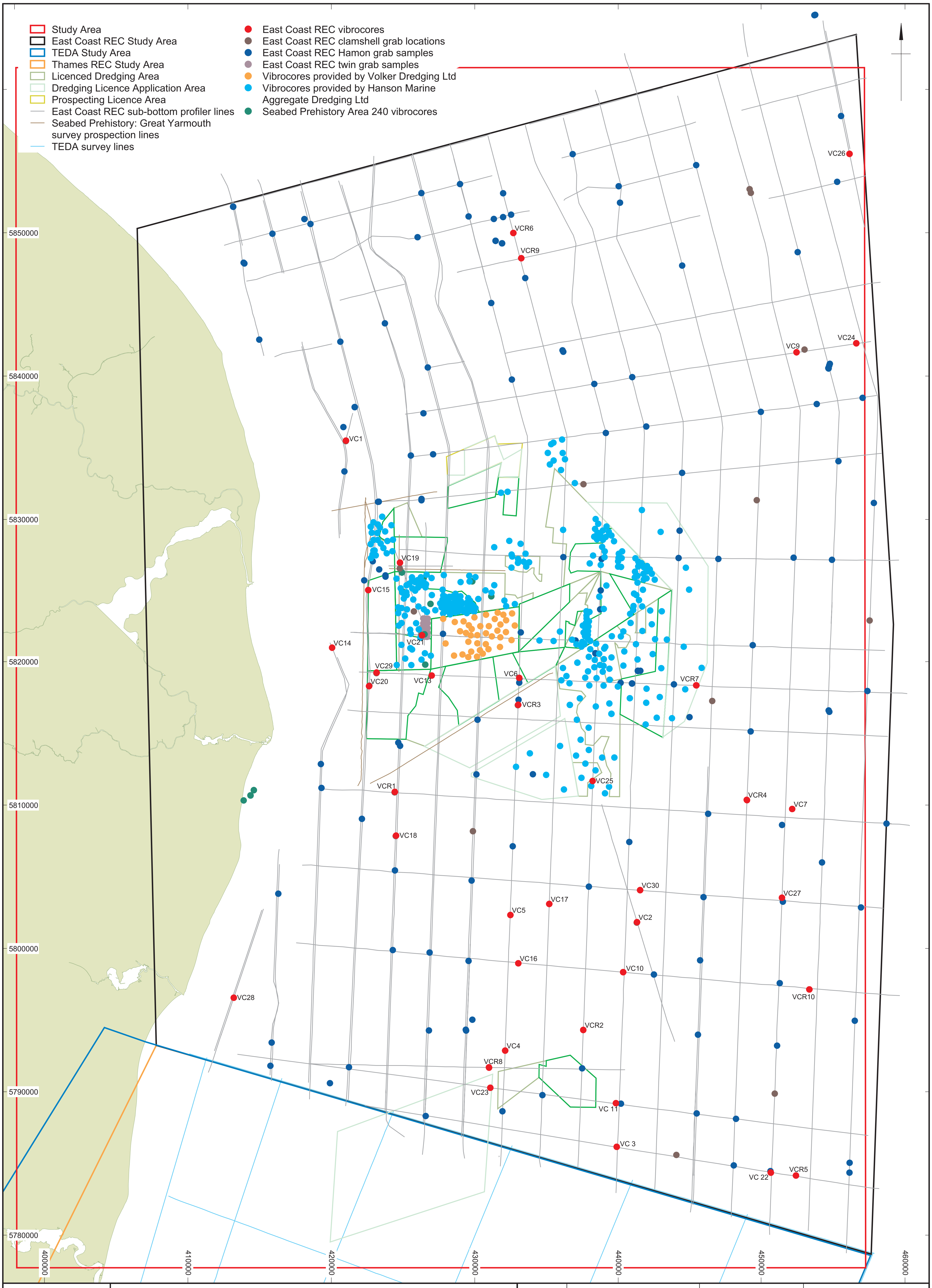
East Coast REC geophysics line plan

Figure 3



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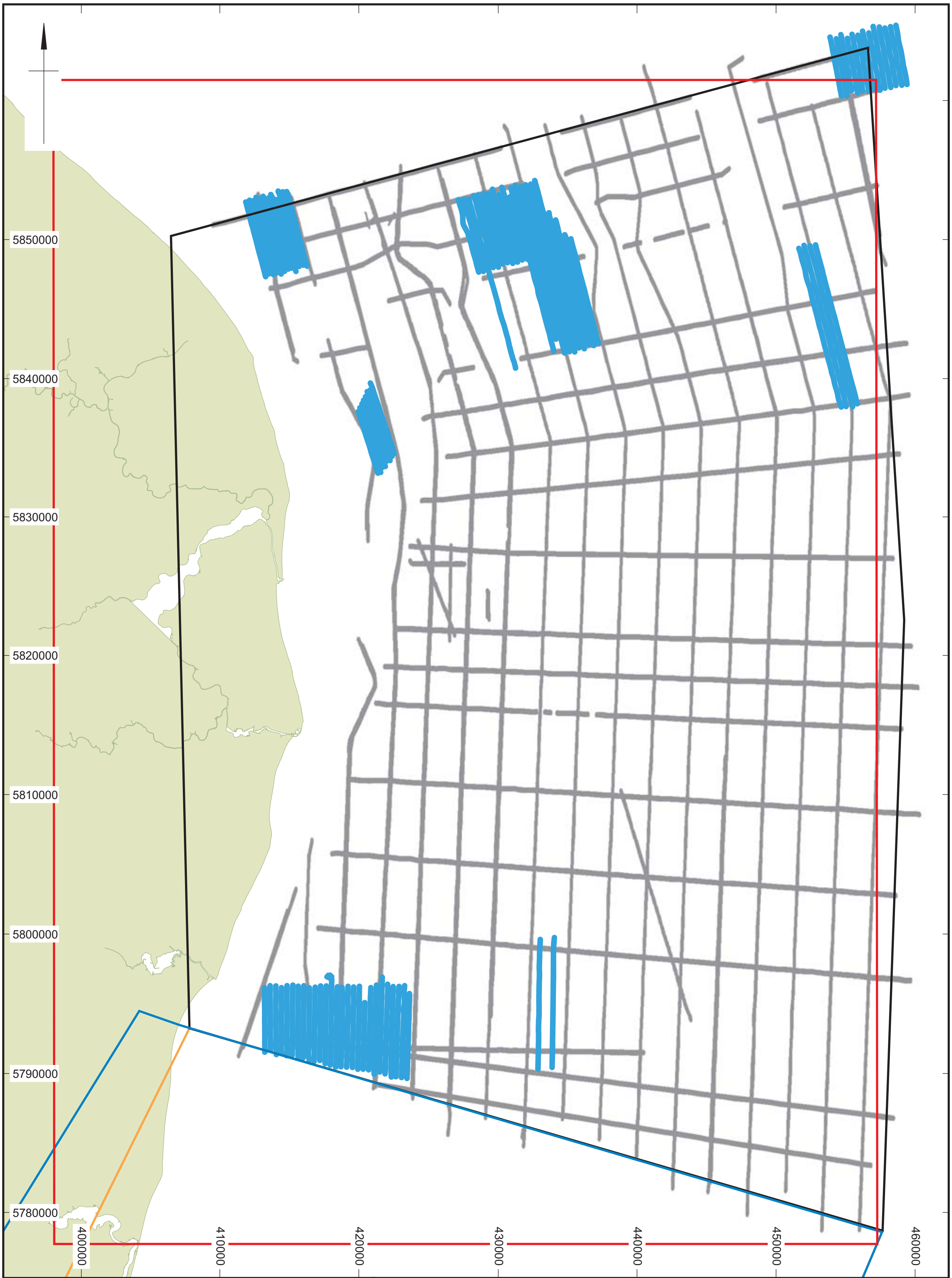
Geophysical (sub-bottom profiler) trackplot and geotechnical data

Figure 4



Study Area
East Coast REC Study Area
TEDA Study Area
Thames REC Study Area
Geophysical survey SSS coverage
Groundtruthing survey SSS coverage

Wessex Archaeology

0 10km

Drawing projection: UTM WGS84 z31N

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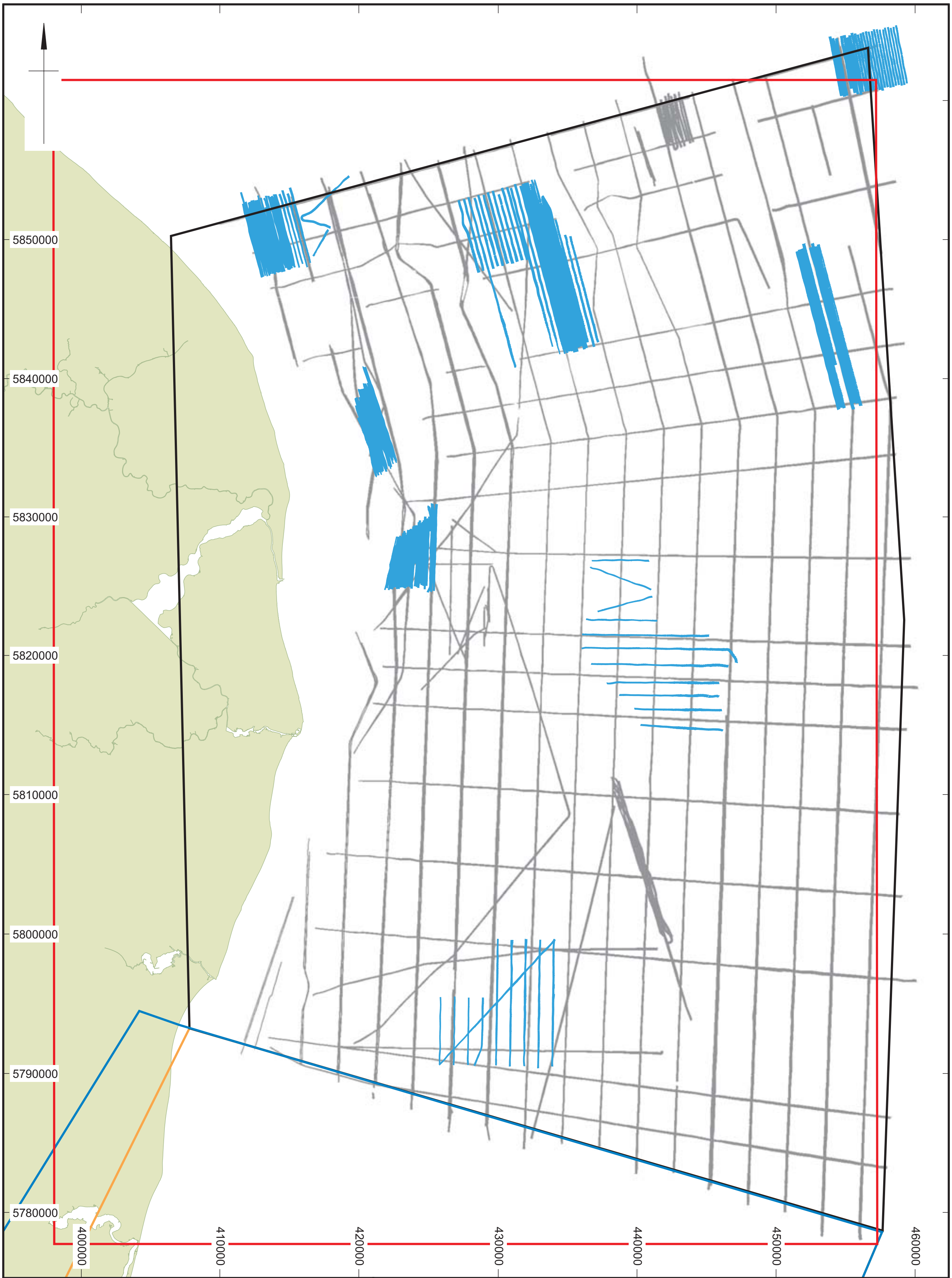
Geophysical (sidescan sonar) data coverage

Figure 5



- Study Area
- East Coast REC Study Area
- TEDA Study Area
- Thames REC Study Area
- Geophysical survey multibeam coverage
- Groundtruthing survey multibeam coverage

Wessex Archaeology

0 10km

Drawing projection: UTM WGS84 z31N

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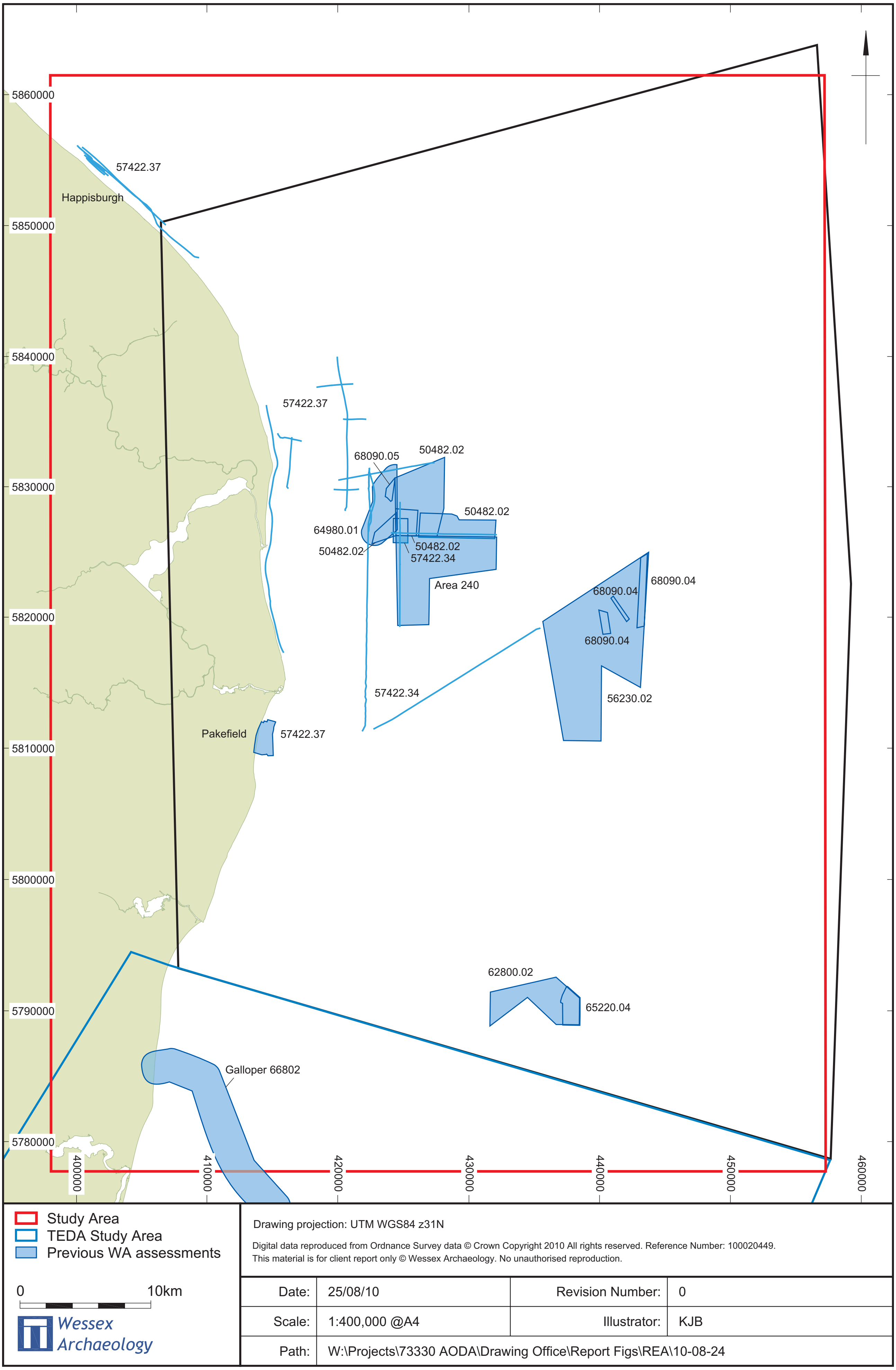
Geophysical (multibeam echosounder) data coverage

Figure 6



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Previous assessments undertaken by Wessex Archaeology in the MAREA Study Area

Figure 7

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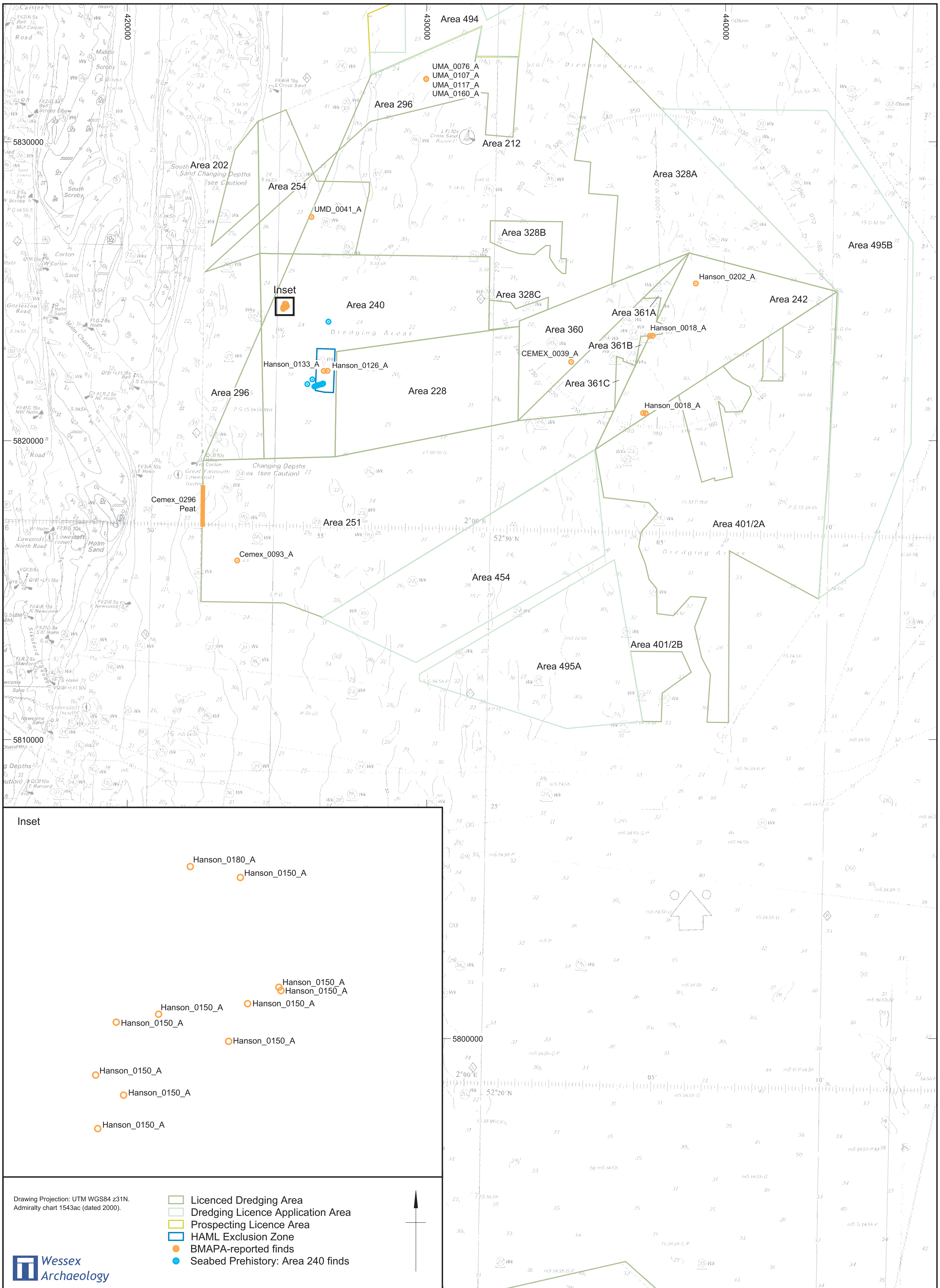
Wessex Archaeology

