



Aggregate Extraction Area 1804 (1 and 2)

Marine Archaeological Desk-Based Assessment

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Summary

Wessex Archaeology was commissioned by ABPmer, on behalf of CEMEX UK Marine, Southampton, to prepare a marine archaeological desk-based assessment, that includes an assessment of geotechnical vibrocores and available geophysical survey data, and a high-level Environmental Impact Assessment for marine aggregate extraction Area 1804 (1 and 2). The area is located in the Anglian dredging region ENE of Lowestoft, Suffolk.

Documentary evidence, geoarchaeological vibrocore data and geophysical survey data were used to assess and verify the location and value of the known and potential archaeological resource within Area 1804 (1 and 2) with regard to palaeogeography and maritime and aviation archaeology. A discussion on the historic seascape character has also been undertaken for the area.

The known and potential archaeological resource within Area 1804 (1 and 2) is summarised as comprising:

- the potential for organic deposits containing material of palaeogeographical interest across the study area;
- 29 seabed features comprising five named shipwrecks (across seven records), two unidentified wreck sites, five areas of debris (three of which may be associated with wreck sites), two linear features interpreted as rope/chain (one of which may be associated with a wreck site), ten areas of possible debris/natural features (one of which may be associated with a wreck site), and three natural features;
- no known aircraft crash sites are recorded, but aircraft material has been recovered from the locality as part of the Marine Aggregates Industry Protocol for Reporting Finds of Archaeological Interest;
- the potential for additional currently unknown maritime and aviation seabed features to exist; and
- a Historic Seascape Character that includes, fishing, navigation and industry.

There is potential for the proposed dredging activities to impact as yet unknown archaeological sites related to palaeogeography, shipwrecks and aircraft crash sites.

The key mitigation to reduce the significance of effects with regard to the loss of archaeological material within the volume of aggregate, and to deal with new discoveries once they occur, is the existing Marine Aggregate Industry Protocol for Reporting Finds of Archaeological Interest, including the provision for Temporary Exclusion Zones should archaeological material of importance be discovered during dredging works. Additional mitigation could include the implementation of Archaeological Exclusion Zones to prevent direct impacts to known archaeological receptors. Preservation by record and archaeological watching briefs are also methods of offsetting and reducing disturbances to sites.



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Wessex Archaeology would also like to thank the United Kingdom Hydrographic Office for supplying the known wreck and obstruction data and the National Marine Heritage Record for supplying sites and monuments data.

The report was compiled by Victoria Lambert with contributions from Claire Mellett in regard to the geoarchaeological assessment and Robyn Pelling in regard to the marine geophysical survey data assessment. Figures were prepared by Kitty Foster. Dr Andrew Bicket managed the report on behalf of Wessex Archaeology and provided quality assurance of the report.



Aggregate Extraction Area 1804 (1 and 2)

Marine Archaeological Desk-Based Assessment

1 INTRODUCTION

1.1 Project background

1.1.1 Wessex Archaeology was commissioned by ABP Marine Environmental Research Ltd (ABPmer) on behalf of CEMEX UK Marine, Southampton (CEMEX) to prepare a marine archaeological desk-based assessment (DBA), that includes an assessment of geotechnical vibrocores, and a high-level Environmental Impact Assessment (EIA) for marine aggregate extraction Area 1804 (1 and 2).

1.1.2 This assessment will in turn inform an Environmental Statement (ES) to support a marine licence application to the Marine Management Organisation (MMO) to undertake aggregate dredging in the area.

1.1.3 Area 1804/1, measuring 6.12 km², is located within English Territorial Waters, just over 7 km offshore to the ENE of Lowestoft, Suffolk in the Anglian dredging region and Area 1804/2, which measures 7.85 km², is located a further 10 km to the east (Figure 1).

1.2 Development proposal

1.2.1 CEMEX have been awarded a prospecting area by The Crown Estate for Area 1804, located in the Anglian dredging region. Area 1804 is adjacent to existing aggregate extraction Areas 511 and 513. It comprises two discrete sub-areas: 1804/1 is located to the west of Area 511 and 1804/2 is located in between 513/1, 513/2 and 401/2A. The location of Area 1804 (1 and 2) within the Anglian dredging region is shown in Figure 1.

1.2.2 The potential dredging resource consists of sand and gravelly sand and the total tonnage applied for will be 9,750,000 tonnes over 15 years. The method of aggregate collection will use a trailer suction hopper dredger, with screening and hopper washing. The penetration depth depends on the nature of the seabed, but individual furrows are typically around 1.5 to 3 m wide and up to 0.5 m deep.