Known prehistoric sites

Figure 8



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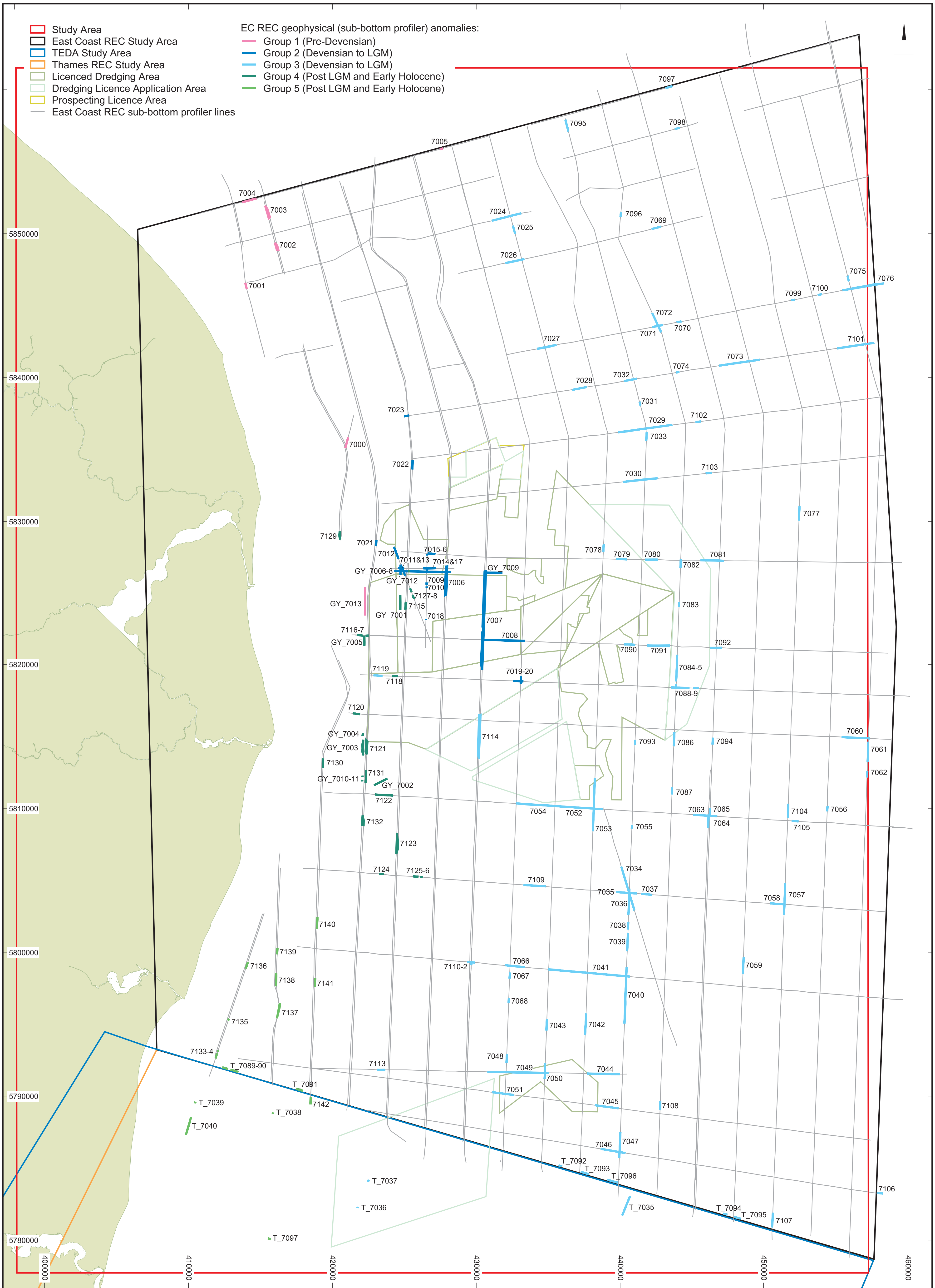
Prehistoric finds within the offshore area (BMAPA)

Figure 9



0 10km

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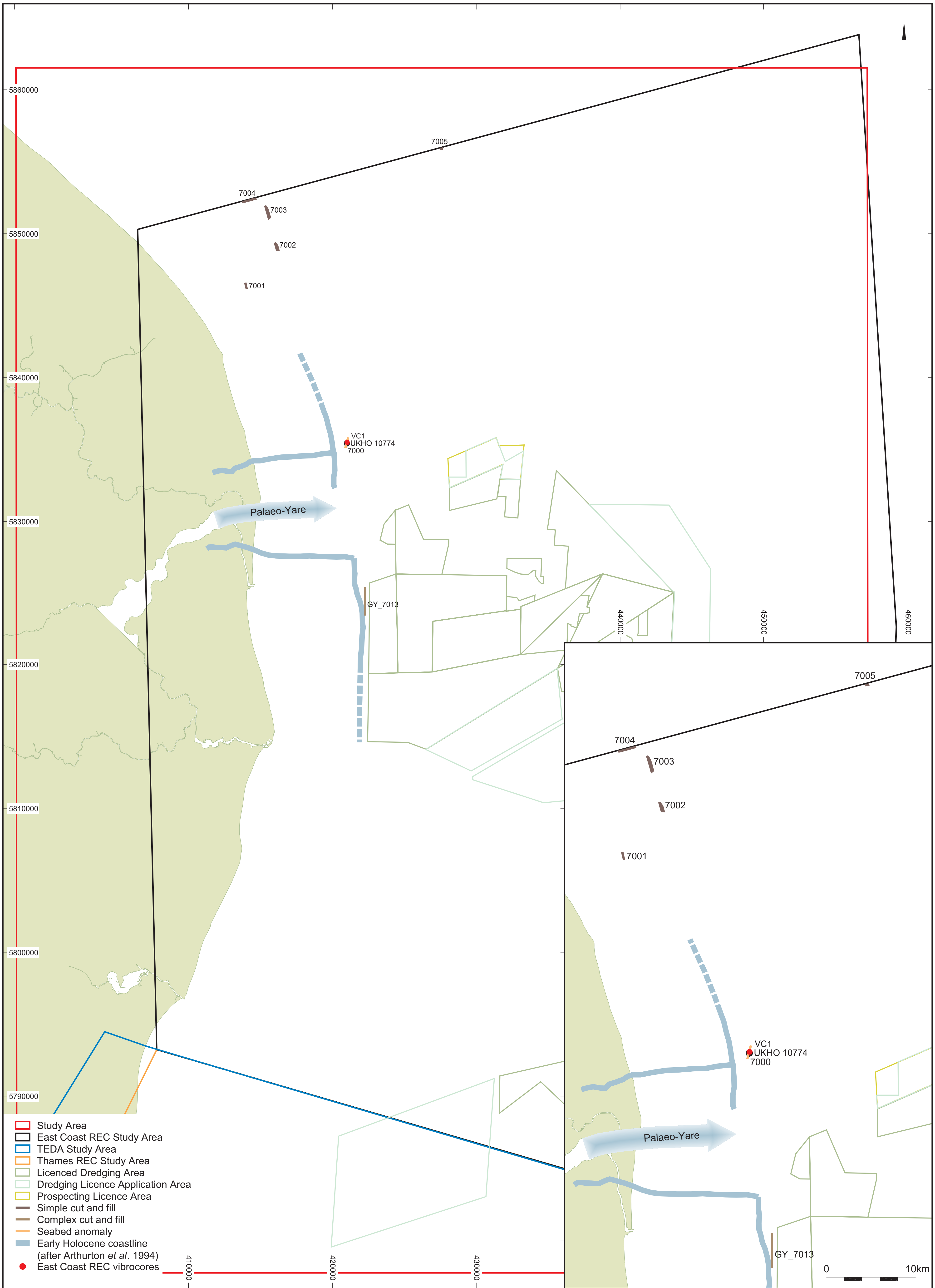
Geophysical (sub-bottom profiler) anomalies according to group

Figure 10



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0 10km

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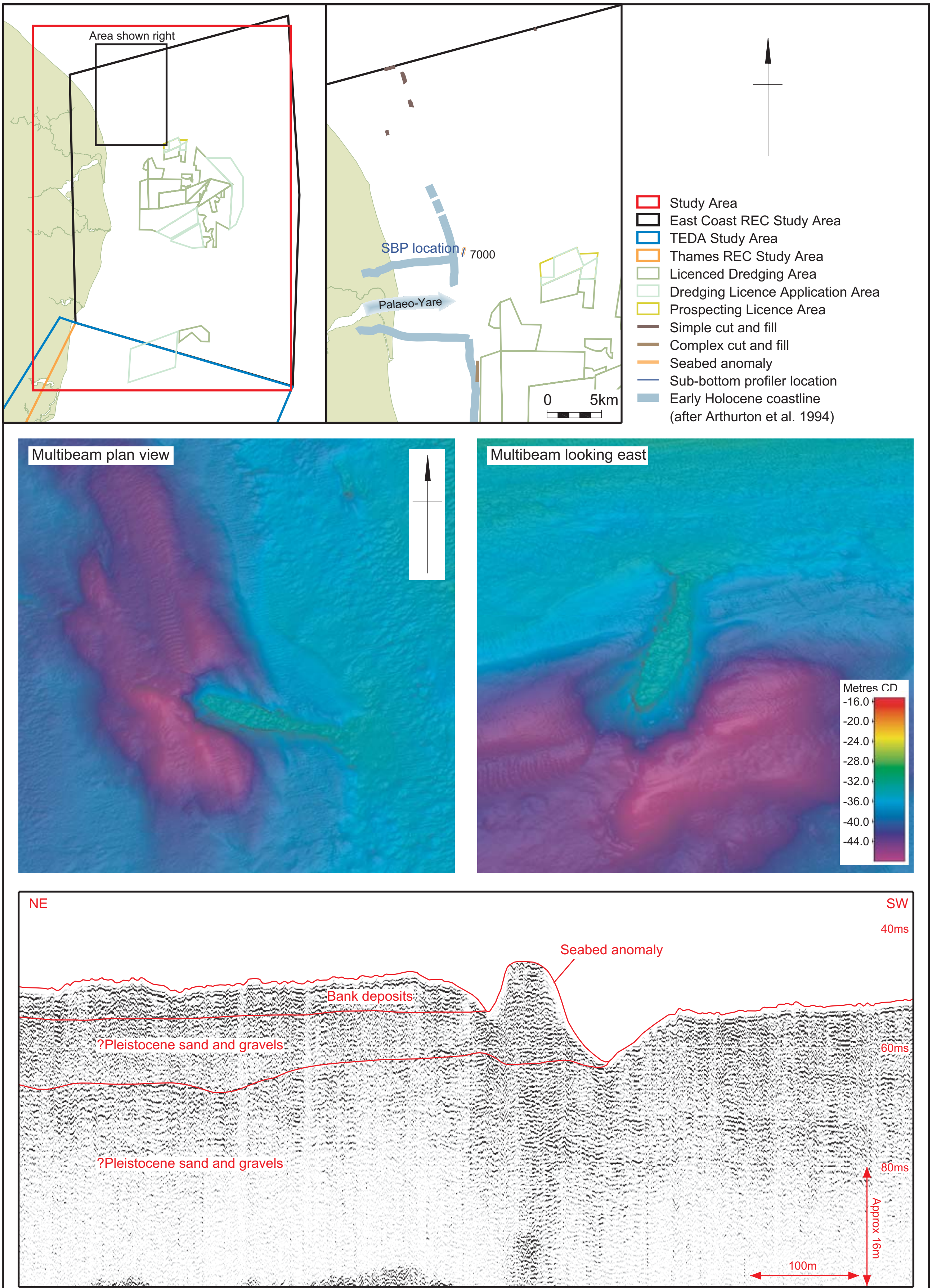
Group 1 (Pre-Devensian) geophysical (sub-bottom profiler) anomalies

Figure 11



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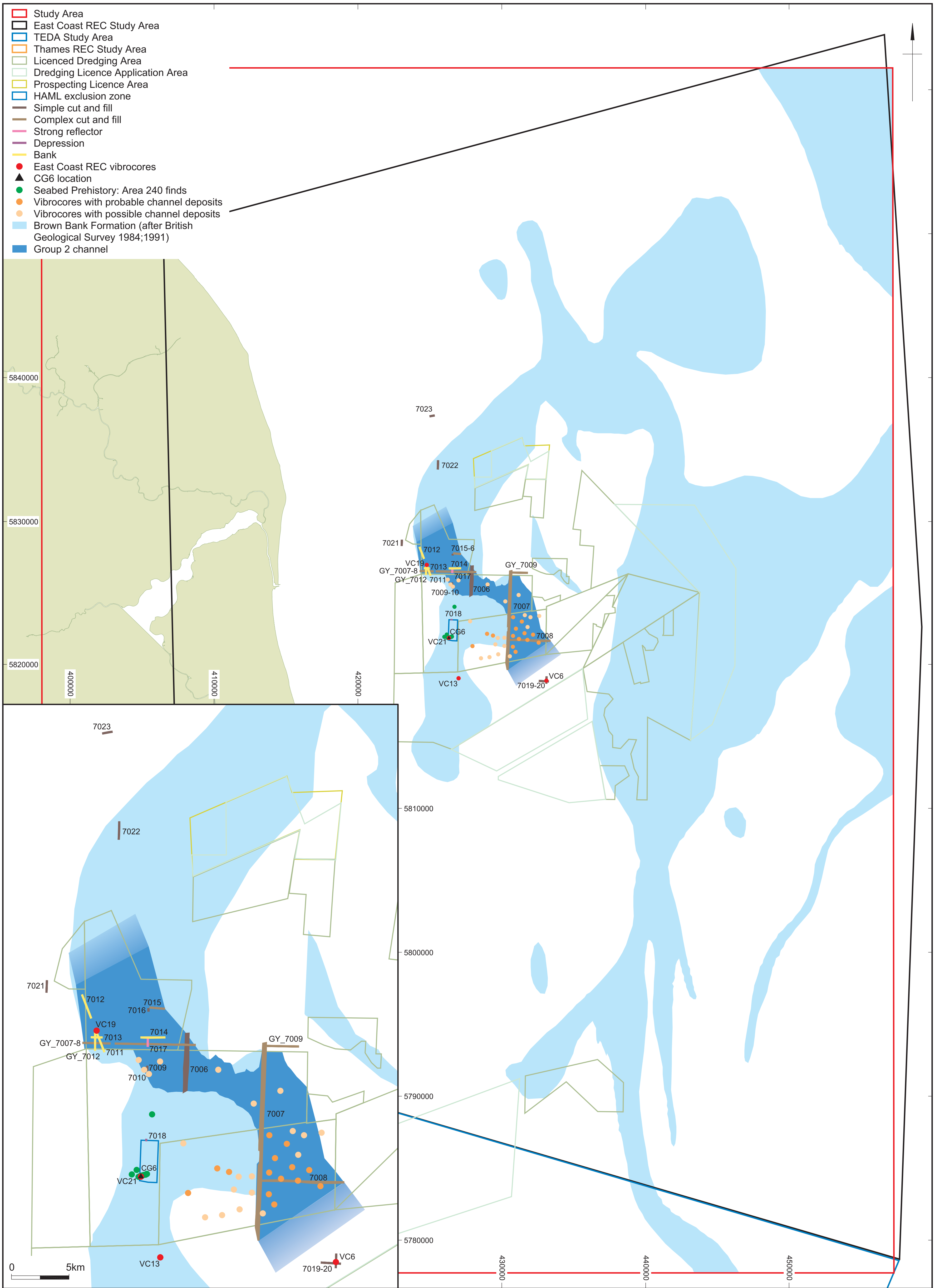
Wessex Archaeology

Group 1 (Pre-Devensian) anomaly: Seabed anomaly (7000)

Figure 12



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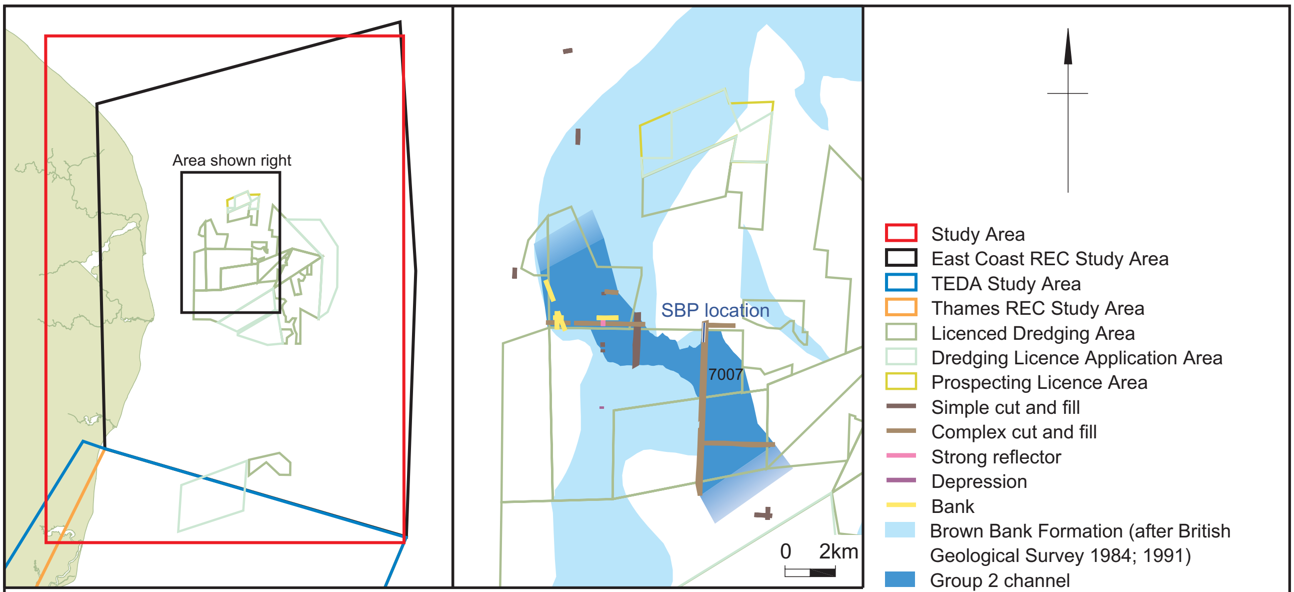
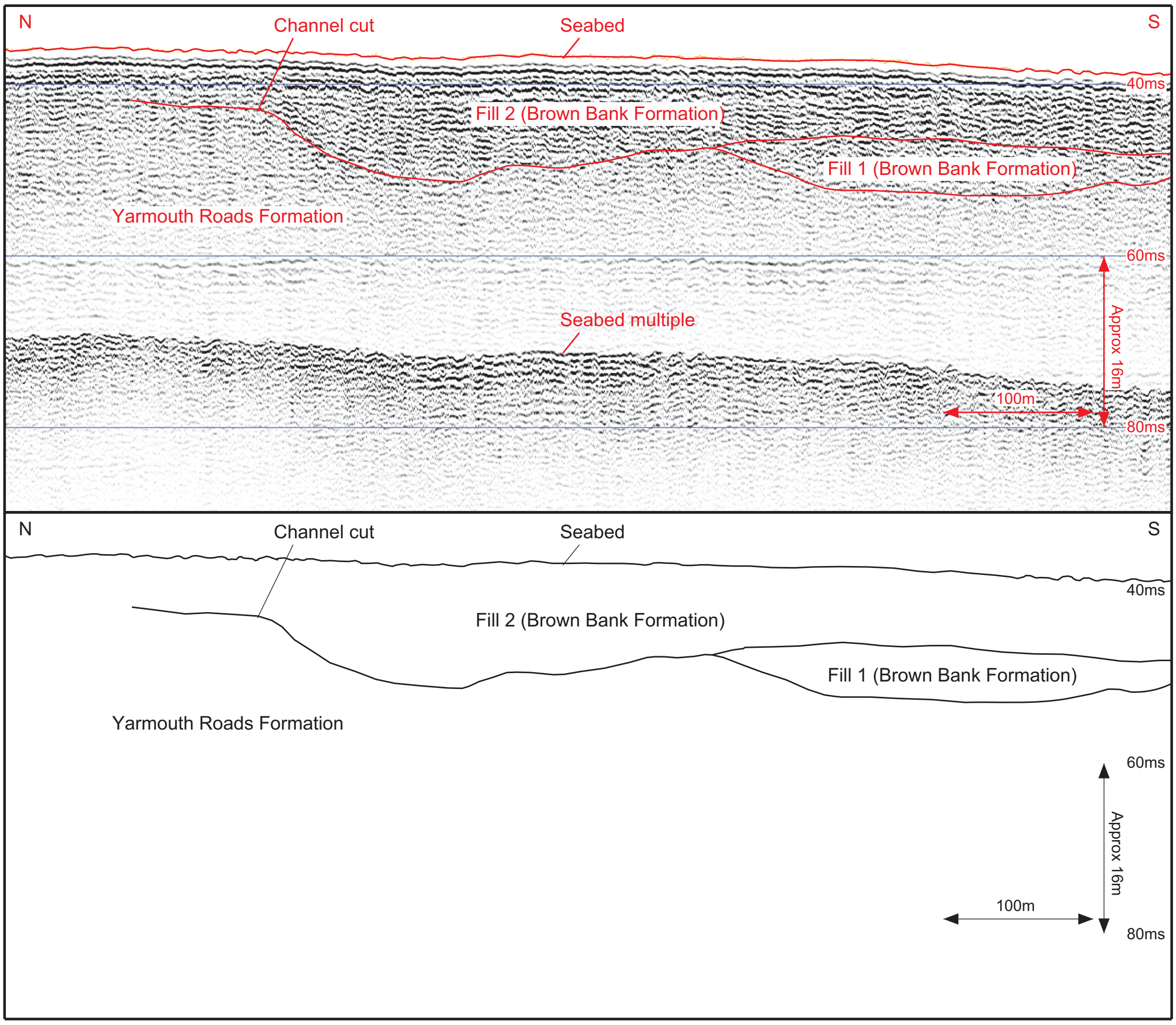
Group 2 (Devensian to LGM) geophysical (sub-bottom profiler) anomalies