1.2.3 An application was made to the MMO in August 2021 with regards to collecting vibrocores from Area 1804. The aim of the survey was to collect cores of seabed sediment within the marine aggregate interest area for resource assessment including geoarchaeological assessment. The application proposed that approximately 12 cores would be collected within the survey area. Following a variation to the application in January 2022, the MMO agreed that a marine licence was not required for this survey as the activity meets the terms of a marine licence exemption set out in Article 17 of the *Marine Licence (Exempted Activities) Order 2011* (as amended). However, this exemption was subject to the requirement that notification of the intention to carry out the activity is given to the MMO prior to the commencement of the activity.

1.3 Previous impact

1.3.1 Area 1804/1 is a new dredging area and has not been targeted for aggregate prior to this proposal. Area 1804/2 overlaps with three earlier aggregate licence areas: 242, 361B and



361C. These earlier areas were surrendered over time with the last sections having been given just under ten years ago. At the time of writing this report, Area 242/361 still exists but is located 2.5 km to the north-east of Area 1804/2 and neither area overlaps.

1.4 Scope of document

1.4.1 The purpose of this assessment is to determine, as far as is possible from existing information and survey data, the nature, extent and significance of the known and potential marine archaeological resource within the boundary of the proposed aggregate area and its environs, and to assess the potential impacts to this resource as a result of dredging activities.

1.5 Aims and objectives

1.5.1 The specific aims of this assessment are to:

- outline the known and potential marine heritage assets within the boundary of the study area based on a review of existing information within and beyond the area, forming the baseline;
- provide a summary of the value and sensitivity of known and potential heritage assets;
- introduce a high-level environmental appraisal for Area 1804 (1 and 2) with regards the known and potential heritage resource and suggested mitigation for dredging works; and
- inform the production of an ES for Area 1804 (1 and 2).

1.5.2 The objectives of the baseline characterisation are:

- to outline the relevant statutory, planning and policy guidelines relating to the historic environment within the study area;
- to provide a desk-based overview of the marine historic environment within the study area, based on existing archaeological evidence and records, secondary sources and available geophysical and geotechnical data;
- to highlight known palaeogeography, seabed features including maritime and aviation sites present within the study area;
- to summarise the potential for the presence of hitherto unknown palaeogeographic, maritime and aviation sites that may be present within the study area;
- to provide a summary of the historic seascape character of the study area and its environs; and
- to comment on the importance of known and potential sites in accordance with established frameworks for assessing archaeological importance.

1.6 Copyright

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2 LEGISLATION, GUIDANCE AND POLICY

2.1 Introduction

2.1.1 The study area is located inside England's Territorial Waters, which extend to 12 nautical miles (nm) from the coast.

2.1.2 This section provides a summary of the national, regional and local planning and legislative framework that governs how the marine historic environment is dealt with in regard to the planning process. More comprehensive details are provided in Appendix 2.

2.2 Marine legislation

2.2.1 The following legislation applies to marine heritage within the study area:

- Marine and Coastal Access Act 2009;
- Protection of Wrecks Act 1973: Section One and Two;
- Ancient Monuments and Archaeological Areas Act 1979 (as amended);
- Protection of Military Remains Act 1986; and
- Merchant Shipping Act 1996.

2.2.2 The above legislation provides a context for focussing approaches and consultation requirements. These legal frameworks provide protection for marine historic assets of high historical, archaeological or artistic value, as well as allowing military wrecks and aircraft remains to be protected. Ownership of any wreck remains is determined in accordance with the *Merchant Shipping Act 1995* as administered by the Receiver of Wreck.

2.3 International conventions

2.3.1 The UNESCO Convention on the Protection of Underwater Cultural Heritage was concluded in 2001 and is a comprehensive attempt to codify the law internationally, with regards to underwater cultural heritage. The UK abstained in the vote on the final draft of the Convention, however it has stated that it has adopted the Annex of the Convention, which governs the conduct of archaeological investigations, as best practice for archaeology. Although the UK is not a signatory, the Convention entered into force on 2nd January 2009, having been signed or ratified by 20 member states. It has since been ratified or accepted by an additional 60 member states.

2.4 National planning policy framework (NPPF)

2.4.1 The *National Planning Policy Framework* (NPPF) was revised and published by the Ministry of Housing, Communities and Local Government in July 2021.