Figure 13





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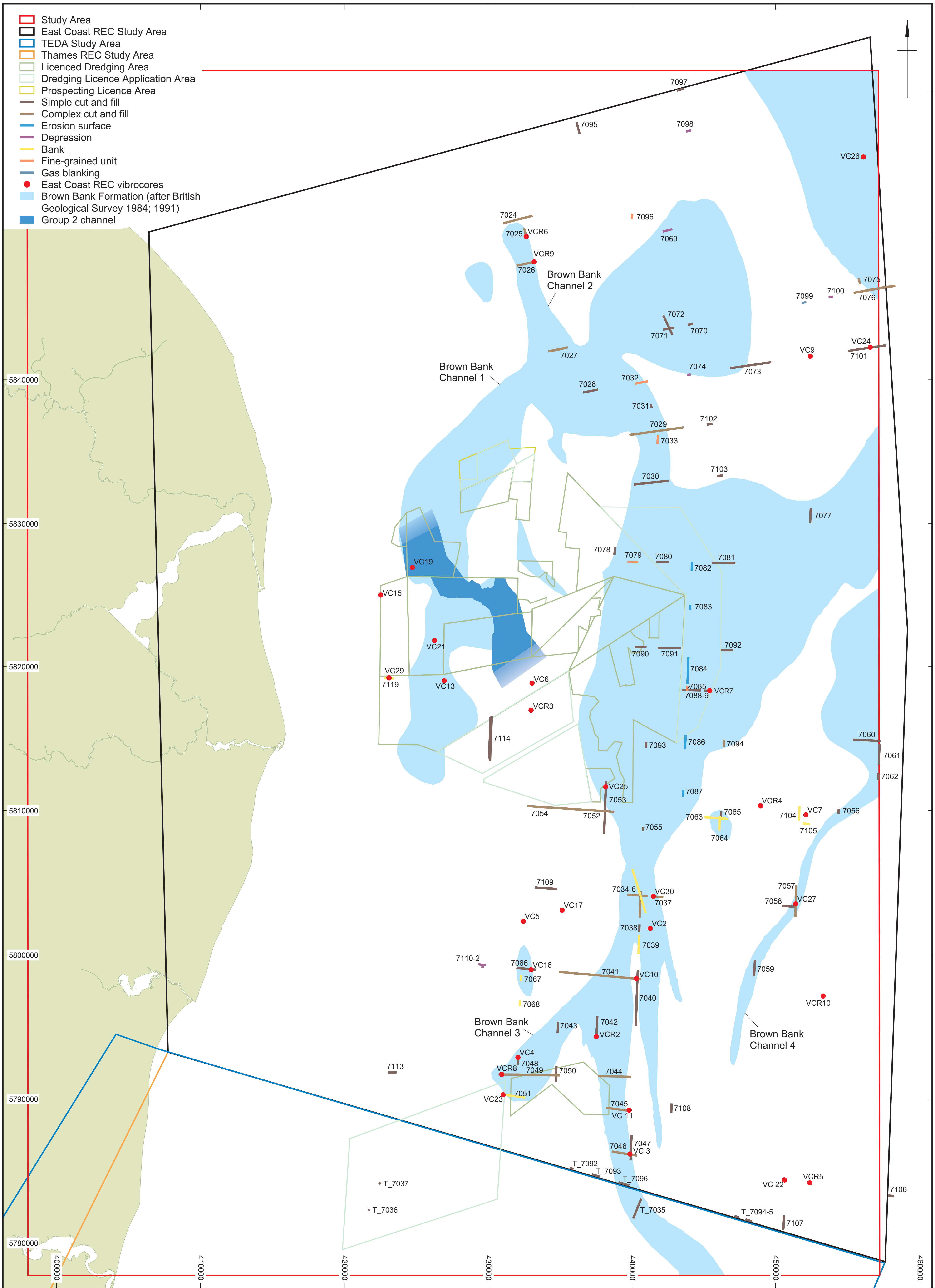
Group 2 (Devensian to LGM) anomaly: Complex cut and fill (7007)

Figure 14



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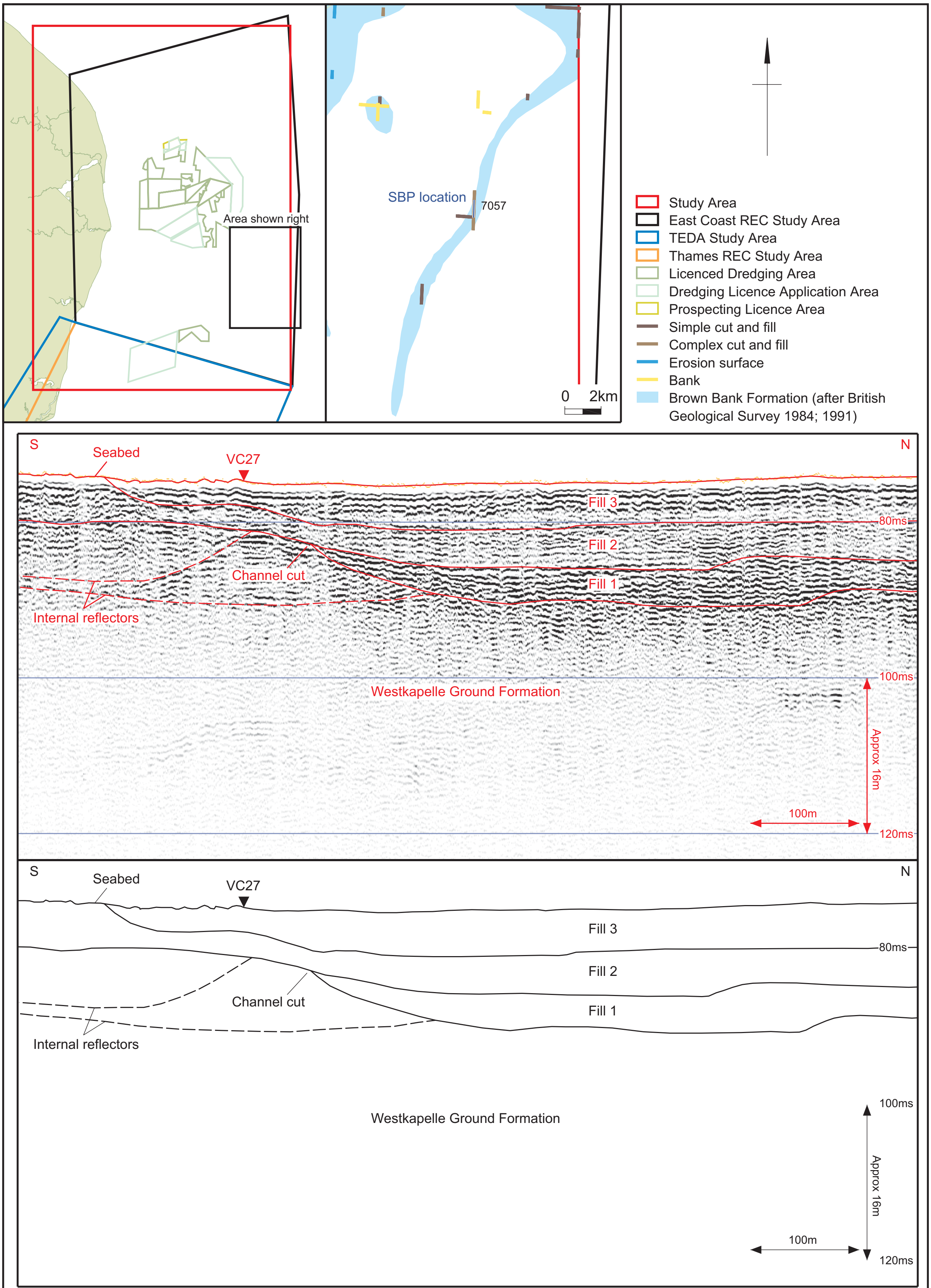
Group 3 (Devensian to LGM) geophysical (sub-bottom profiler) anomalies

Figure 15



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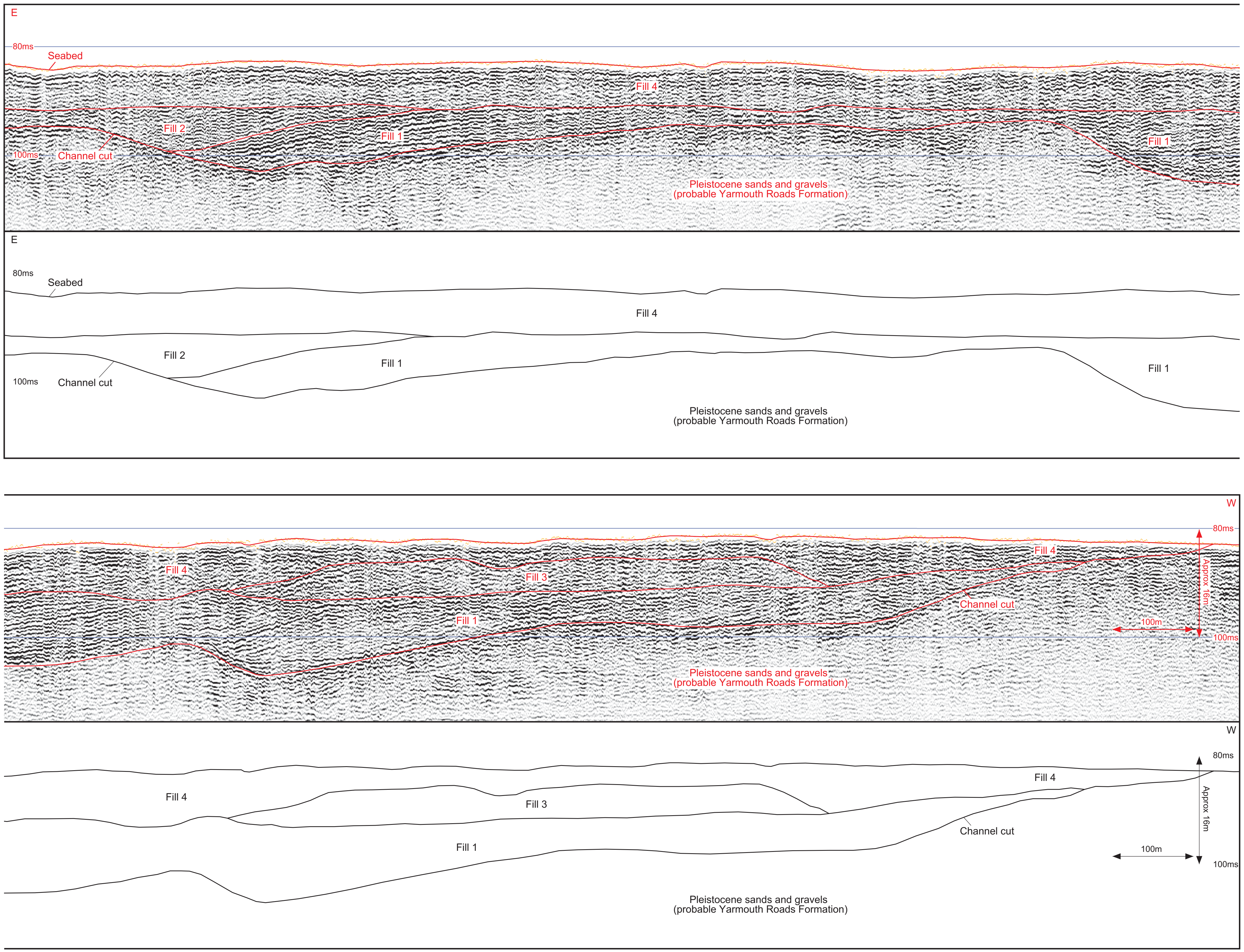
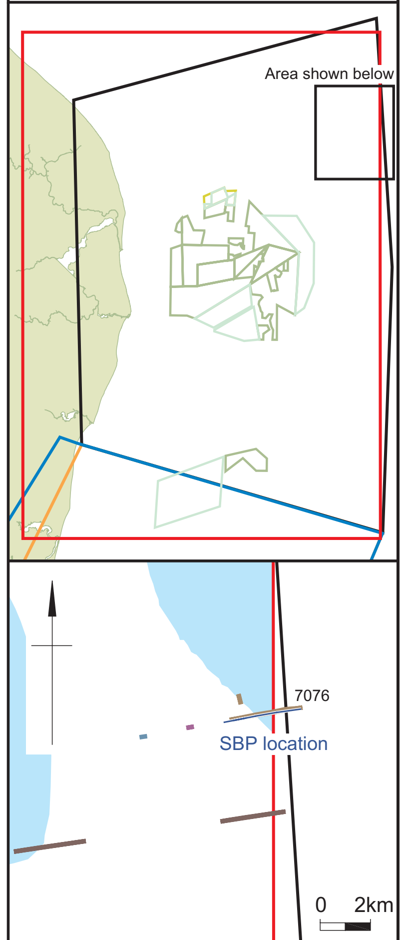
Wessex Archaeology

Group 3 (Devensian to LGM) anomaly: Complex cut and fill (7057)

Figure 16



Wessex Archaeology



- Study Area
- East Coast REC Study Area
- TEDA Study Area
- Thames REC Study Area
- Licenced Dredging Area
- Dredging Licence Application Area
- Prospecting Licence Area
- Simple cut and fill
- Complex cut and fill
- Depression
- Gas blanking
- Brown Bank Formation (after British Geological Survey 1984; 1991)

Drawing projection: UTM WGS84 z31N

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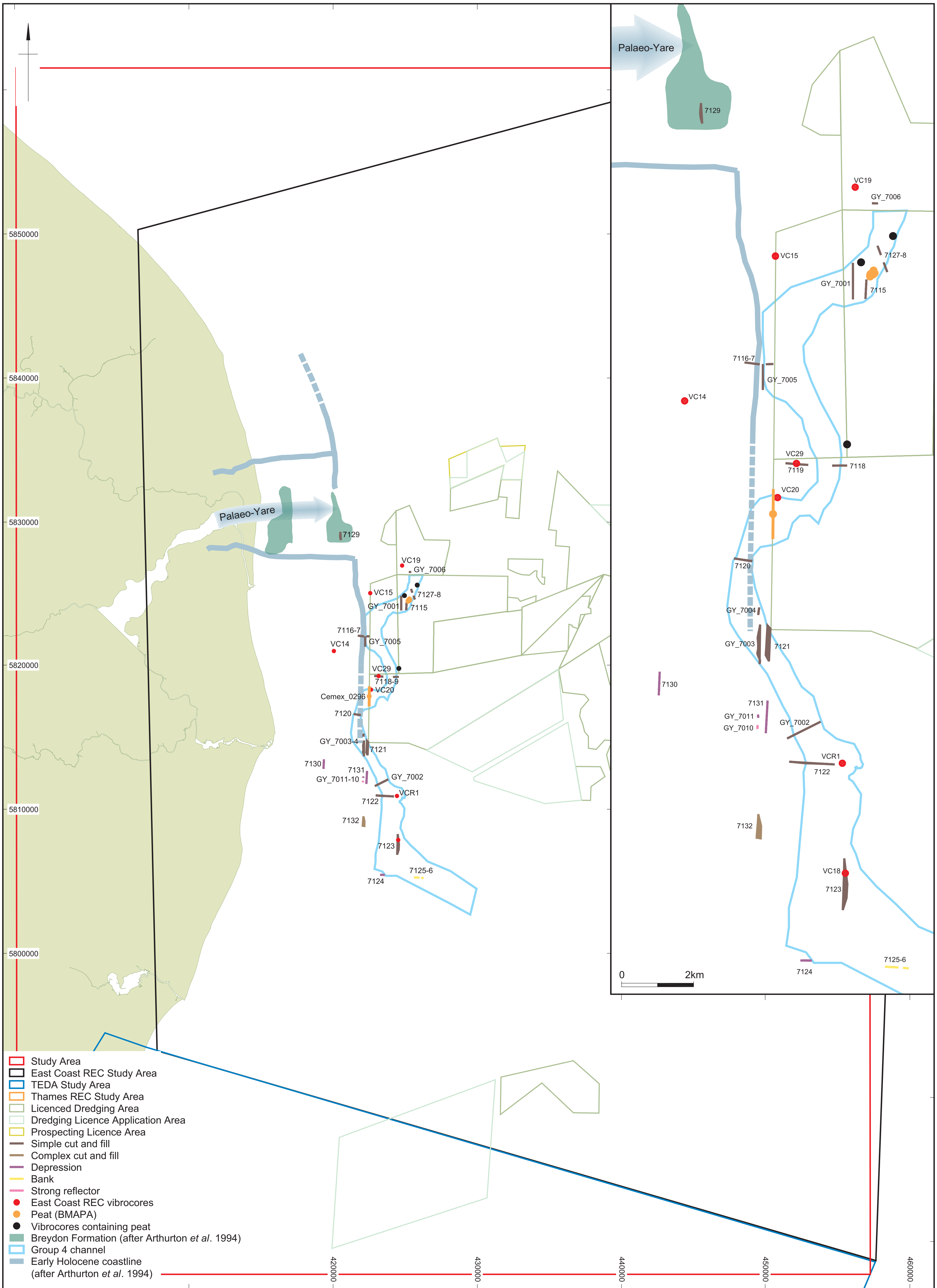
Group 3 (Devensian to LGM) anomaly: Complex cut and fill (7076)

Figure 17



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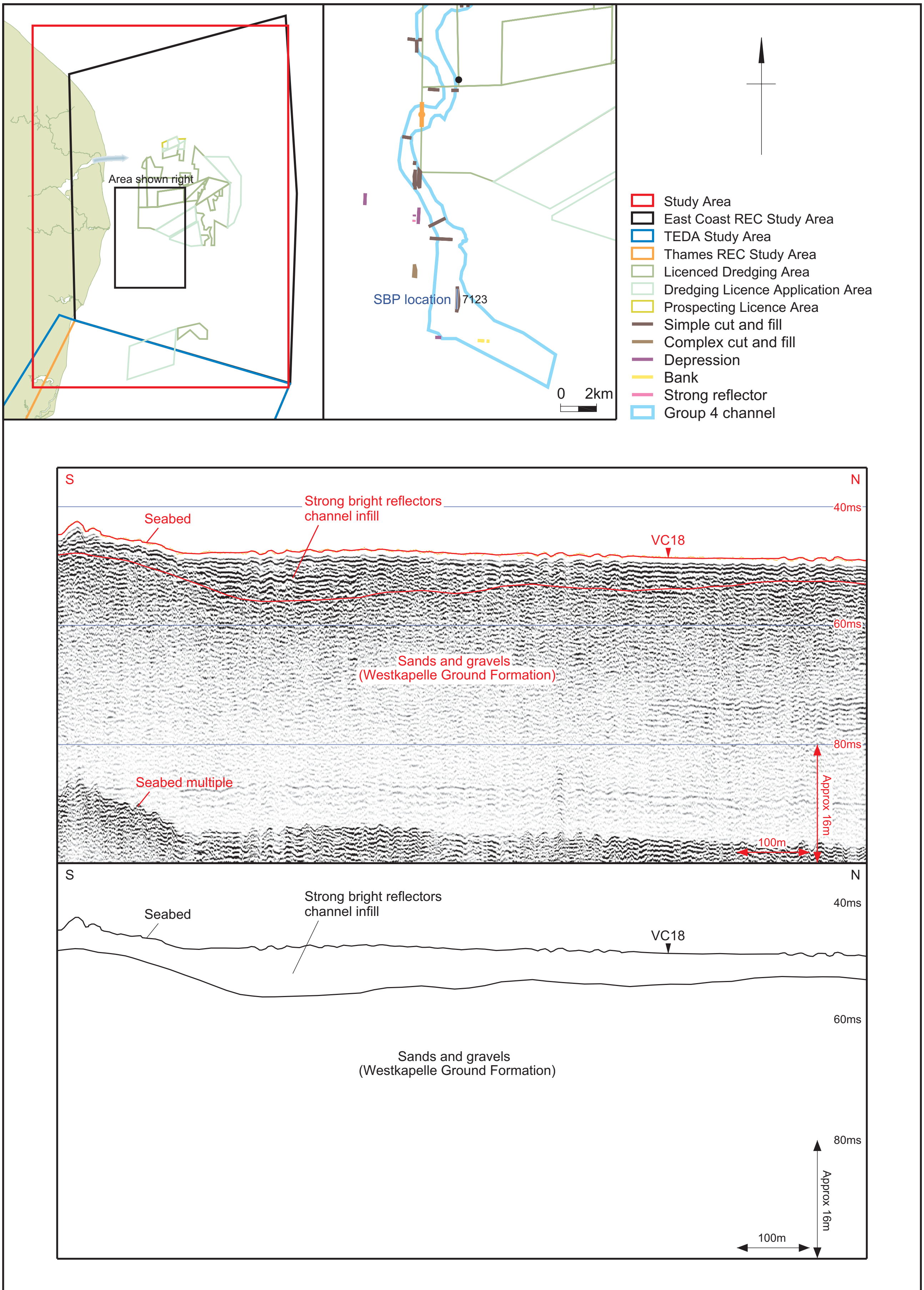
Group 4 (Post LGM) geophysical (sub-bottom profiler) anomalies