2.4.2 Section 15 of the NPPF entitled 'Conserving and enhancing the historic environment' sets out the principal national guidance on the importance, management and safeguarding of heritage assets within the planning process. The aim of NPPF Section 15 is to ensure that Regional Planning Bodies and Local Planning Authorities, developers, and owners of



heritage assets adopt a consistent and holistic approach to their conservation and to reduce complexity in planning policy relating to proposals that affect them. The government guidance provides a framework that:

- recognises that heritage assets are an irreplaceable resource;
- requires applicants to provide proportionate information on the significance of heritage assets affected by the proposals and an impact appraisal of the proposed development on that significance;
- takes into account the desirability of sustaining and enhancing the significance of heritage assets and their setting;
- places weight on the conservation of designated heritage assets;
- requires developers to record and advance understanding of the significance of any heritage assets to be lost (wholly or in part) in a manner proportionate to their importance and impact, and to make this evidence (and any archive generated) publicly accessible; and
- promotes the conservation of heritage assets in a manner appropriate to their significance, so that they can be enjoyed for their contribution to the quality of life for this and future generations.

2.5 Marine policy

2.5.1 The *Marine and Coastal Access Act 2009* (MCAA) is the primary legislation relevant to marine development plans. Under this legislation, marine plans must be consistent with the *Marine Policy Statement* (MPS; Department for Environment, Food and Rural Affairs 2011) and fully reflect the requirements of the MPS at a local level. Marine plans must also be in accordance with other UK national policy, including the NPPF (Ministry of Housing, Communities and Local Government 2021). The MCAA will be incorporated within the requirements of the project's Development Consent Order necessary under the provisions of the Planning Act 2008.

2.5.2 Under the MCAA, the UK was divided into marine planning regions, with an associated authority responsible for preparing a Marine Plan for that area. The MPS sets out the framework for preparing Marine Plans and making decisions affecting the marine environment. The MPS also states that Marine Plans must ensure a sustainable marine environment that will protect heritage assets.

2.5.3 In England, the MMO have divided the inshore and offshore waters into 11 plan areas for which marine plans are to be produced. Aggregate extraction Area 1804 (1 and 2) is within the East Inshore and East Offshore plan areas. The East Inshore and East Offshore Marine Plans were released in April 2014 (East Marine Plans page on the gov.uk website, accessed February 2022).

2.6 Marine guidance

2.6.1 This assessment will be undertaken in a manner consistent with available guidance as described below in chronological order of issue:



- Identifying and Protecting Palaeolithic Remains: Archaeological Guidance for Planning Authorities and Developers (Historic England (formerly English Heritage) 1998);
- Managing Lithic Scatters: Archaeological Guidance for planning authorities and developers (Historic England (formerly English Heritage) 2000);
- Military Aircraft Crash Sites: Guidance on their significance and future management (Historic England (formerly English Heritage) 2002);
- Marine Aggregate Dredging and the Historic Environment Assessing, evaluating, mitigating and monitoring the archaeological effects of marine aggregate dredging (British Marine Aggregate Producers Association (BMAPA) and English Heritage (now Historic England) 2003);
- The Code of Practice for Seabed Developers (Joint Nautical Archaeology Policy Committee and The Crown Estate 2006);
- Conservation Principles, Policies and Guidance for the Sustainable Management of the Historic Environment (English Heritage (now Historic England) 2008, with an updated consultation draft 10/11/2017);
- Our Seas – A shared resource: High level marine objectives (Department for Environment, Food and Rural Affairs (DEFRA) 2009);
- Environmental Archaeology: A Guide to the Theory and Practice of Methods, from Sampling and Recovery to Post-excavation (second edition) (English Heritage (now Historic England) 2011);
- Offshore Geotechnical Investigations and Historic Environment Analysis: Guidance for the Renewable Energy Sector (COWRIE 2011);
- Ships and Boats: Prehistory to Present: Designation Selection Guide (English Heritage (now Historic England) 2012);
- Aggregate Dredging and the Marine Environment: an overview of recent research and current industry practice (Newell and Woodcock 2013);
- Standard and Guidance for Historic Environment Desk-based Assessment (Chartered Institute for Archaeologists 2014);
- The Setting of Heritage Assets – Historic Environment Good Practice Advice in Planning: 3 (Historic England 2015); and
- Geoarchaeology: Using Earth Sciences to Understand the Archaeological Record (English Heritage (now Historic England) 2015).

2.7 Licence and consent

Exploration and agreements with The Crown Estate

- 2.7.1 The Crown Estate owns the seabed out to 12 nm and the mineral rights to the limit of the UK Territorial Waters.

Marine licence

2.7.2 The MMO is the responsible regulatory authority for implementing marine licensing necessary for dredging to extract aggregates within the seas around England to ensure they are carried out in a sustainable way. The MMO is responsible for licencing, regulating and planning marine activities around England to ensure they are carried out in a sustainable way.

Archaeological curator

2.7.3 The archaeological curator responsible for the offshore archaeological resource, from Mean High Water Springs (MHWS) to the 12 nm limit are the Historic England Marine Planning Unit, with specialist advice provided by the Historic England East of England Science Advisor with regard to activities undertaken as part of the project. Historic England also act as specialist advisors to the MMO.

3 METHODOLOGY

3.1 Study area

Scope

3.1.1 The study area assessed in this report is defined by the boundary extent of Area 1804/1 and Area 1804/2 with a 500 m buffer (Figure 1).

3.1.2 The co-ordinates for Area 1804 (1 and 2) were provided by CEMEX and are presented in Table 1 below. For the purposes of this assessment, the co-ordinates were projected to UTM31 using the WGS84 datum, using the conversion programme Quest Geodetic Calculator version 8.0.0.1.

Table 1 Area 1804/1 and 1804/2 co-ordinates (WGS84 lat/long) and area

Sub-area	Latitude			Longitude			Area (km ²)
1804/1	52	34.1037	N	01	50.9681	E	6.12
	52	34.1056	N	01	51.4645	E	
	52	33.7520	N	01	51.4659	E	
	52	31.1233	N	01	51.4912	E	
	52	28.5736	N	01	51.4913	E	
	52	28.2323	N	01	51.4927	E	
	52	28.2316	N	01	51.0059	E	
1804/2	52	33.4072	N	02	03.2075	E	7.85
	52	32.4224	N	02	05.5333	E	
	52	31.4235	N	02	03.0901	E	
	52	32.1166	N	02	03.6141	E	
	52	31.9234	N	02	0.7903	E	

Geophysical survey data coverage

3.1.3 The geophysical survey undertaken in 2014 for the Pre-Dredge Review for Licence Area 511, 512 and 513 (MarineSpace 2015), partially overlaps Area 1804 (1 and 2) with gaps remaining in the west of Area 1804/1 and in the east of Area 1804/2 (Figure 1).

Search area

3.1.4 A search area comprising a 2 km buffer of the boundary of Area 1804/1 and 1804/2 was used for obtaining records from relevant archive databases. The wider search area allows for a greater understanding of the wider archaeological baseline environment, with the dual



purpose of enabling any archaeological trends within the region to be recognised and to allow any heritage assets identified to be represented in a broader archaeological context.

- 3.1.5 All data for heritage assets located within this search area are stored on the Wessex Archaeology archive network and can be made available on request

3.2 Archaeological desk-based assessment

Key themes

- 3.2.1 The methodology follows the best practice professional guidance outlined by the Chartered Institute for Archaeologists' (CIfA) *Standard and Guidance for Historic Environment Desk-Based Assessment* (2014, updated 2020).

- 3.2.2 The marine themes relevant to marine archaeological baseline as assessed in this report are:

- Palaeogeography (for example, palaeochannels and other features that contain prehistoric sediment, and derived Palaeolithic artefacts e.g. handaxes), including their setting;
- Seabed features, including maritime sites (such as shipwrecks and associated material including cargo, obstructions and fishermen's fasteners) and aviation sites (aircraft crash sites and associated debris), including their setting; and
- Historic seascape character.

Data sources

- 3.2.3 A number of sources of information were consulted in order to compile the DBA element of this report. Data generated from marine geotechnical and geophysical surveys were also a main component of the data.

- 3.2.4 This assessment was compiled from the following data sources:

- a geoarchaeological assessment of 54 vibrocores acquired within Area 1804 (1 and 2);
- the United Kingdom Hydrographic Office (UKHO) data for charted wrecks and obstructions;
- the National Marine Heritage Record (NMHR) maintained by Historic England, comprising data for terrestrial and marine archaeological sites, find spots and archaeological events;
- *Licence Area 511, 512 and 513 Pre-Dredge Review* (MarineSpace 2015), which partially overlapped Area 1804 (1 and 2) and contained information regarding seabed features identified from sidescan sonar (SSS) and multibeam bathymetry surveys (MBES) commissioned by CEMEX in 2014, obtained by GEOxyz and archaeologically assessed by MSDS Marine;
- geophysical survey datasets (SSS and MBES) acquired by GEOxyz in 2014, and MBES datasets acquired by GEOxyz in 2016, partially covering the study areas;