Figure 18



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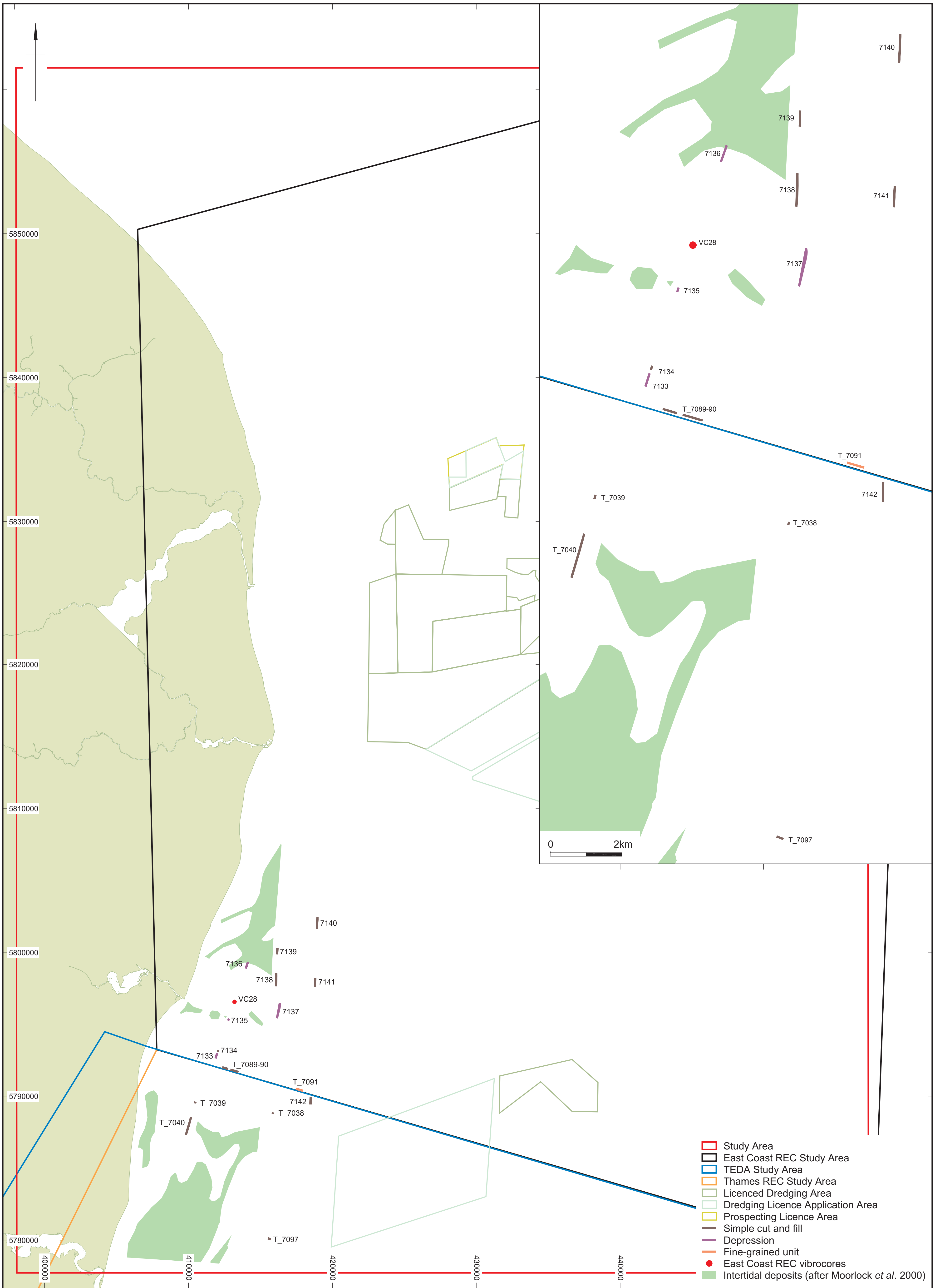
Group 4 (Post LGM) anomaly: Simple cut and fill (7123)

Figure 19



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Drawing projection: UTM WGS84 z31N

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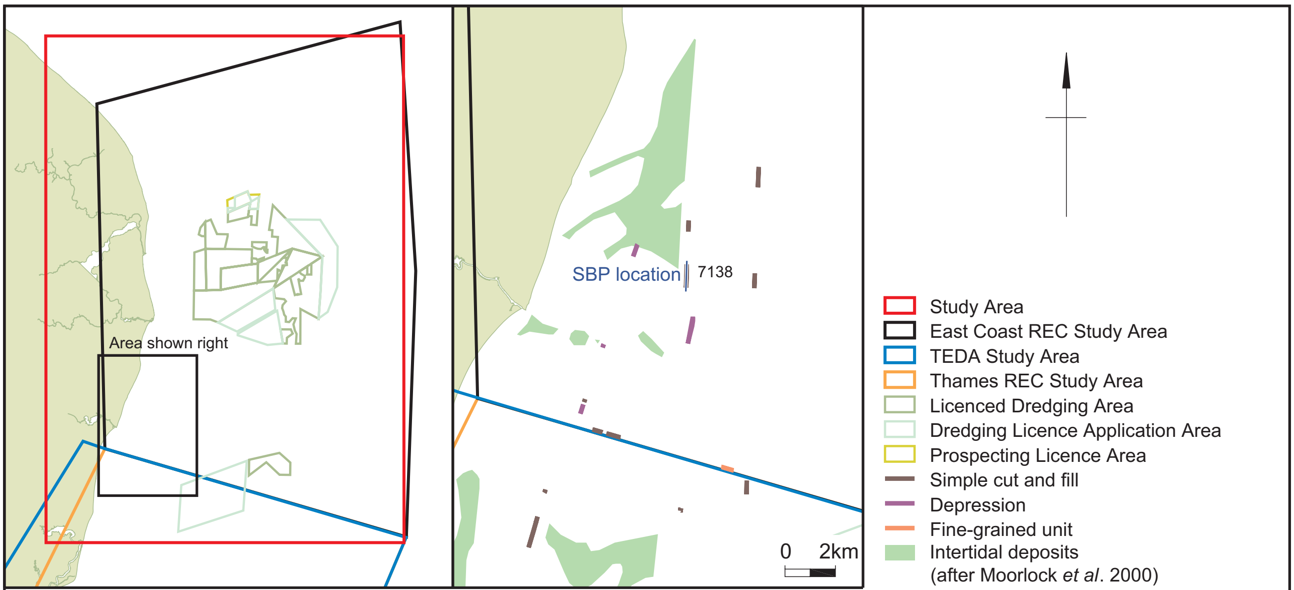
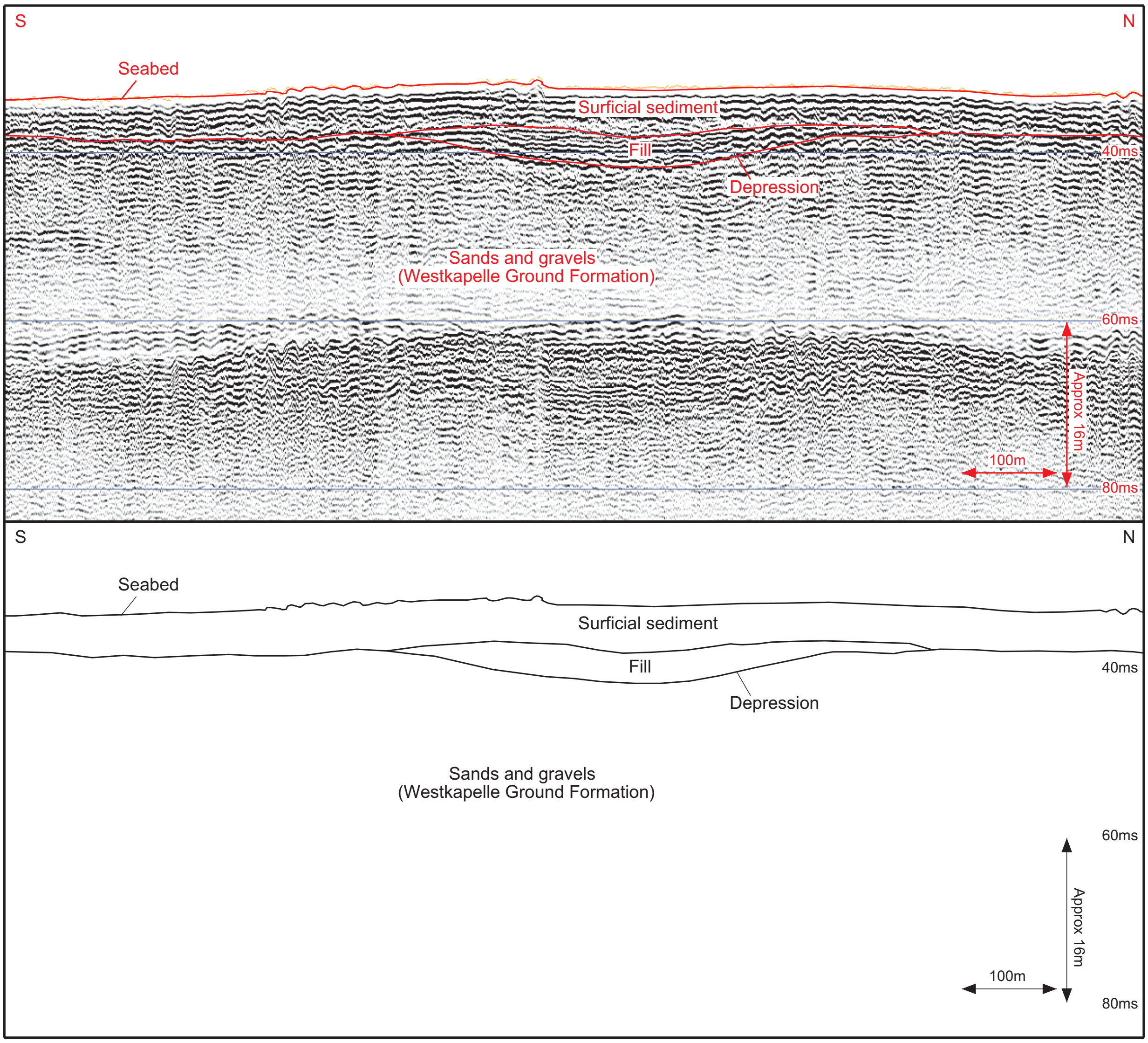
Group 5 (Post LGM) geophysical (sub-bottom profiler) anomalies

Figure 20





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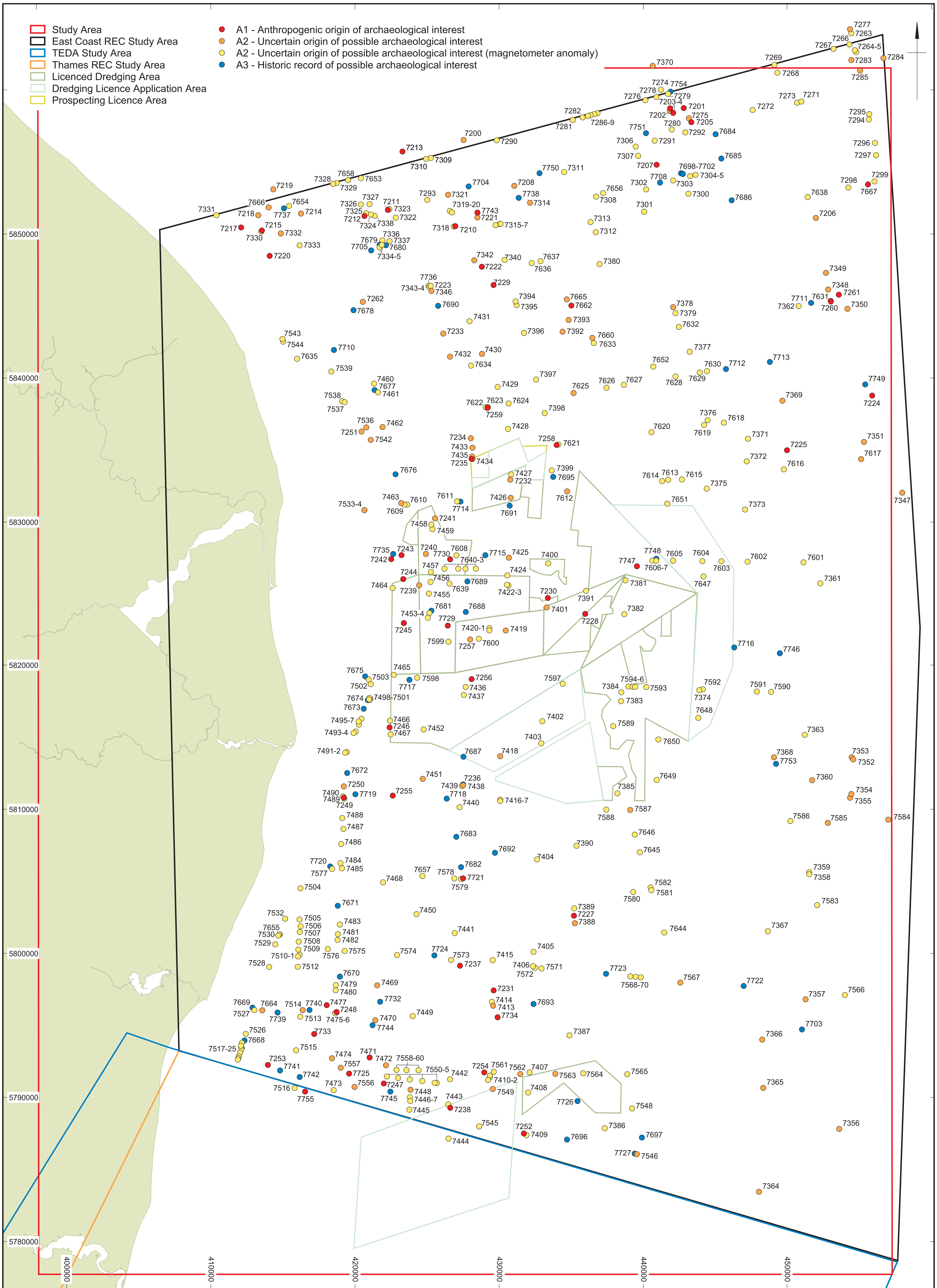
Wessex Archaeology

Group 5 (Post LGM) anomaly: Simple cut and fill (7138)

Figure 21



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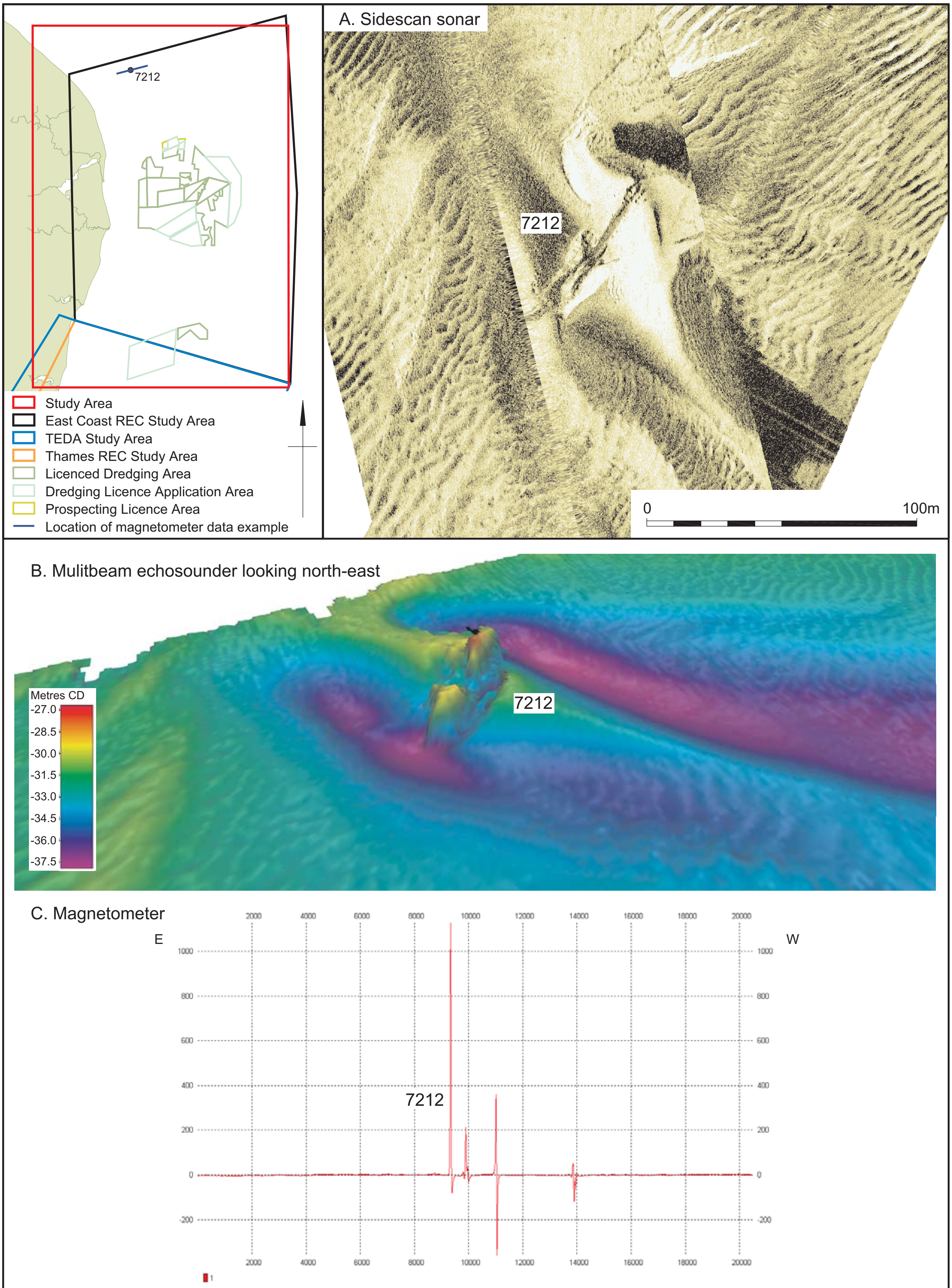
Geophysical anomalies (seabed features)