- records of recovered archaeological material recovered from the within the study area and reported via the Marine Aggregates Industry *Protocol for Reporting Finds of Archaeological Interest* (BMAPA and English Heritage 2005);
- the National Heritage List for England maintained by Historic England, comprising data of designated heritage assets including sites protected under the *Protection of Military Remains Act 1986* and the *Protection of Wrecks Act 1973*;
- the Historic Seascape Characterisation (HSC) report for Newport to Clacton and Adjacent Waters (Oxford Archaeology 2011);
- relevant mapping including Admiralty Charts, historic maps and Ordnance Survey; and
- relevant documentary sources and grey literature held by Wessex Archaeology, and those available through the Archaeological Data Service and other websites (presented in the 'References' section of this document).

3.2.5 For clarity, duplicate entries (i.e., heritage assets or archaeological events that had been listed in more than one dataset) have been removed, with only a single listing for each heritage asset remaining. Maritime Recorded Losses are referred to in the text using the NMHR identification number.

3.2.6 A bibliography of documentary sources consulted is presented in the Reference section of this report.

Data structure

3.2.7 This report is supported by a Geographic Information System (GIS) using ArcGIS 10.8, incorporating the positional information of the various data sources listed above, allowing the data to be spatially analysed. The data were subsequently compiled into appendices of the palaeogeographic, maritime and aviation resources within the study area.

3.2.8 Within this assessment, the appendices are compiled and presented in Universal Transverse Mercator (UTM) Zone 31 North projected from a World Geodetic System (WGS) 1984 datum. Any data not already in this co-ordinate system have been converted using the conversion programme Quest Geodetic Calculator, version 8.0.0.1.

3.2.9 Information relating to the marine heritage that did not include location or positional information were also used to inform the marine archaeological baseline assessment where relevant.

Chronology

3.2.10 Archaeological material is generally studied within a framework of 'periods' or 'ages' that reflect the activities and cultural changes taking place over time. All dates are referred to as BC (Before Christ), BP (Before Present) or AD (Anno Domini) within the text. By convention, BC refers to calibrated radiocarbon chronology that can be considered equivalent to calendar years. BP dates are used for periods of time older than circa 10,000 years ago.

3.2.11 A list of the main archaeological periods in Britain referred to in the text, along with their broadly defined dates are presented in Appendix 1.



Palaeogeography

- 3.2.12 The baseline assessment for palaeogeography was undertaken based on a range of secondary sources, including academic papers, monographs, geological information (e.g. BGS mapping), and previous work undertaken by Wessex Archaeology within the North area and the wider region. This has been enhanced by the geoarchaeological review of geotechnical vibrocores located within the study area to produce a stratigraphic framework for understanding the archaeological potential of the Quaternary geology within the area investigated.
- 3.2.13 This baseline for the palaeogeographic assessment aids in producing a stratigraphy for the study area, assigning archaeological potential to identified units, and informing future sampling strategies.
- 3.2.14 The locations of the vibrocores are compiled in Appendix 3 and the results of the Stage 1 geoarchaeological review are presented in Appendix 5, which was used to understand the palaeogeographic baseline of the area.

Seabed features: maritime and aviation sites

- 3.2.15 The baseline summary for maritime and aviation archaeology was assessed by means of accessing any records of sites, wrecks, casualties and other seabed features obtained from the UKHO and NMHR located within the study area. Geophysical anomalies identified within the study area from the Pre-Dredge Review for Areas 511, 512 and 513 (MarineSpace 2015) were also incorporated. No additional primary archaeological assessment of geophysical data was undertaken, but additional targets were identified during an assessment of previous works (listed in section 3.2.4). Findspots of archaeological material recovered from the study area was also accessed from the Marine Aggregates Industry Protocol for Reporting Finds of Archaeological Interest.
- 3.2.16 The data obtained were reviewed and those located within the study area were extracted and compiled to form a gazetteer of the known seabed features. These records were each given a unique identifier beginning with 2001 and continuing sequentially (Appendix 6) and were added to the project GIS.
- 3.2.17 The gazetteer indicates those records of seabed features that are located within the boundaries of Area 1804/1 and 1804/2, where impact on the seabed is expected, and also those features located within the 500 m buffers where impact on the seabed is less likely but not unexpected depending on the size of the seabed feature and its Archaeological Exclusion Zone (AEZ), if applicable.
- 3.2.18 For anomalies covered by the available geophysical datasets, coordinates were obtained from the MBES data, with the 2016 dataset used primarily where possible. With anomalies that were not visible in the MBES data positions were obtained from the SSS. For archaeological features not covered by the geophysical datasets that were recorded in both the UKHO and NMHR datasets, the co-ordinates from the UKHO have been used in the gazetteer and in the figures. As these relate to survey co-ordinates, they have been assessed as likely to be more accurate.
- 3.2.19 Each anomaly has been attributed a Wessex Archaeology ID number. As this has primarily been an assessment of anomalies previously identified, the external ID number has been provided in Appendix 5. The anomalies provided by the MarineSpace assessment are prefixed with MS_.