Figure 22



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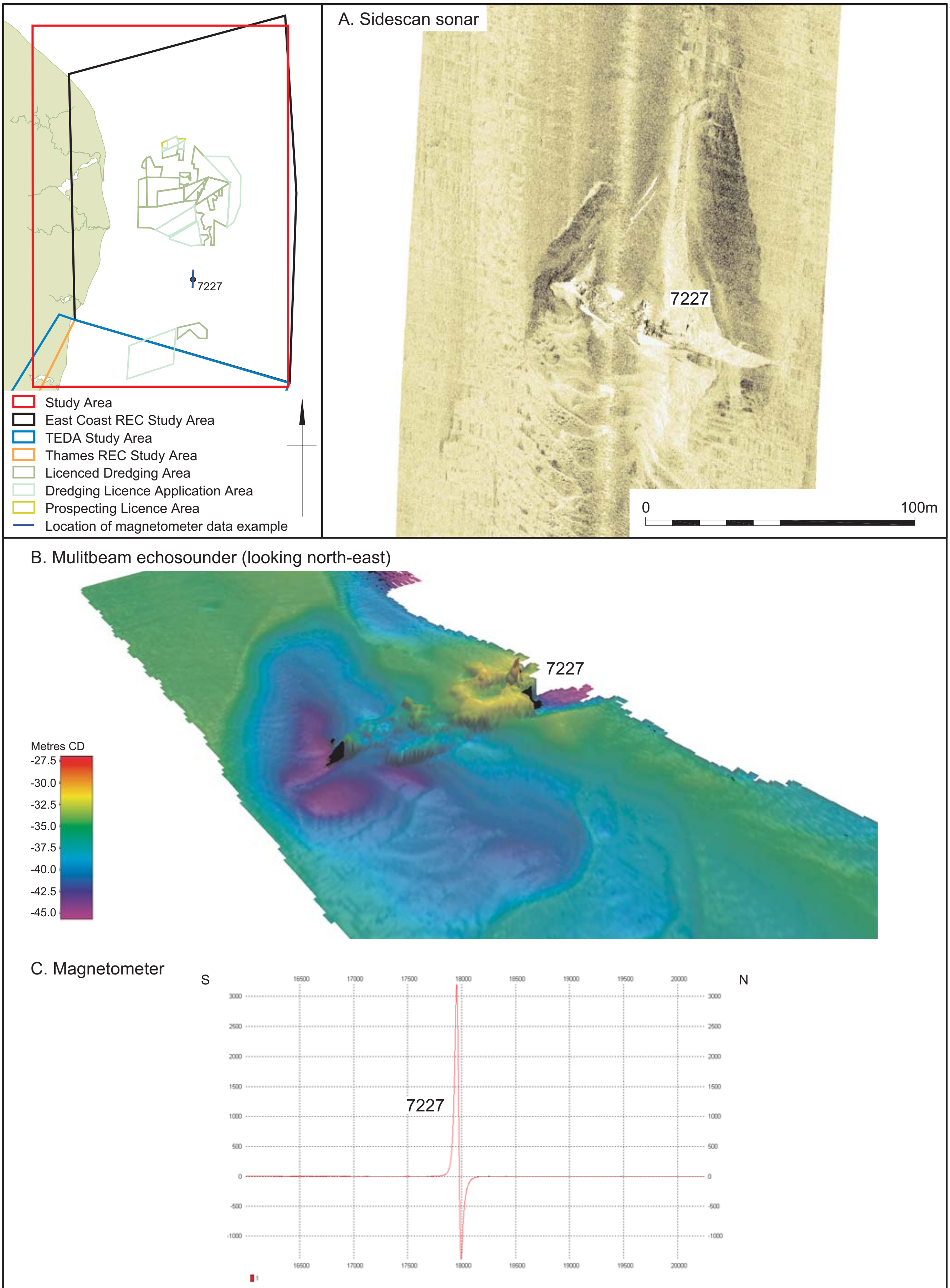
Sidescan sonar and magnetometer and multibeam echosounder images from possible uncharted wreck 7212

Figure 23



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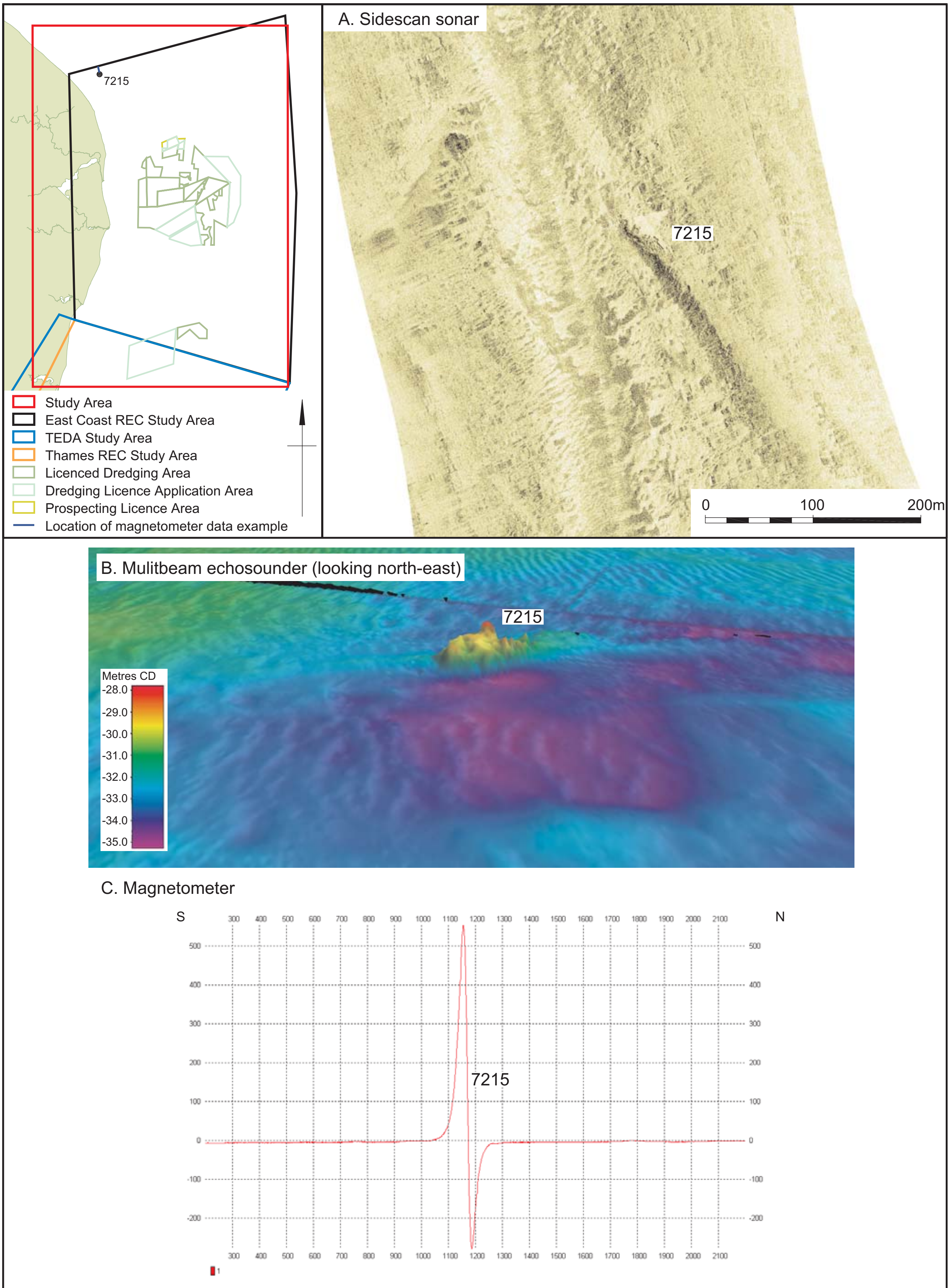
Sidescan sonar and magnetometer and multibeam echosounder images from possible known wreck 7227 (UKHO10992)

Figure 24



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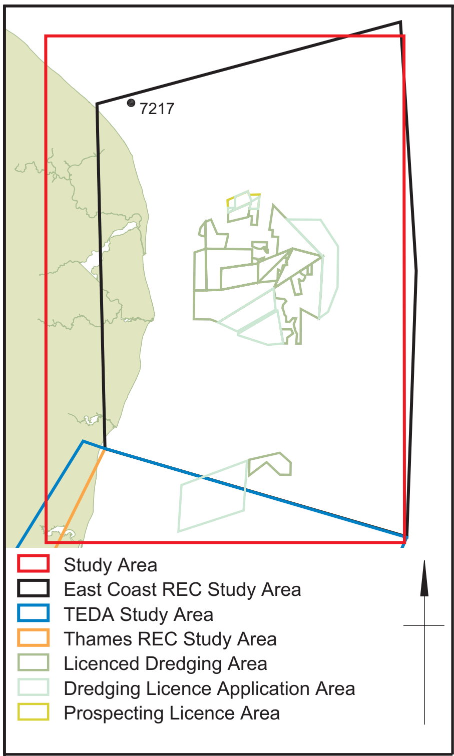
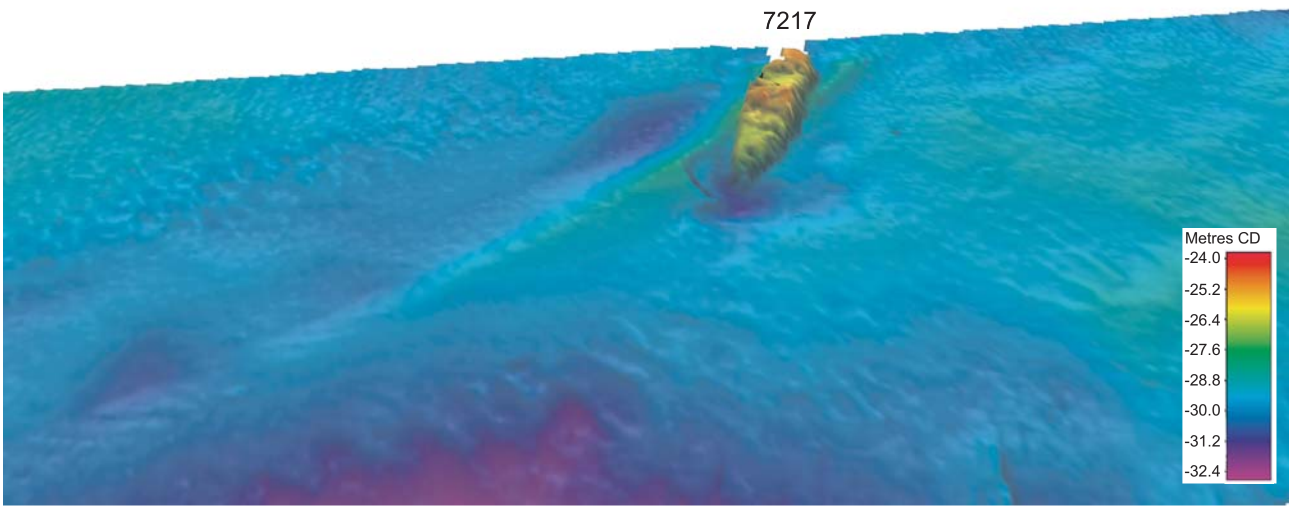
	Path:	W:\Projects\73330 AODA\Drawing Office\Report Figs\REA\10-08-24		

Sidescan sonar and magnetometer and multibeam echosounder images from possible known wreck 7215 (UKHO10550)

Figure 25



A. Mulitbeam echosounder (looking west)



Mulitbeam echosounder coverage only. Outside limits of sidescan sonar.

Drawing projection: UTM WGS84 z31N

Date:	02/09/10	Revision Number:	0
Scale:	(Inset 1:1,250,000) @A4	Illustrator:	KJB
Path:	W:\Projects\73330 AODA\Drawing Office\Report Figs\REA\10-08-24		

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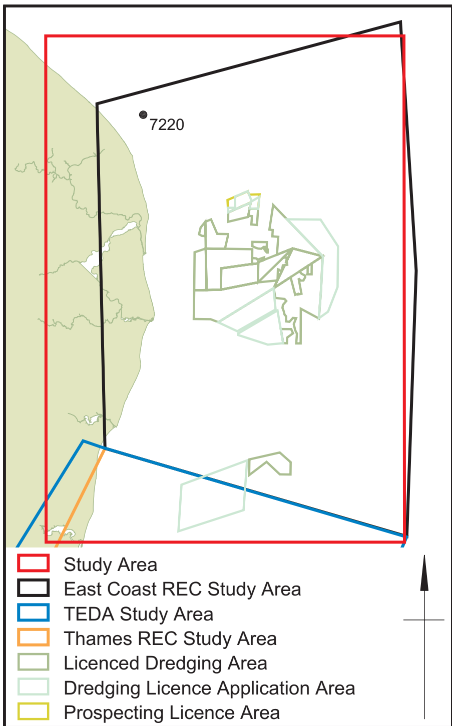
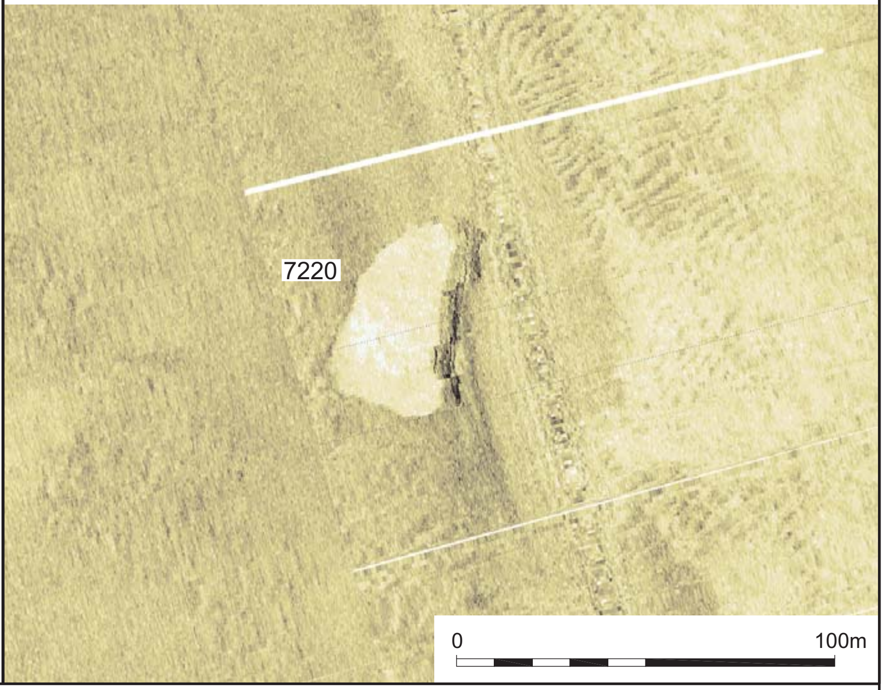
Multibeam echosounder images from possible known wreck 7217 (UKHO10660)

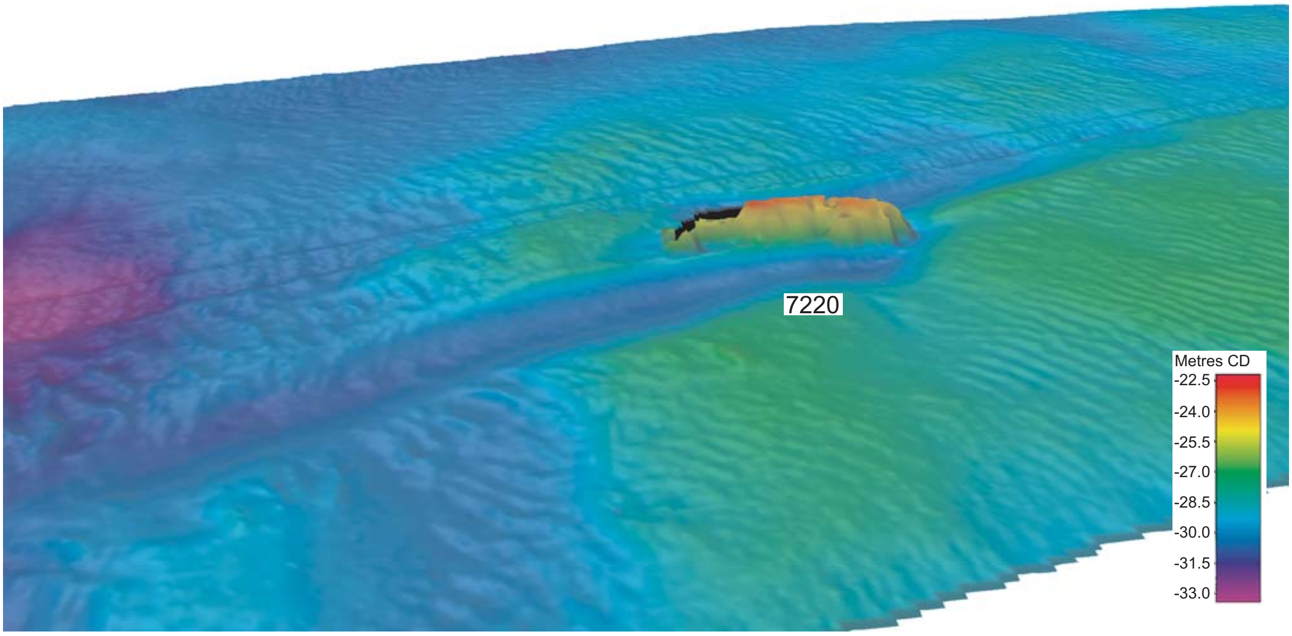
Figure 26



A. Sidescan sonar



B. Mulitbeam echosounder (looking west)



No magnetometer data acquired for this area.

Drawing projection: UTM WGS84 z31N

Date:	02/09/10	Revision Number:	0
Scale:	A 1:2000 (Inset 1:1,250,000) @A4	Illustrator:	KJB
Path:	W:\Projects\73330 AODA\Drawing Office\Report Figs\REA\10-08-24		

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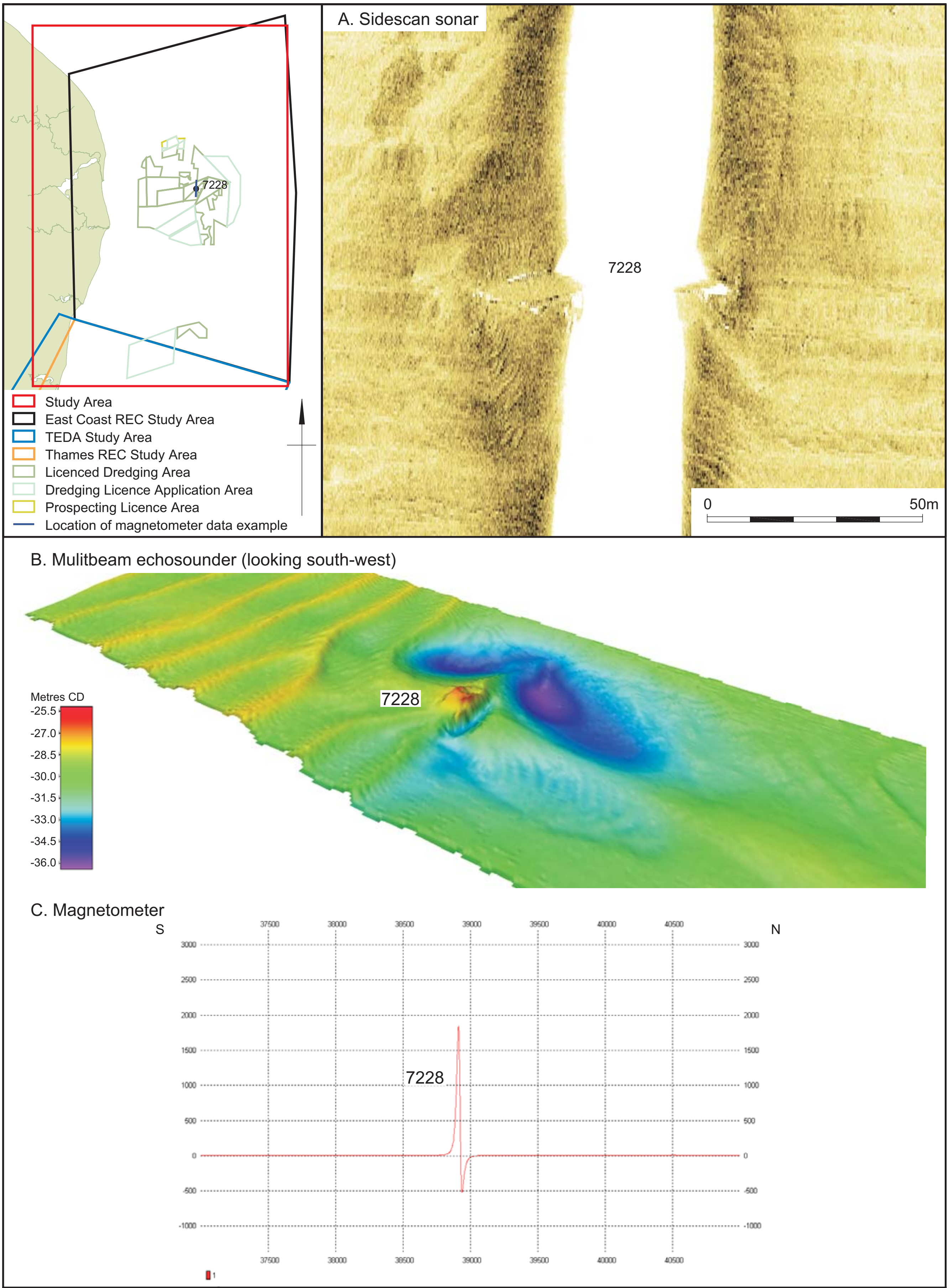
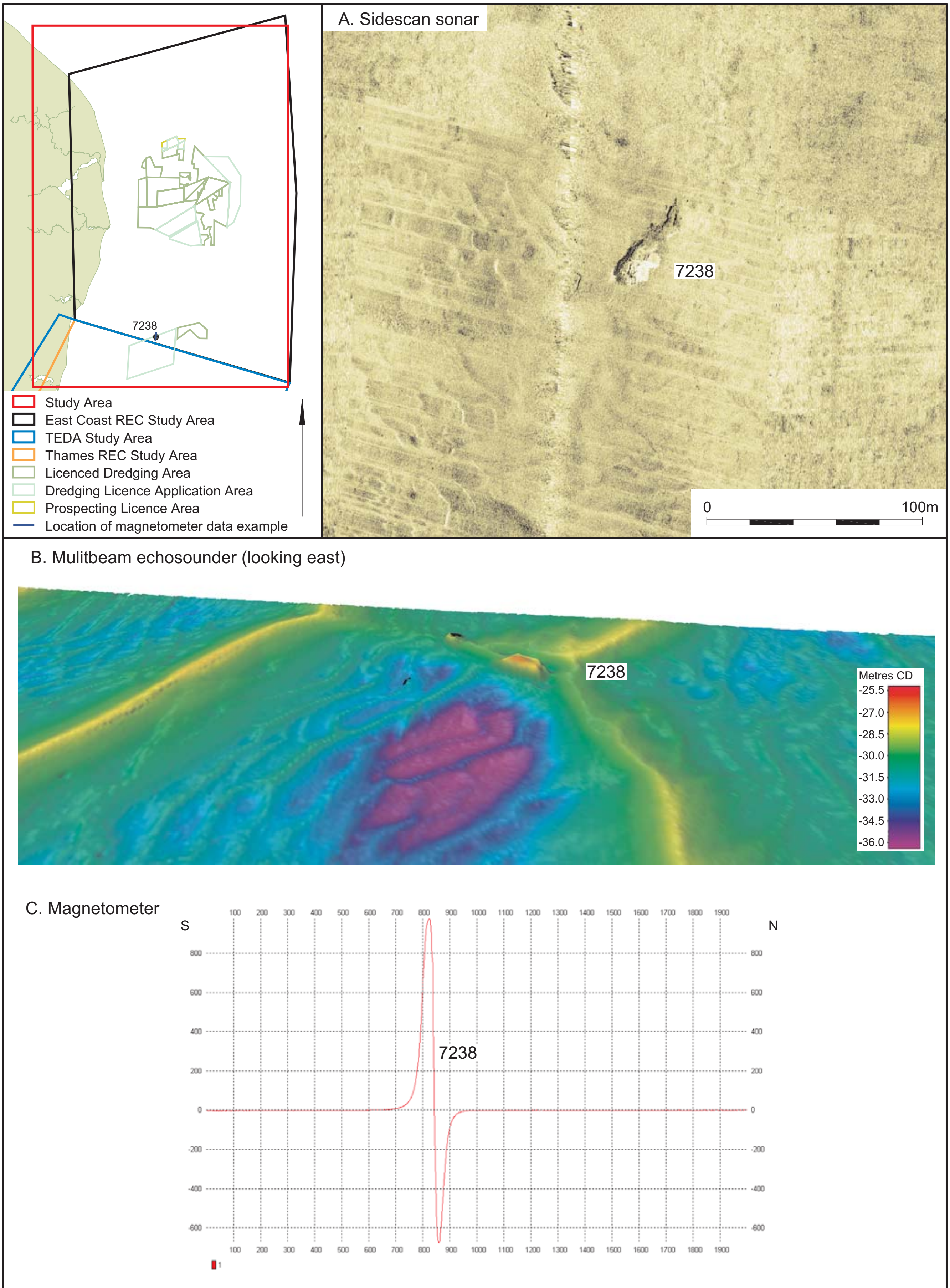
Sidescan sonar and multibeam echosounder images from possible known wreck 7220 (UKHO10547) Figure 27



Drawing projection: UTM WGS84 z31N	Digital data reproduced from Ordnance Survey data © Crown Copyright 2010 All rights reserved. Reference Number: 100020449. This material is for client report only © Wessex Archaeology. No unauthorised reproduction.		
Wessex Archaeology	Date: 02/09/10	Revision Number:	0
	Scale: B 1:40,000 horizontal (Inset 1:1,250,000) @A4	Illustrator:	KJB
	Path: W:\Projects\73330 AODA\Drawing Office\Report Figs\REA\10-08-24		

Sidescan sonar and magnetometer and multibeam echosounder images from possible known wreck 7228 (UKHO11031)

Figure 28



Drawing projection: UTM WGS84 z31N

Date:	02/09/10	Revision Number:	0
Scale:	A 1:2000, C 1:20,000 horizontal (Inset 1:1,250,000) @A4	Illustrator:	KJB
Path:	W:\Projects\73330 AODA\Drawing Office\Report Figs\REA\10-08-24		

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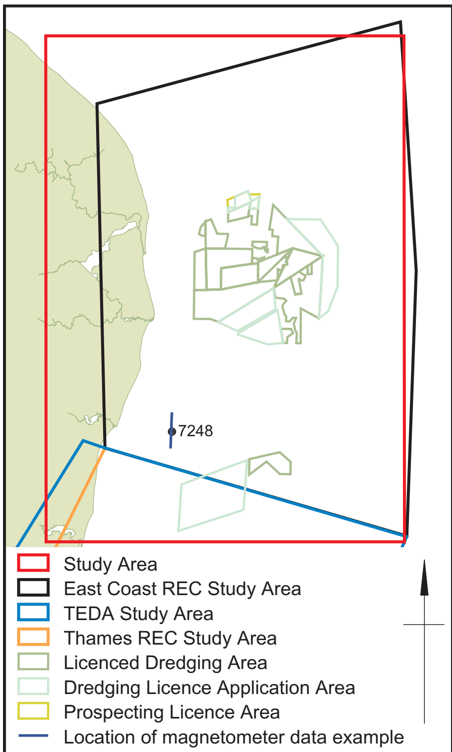
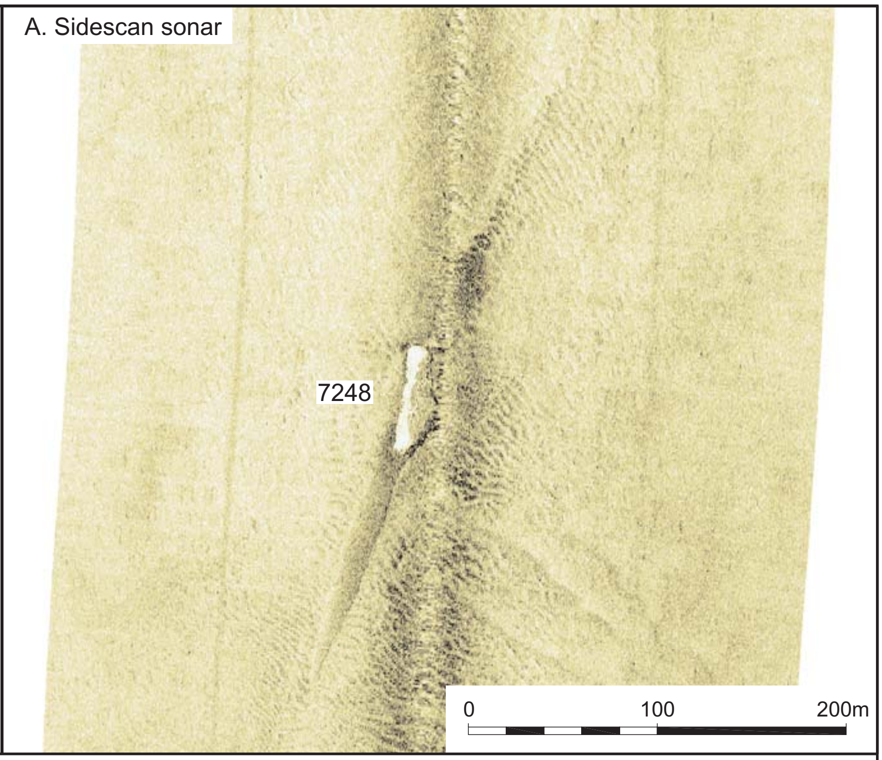
Sidescan sonar and magnetometer and multibeam echosounder images from possible known wreck 7238 (UKHO10335)

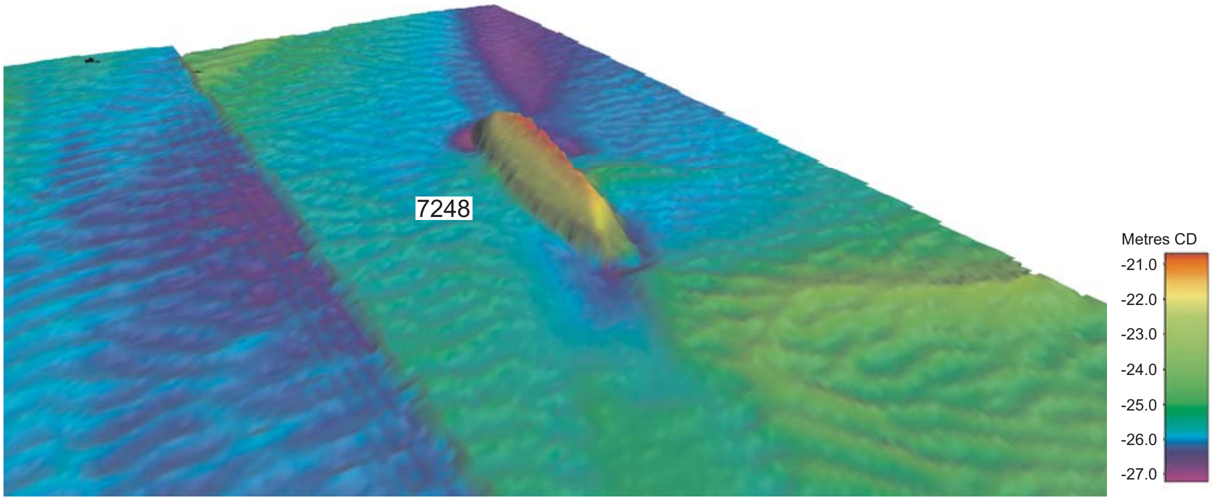
Figure 29



A. Sidescan sonar



B. Mulitbeam echosounder (looking north-east)

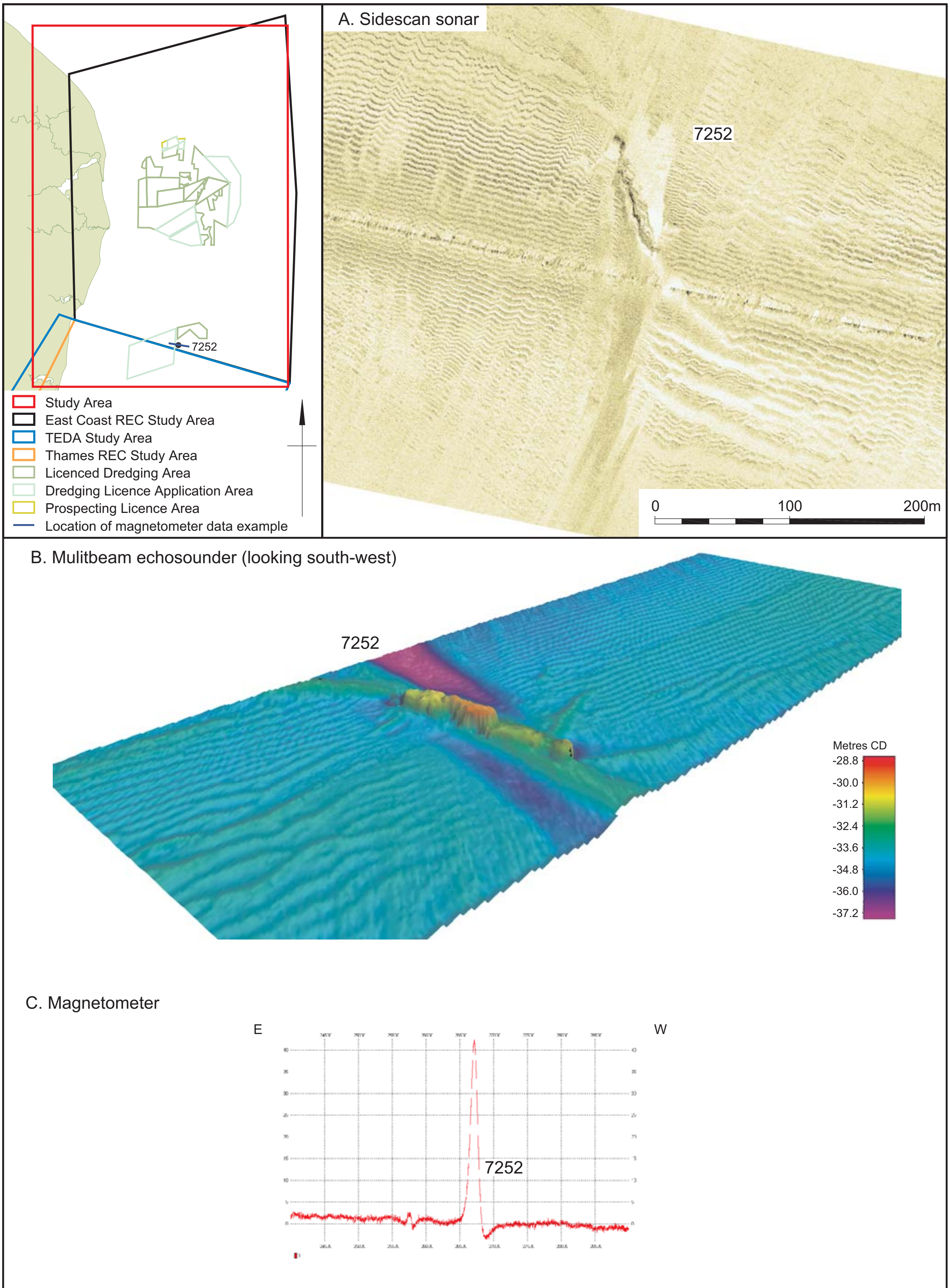


C. Magnetometer

Drawing projection: UTM WGS84 z31N	Digital data reproduced from Ordnance Survey data © Crown Copyright 2010 All rights reserved. Reference Number: 100020449. This material is for client report only © Wessex Archaeology. No unauthorised reproduction.		
Wessex Archaeology	Date: 02/09/10	Revision Number:	0
	Scale: A 1:4000, C 1:80,000 horizontal (Inset 1:1,250,000) @A4	Illustrator:	KJB
	Path: W:\Projects\73330 AODA\Drawing Office\Report Figs\REA\10-08-24		

Sidescan sonar and magnetometer and multibeam echosounder images from possible known wreck 7248 (UKHO10349)

Figure 30

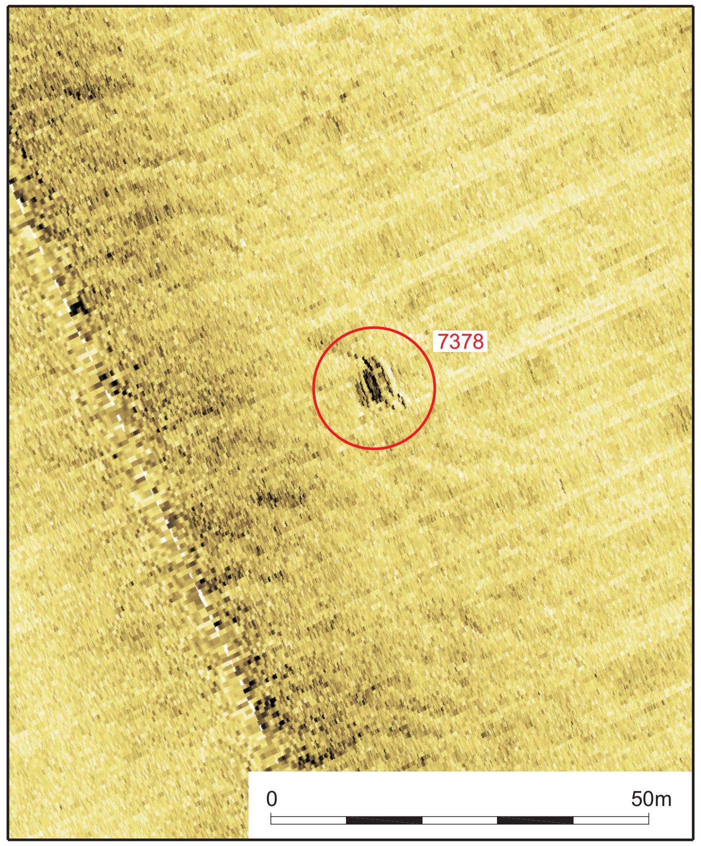


Drawing projection: UTM WGS84 z31N	Digital data reproduced from Ordnance Survey data © Crown Copyright 2010 All rights reserved. Reference Number: 100020449. This material is for client report only © Wessex Archaeology. No unauthorised reproduction.		
	Date: 02/09/10	Revision Number:	0
Wessex Archaeology	Scale: A 1:4000, C 1:80,000 horizontal (Inset 1:1,250,000) @A4	Illustrator:	KJB
	Path: W:\Projects\73330 AODA\Drawing Office\Report Figs\REA\10-08-24		

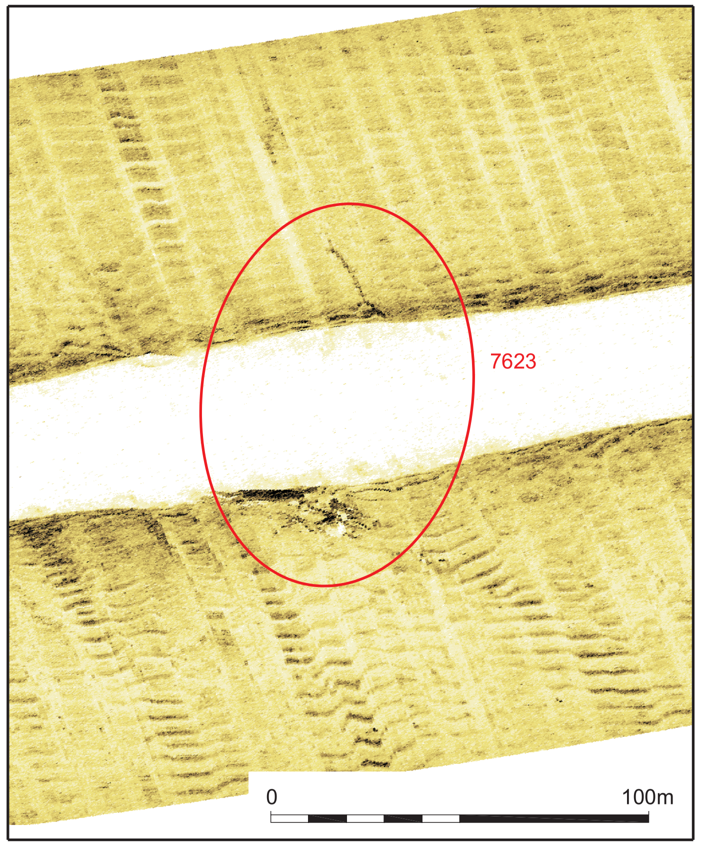
Sidescan sonar and magnetometer and multibeam echosounder images from possible known wreck 7252 (UKHO10962)

Figure 31

Debris

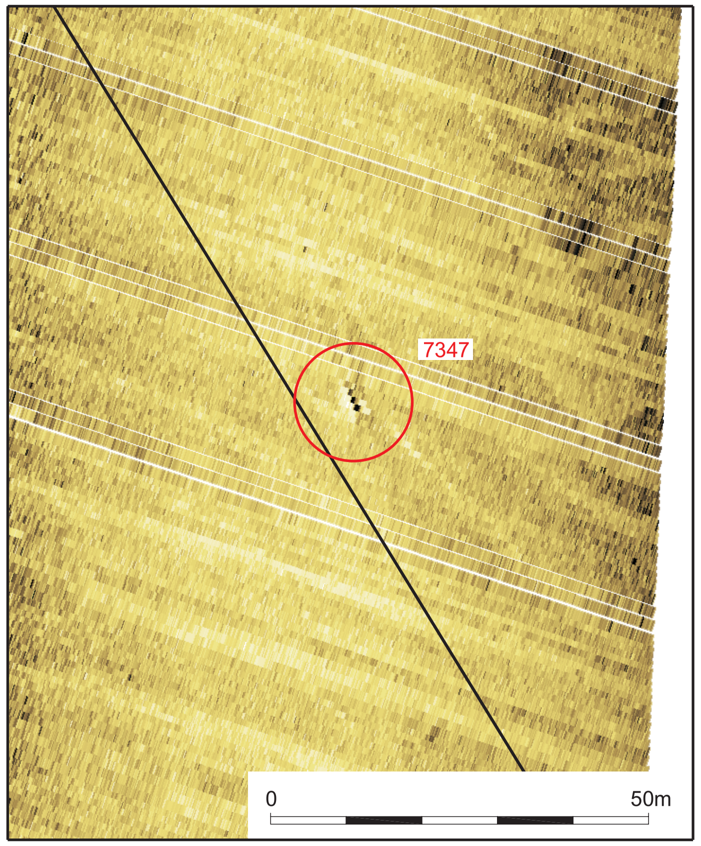


A. 7378 - Physical Region 1 - 6.5m x 4.7m x 0.3m. Isolated debris.

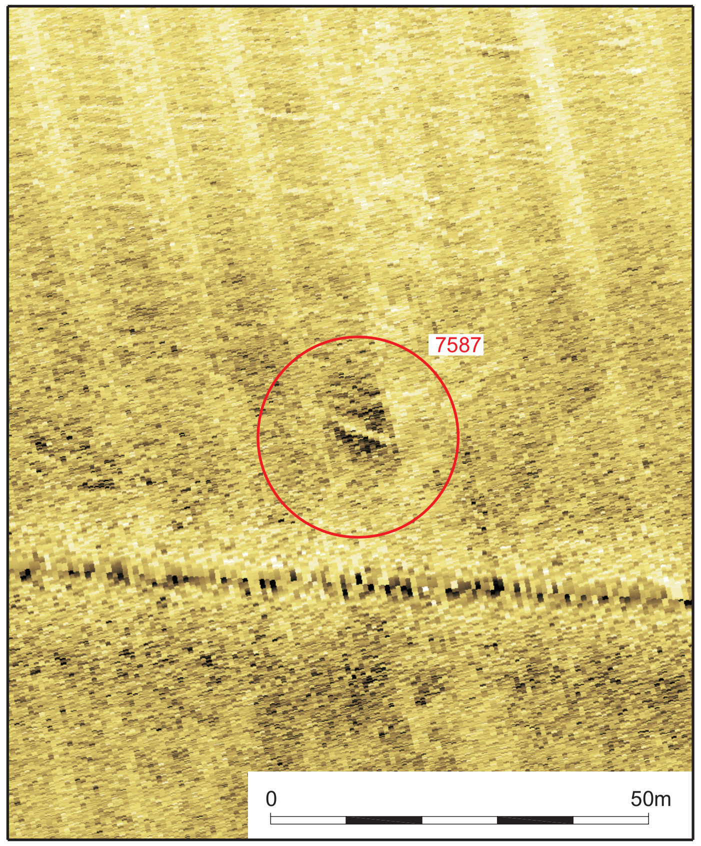


B. 7623 - Physical Region 1 - 34.8m x 1.9m x 0.7m. Numerous items of associated debris (water column intentionally not removed).

Dark reflector

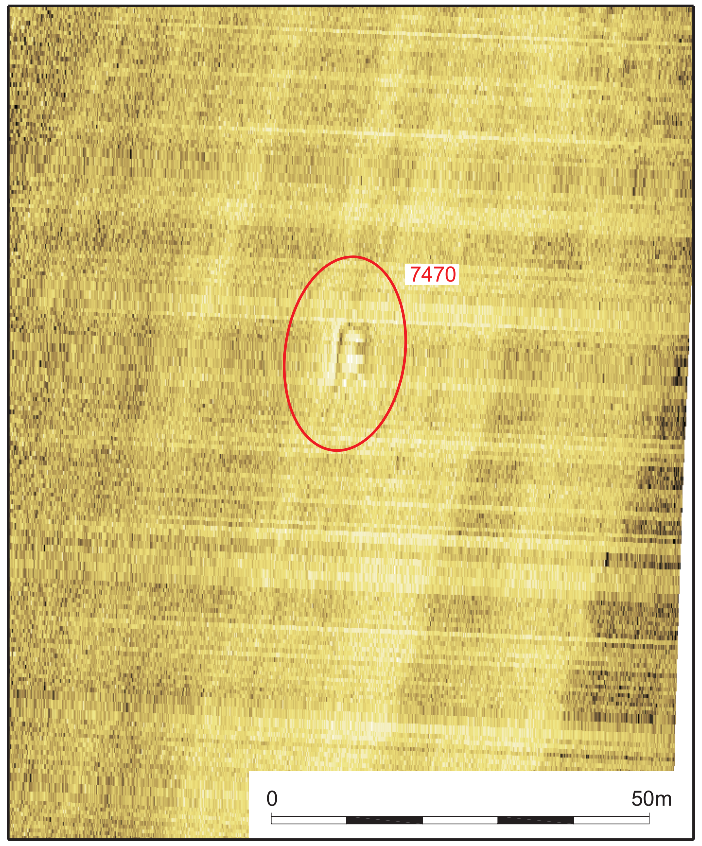


C. 7347 - Physical Region 2 - 10.8m x 6.1m x 0m. Small, isolated dark reflector.

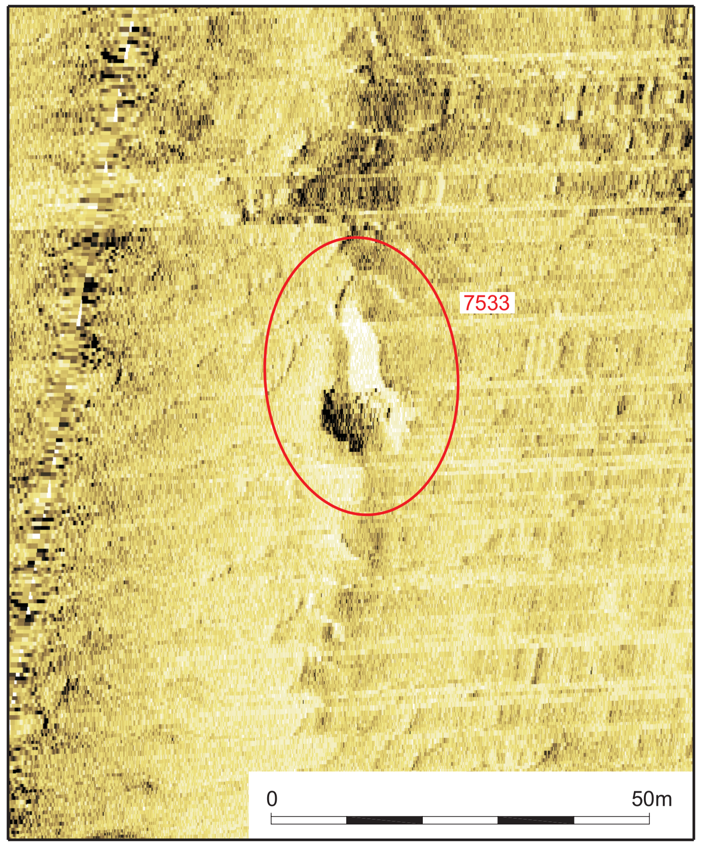


D. 7587 - Physical Region 2 - 12.1m x 8.7m x 0m. Small, isolated dark reflector.

Seafloor disturbance



E. 7470 - Physical Region 3 - 30m x 20m x 0m. Isolated seafloor disturbance, possible debris.



F. 7533 - Physical Region 1 - 12.4m x 5.7m x 0m. Seafloor disturbance, with dark and bright reflectors.

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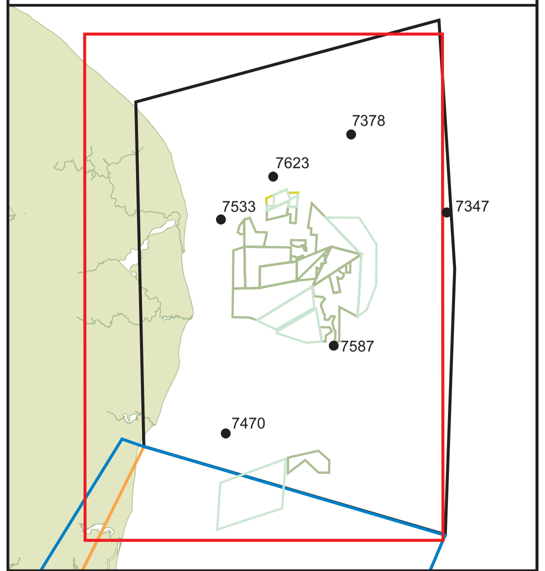


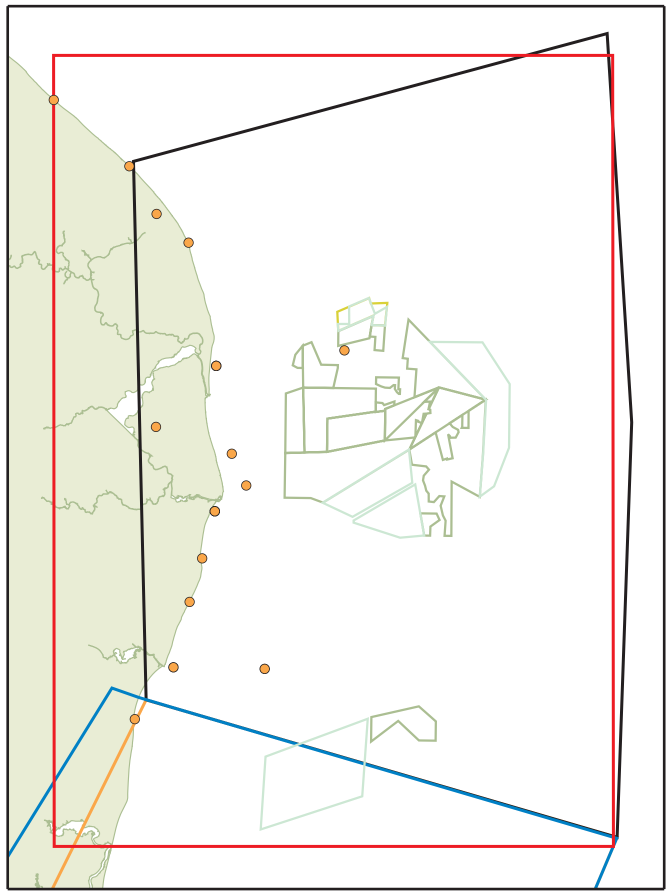
- Study Area
- East Coast REC Study Area
- TEDA Study Area
- Thames REC Study Area
- Licenced Dredging Area
- Dredging Licence Application Area
- Prospecting Licence Area

Revision Number:	1
Illustrator:	KJB
Date:	19/11/10
Scale:	A,C-F 1:1000, B 1:2000
Path:	W:\Projects\73330 AODA\

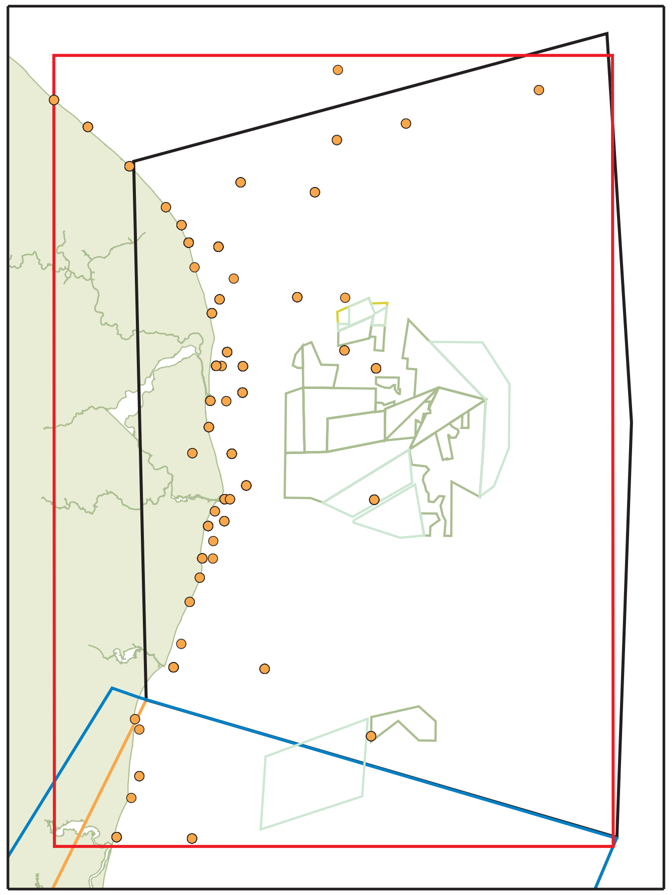
Drawing Office\Report Figs\REA\10-11-18

Data examples of sidescan sonar anomalies

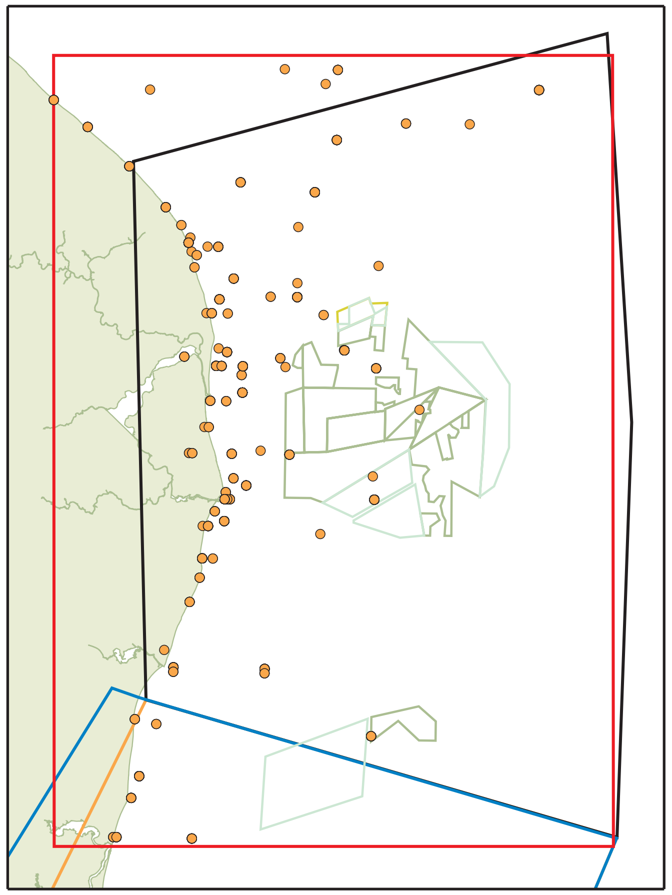
Figure 32



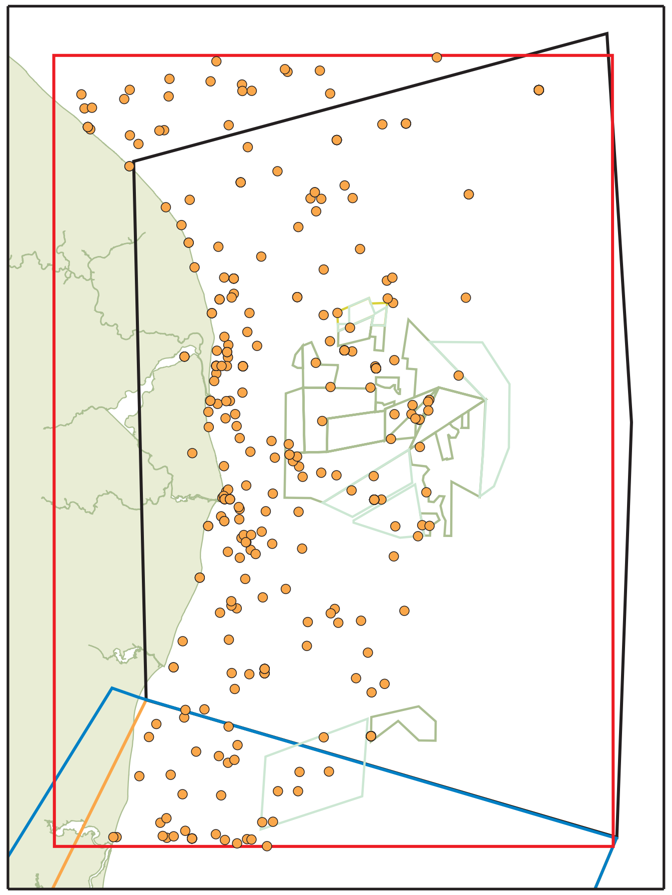
A. Pre-1508 AD



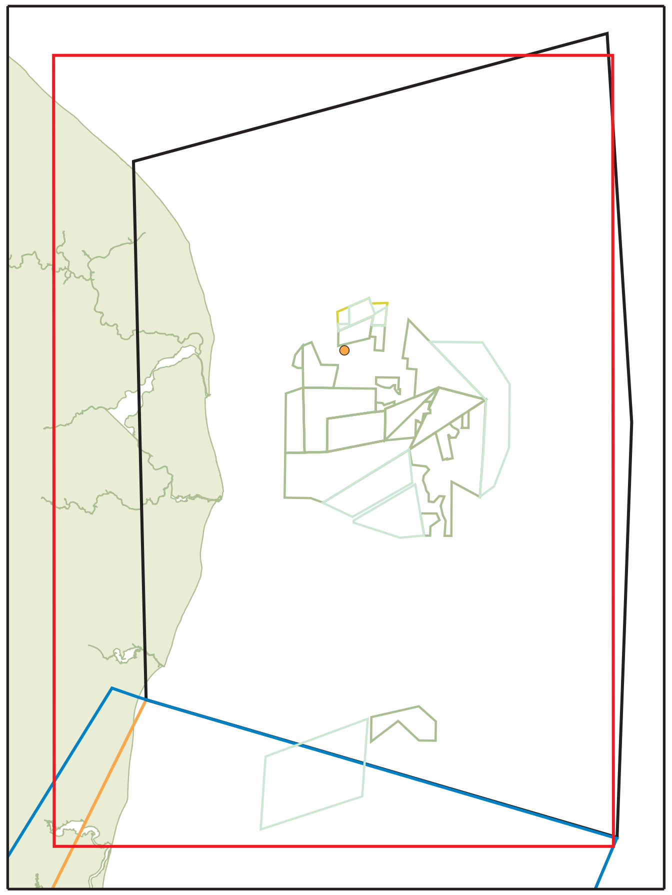
B. 1509-1815



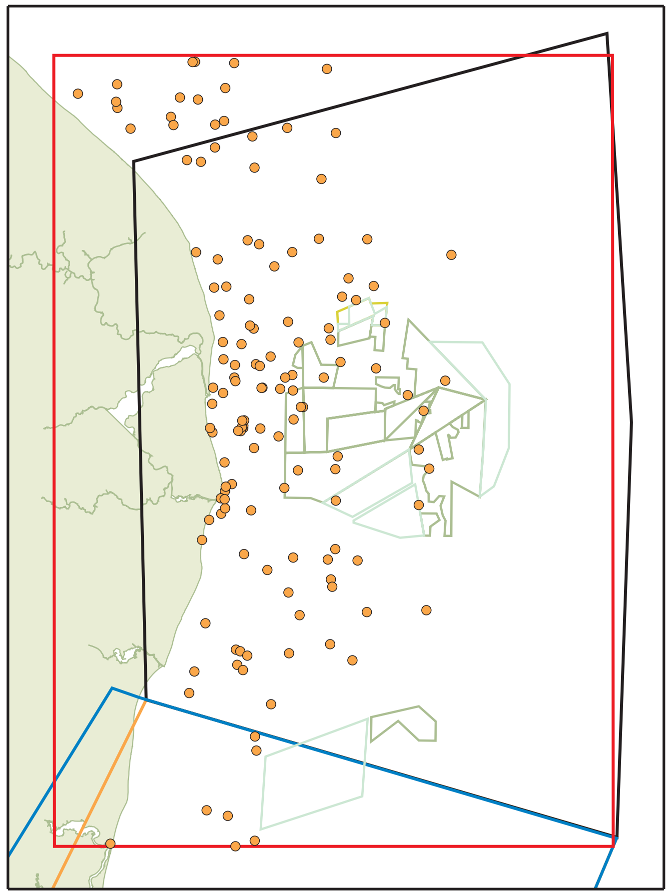
C. 1816-1913



D. 1914-1945



E. Post 1946



F. Unassigned wreck losses

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- Study Area
- East Coast REC Study Area
- TEDA Study Area
- Thames REC Study Area
- Licenced Dredging Area
- Dredging Licence Application Area
- Prospecting Licence Area
- Shipping casualties

0 50km

Drawing projection UTM WGS84 z31N

Revision Number:	0
Illustrator:	KJB
Date:	06/09/10
Scale:	1:800,000 @A3
Path:	W:\Projects\73330\Drawing Office\Report Figs\REA\10-08-24

NMR Shipping casualties within the MAREA Study Area

Figure 33

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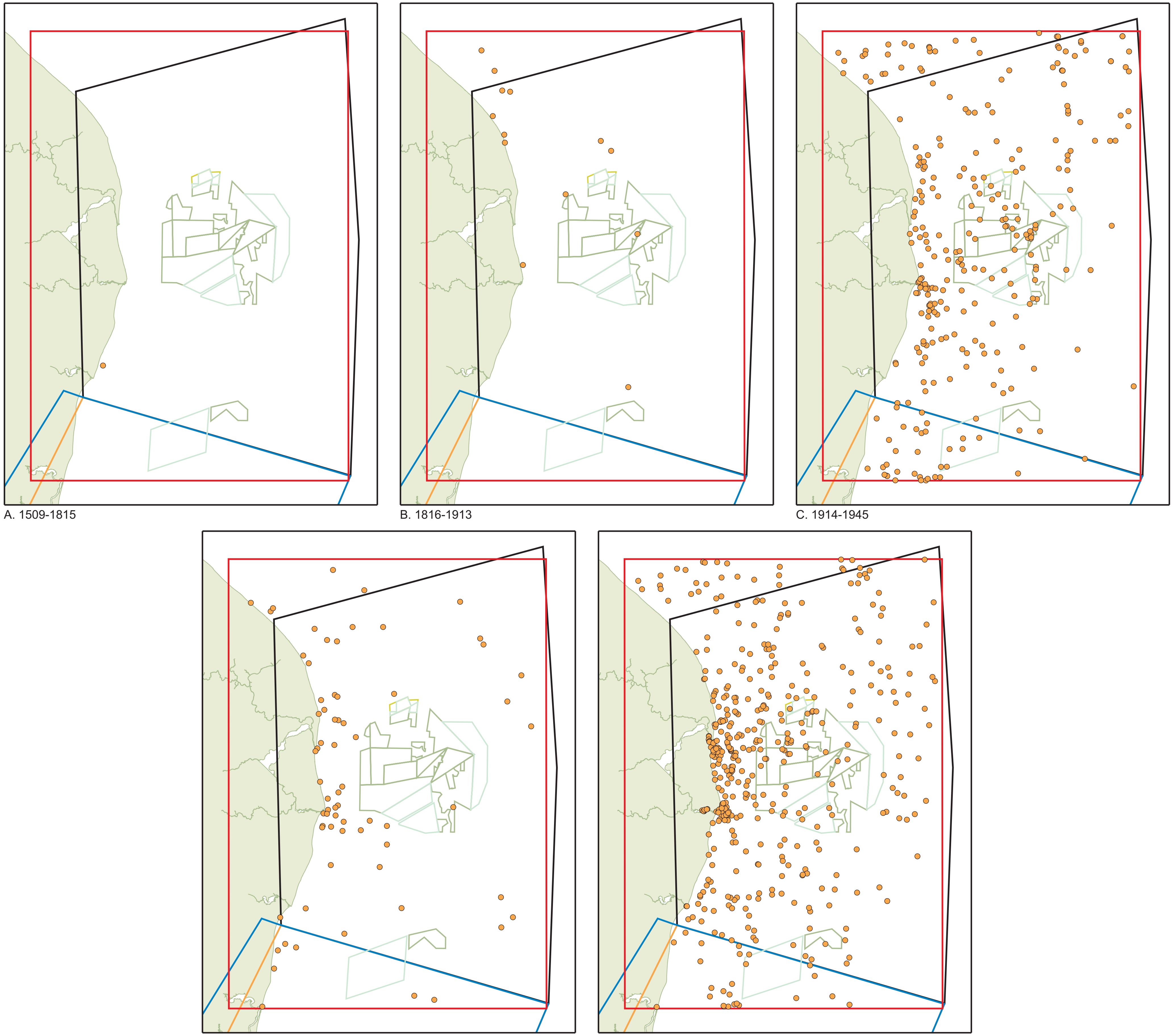


A. 1509-1815

B. 1816-1913

C. 1914-1945

D. Post 1946

E. Unassigned losses

- Study Area
- East Coast REC Study Area
- TEDA Study Area
- Thames REC Study Area
- Licenced Dredging Area
- Dredging Licence Application Area
- Prospecting Licence Area
- UKHO charted wrecks

0 50km

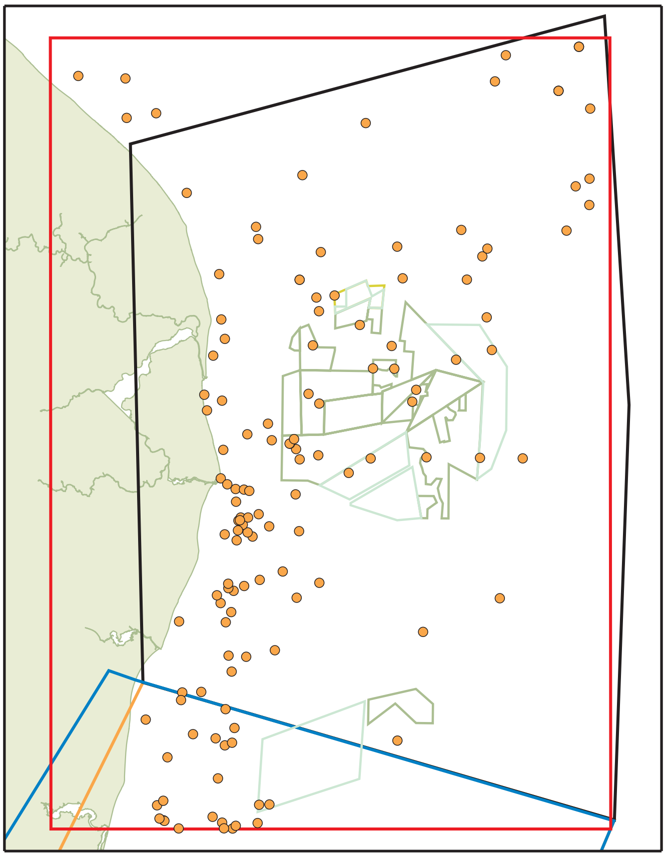
Drawing projection UTM WGS84 z31N

Revision Number:	0
Illustrator:	KJB
Date:	08/09/10
Scale:	1:800,000 @A3
Path:	W:\Projects\73330 AODA\

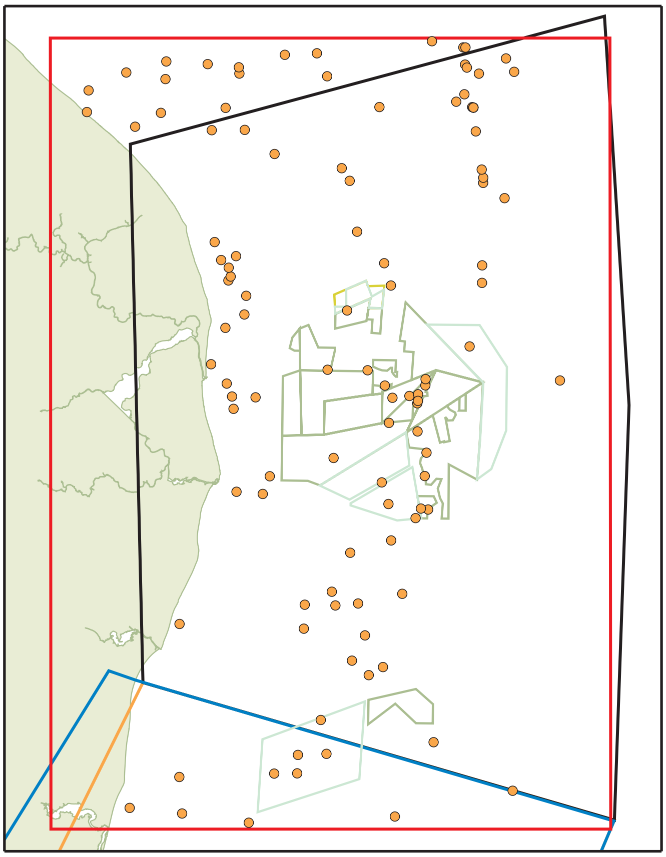
Drawing Office\Report Figs\REA\10-08-24

SeaZone charted wrecks sites within the MAREA Study Area

Figure 34



A. World War One charted Merchant Navy casualties



B. World War Two charted Merchant Navy casualties

Study Area
East Coast REC Study Area
TEDA Study Area
Thames REC Study Area
Licenced Dredging Area
Dredging Licence Application Area
Prospecting Licence Area
UKHO Merchant Navy casualties

0 50km

Drawing projection UTM WGS84 z31N

Date:	08/09/10	Revision Number:	0
Scale:	1:800,000 @A3	Illustrator:	KJB
Path:	W:\Projects\73330 AODA\Drawing Office\Report Figs\REA\10-08-24		

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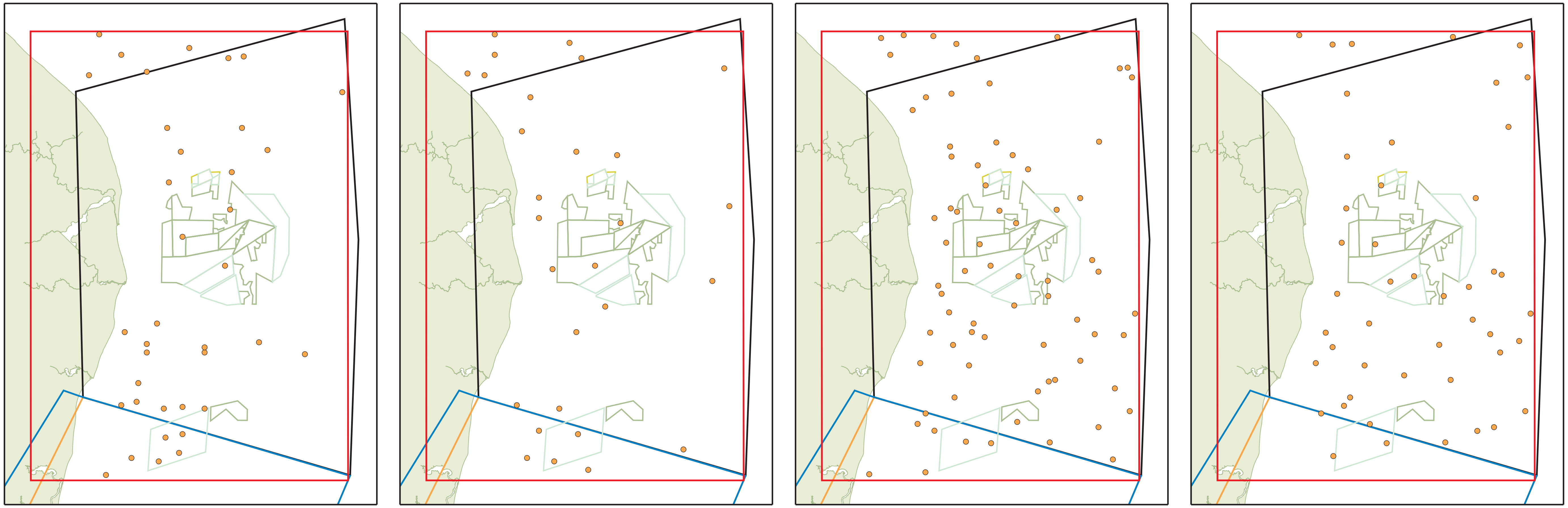
SeaZone World War I and World War II charted Merchant Navy casualties

Figure 35



A. 1941-2 B. 1942-3 C. 1943-4 D. 1944-5

Study Area
East Coast REC Study Area
TEDA Study Area
Thames REC Study Area
Licenced Dredging Area
Dredging Licence Application Area
Prospecting Licence Area
RAF aircraft losses

0 50km
Drawing projection UTM WGS84 z31N

Date:	13/09/10	Revision Number:	0
Scale:	1:800,000 @A3	Illustrator:	KJB
Path:	W:\Projects\73330\Drawing Office\Report Figs\REA\10-08-24		

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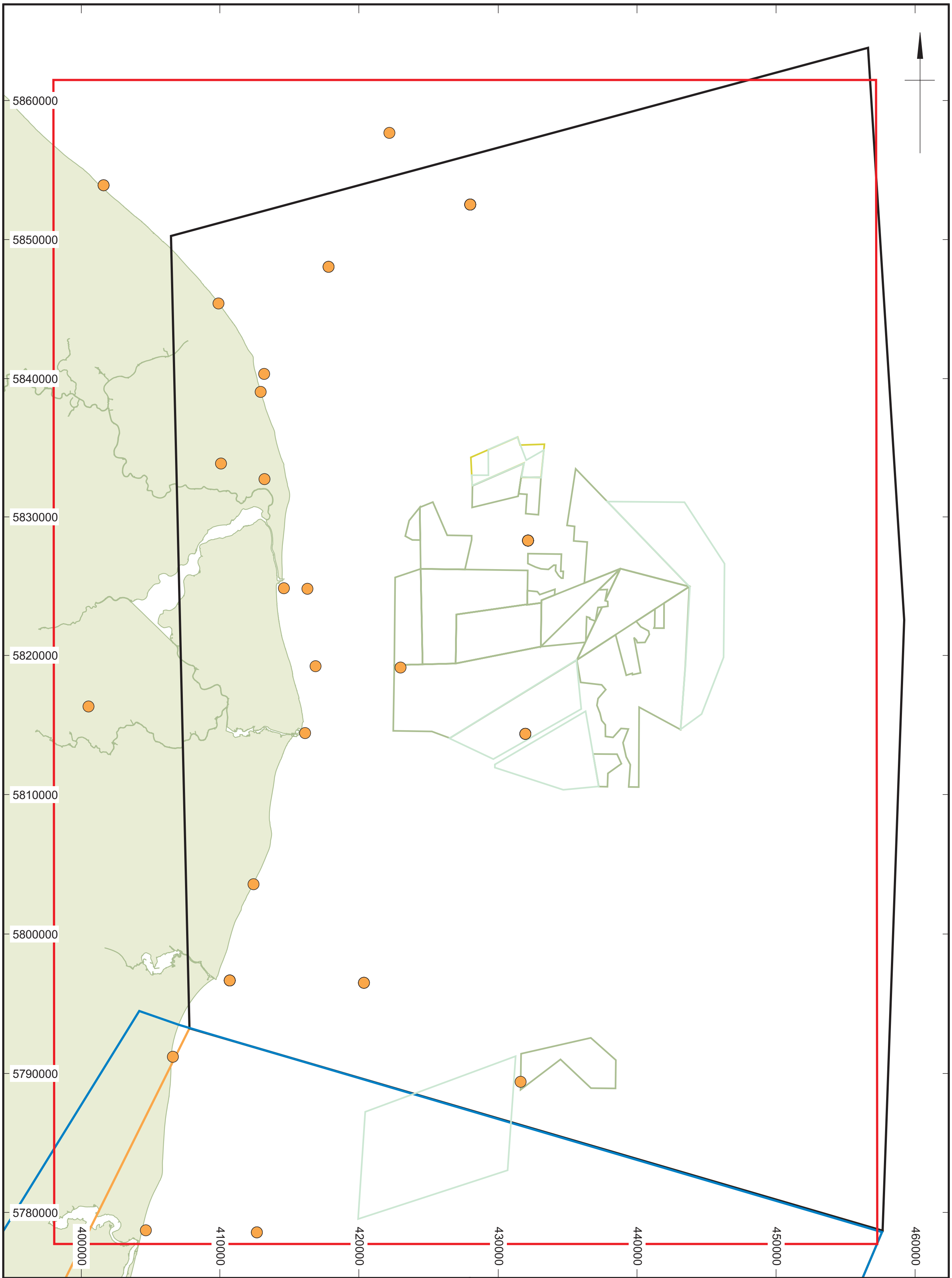
World War II Air & Sea Rescue Operations

Figure 36



0 10km	Study Area East Coast REC Study Area TEDA Study Area Thames REC Study Area Licenced Dredging Area Dredging Licence Application Area Prospecting Licence Area NMR aircraft crash sites	Drawing projection: UTM WGS84 z31N	

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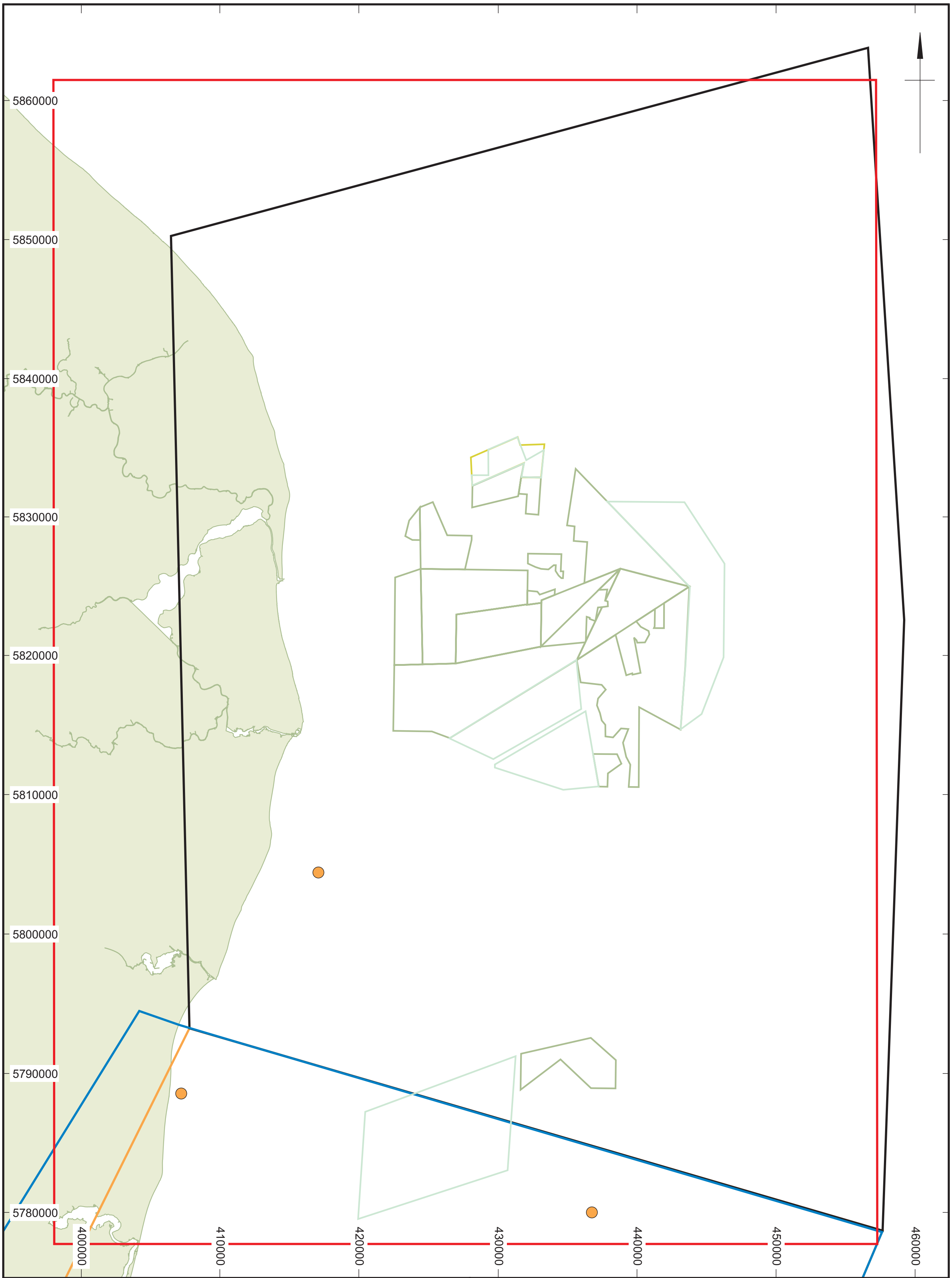
Date:	13/09/10	Revision Number:	0
Scale:	1:400,000 @A4	Illustrator:	KJB
Path:	W:\Projects\73330\Drawing Office\Report Figs\REA\10-08-24		

NMR aircraft losses within the MAREA Study Area

Figure 37



Study Area
East Coast REC Study Area
TEDA Study Area
Thames REC Study Area
Licenced Dredging Area
Dredging Licence Application Area
Prospecting Licence Area
Seazone aircraft crash sites

0 10km

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Drawing projection: UTM WGS84 z31N

Date:	13/09/10	Revision Number:	0
Scale:	1:400,000 @A4	Illustrator:	KJB
Path:	W:\Projects\73330\Drawing Office\Report Figs\REA\10-08-24		

SeaZone aircraft crash sites

Figure 38

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