- 3.2.20 Data relating to Recorded Losses were also extracted from the NMHR data sources. Recorded Losses are records for ships or aircraft that are known to have wrecked or crashed offshore, but for which the exact locations are not known. Recorded Losses are often grouped by area into Maritime Named Locations by the NMHR. For example, a Recorded Loss within this dataset may be based on the loss of a vessel 'off the coast at Lowestoft' or associated with a known navigational hazard such as a sand bank or rocks (which may give rise to a falsely precise geographic coordinate for the record). The positional data of these records is unreliable and serves only to provide an indication of the types of vessels that passed through the area and the wrecking incidents that are known to have occurred in the general region. Whilst the remains of these vessels and aircraft are expected to exist somewhere on the seafloor, their location is unknown. As such, they signify the potential maritime and aviation resource.
- 3.2.21 Details regarding Recorded Losses, whose Named Location happens to be located within the study area, are presented in a gazetteer format (Appendix 6 and 7). These records have retained their original identification assigned by the NMHR for ease of cross-referencing. The gazetteer does not include positional data due to the inaccuracies therein.
- 3.2.22 Archaeological material recovered during previous dredging activities within the study area have also been incorporated into the assessment and are presented in Appendix 8. However, since none of the material indicates a coherent archaeological site that could be impacted from future dredging and the material has subsequently been recovered, no positional information is included.
- 3.2.23 The baseline assessment of maritime and aviation archaeology was further supplemented by a review of relevant primary and secondary source material to provide an indication of the nature of maritime and aviation activity across the region. As well as summarising the known archaeological resource, the baseline assessment underlines the potential for encountering unknown shipwreck and aircraft crash sites within the study area.

Historic seascape characterisation

- 3.2.24 In accordance with the European Landscape Convention, 'landscape' can be defined as 'an area, as perceived by people, whose character is the result of the action and interaction of natural and / or human factors' (Council of Europe 2000, Article 1). The term 'seascape' can be defined as a subset of 'landscape', and has 'an area of sea, coastline and land, as perceived by people, whose character results from the actions and interactions of land and sea, by natural and / or human factors' (*ibid.*).
- 3.2.25 Seascape assessment reflects the holistic approach to landscape of the European Landscape Convention, extending it to the sea. Seascape Character Areas include coastal land, intertidal and marine environments and cover the offshore environment to the territorial limit (12 nm). HSC assessment is the identification and interpretation of the historic dimension of the present day coastal and marine environment (Historic England's Characterising Historic Seascape webpage, accessed February 2022).
- 3.2.26 The baseline summary for character of the historic seascape within the study area was assessed using the results of Oxford Archaeology's *Historic Seascape Characterisation: Newport to Clacton and Adjacent Waters* (2011).



3.3 Geoarchaeological review of vibrocores

Introduction

- 3.3.1 To help frame geoarchaeological investigations of this nature, Wessex Archaeology have developed a five-stage approach, encompassing different levels of investigation appropriate to the results obtained, accompanied by formal reporting of the results. The stages are summarised in Table 2.
- 3.3.2 This report outlines the results of a Stage 1 geoarchaeological review of vibrocores, as detailed in Table 2, with recommendations made for further geoarchaeological work if deemed necessary.

Table 2 Staged approach to geoarchaeological investigations

Stage	Description
Stage 1: Geoarchaeological review	Desk-based review of geotechnical and geological data. Establish likely presence/ absence/ distribution of archaeologically relevant deposits. Identify deposits or samples for Stage 2 works.
Stage 2: Geoarchaeological recording/monitoring	Target deposits or samples identified in Stage 1. Describe the sequences recovered and undertake deposit modelling (if suitable). Interpret depositional environment (if possible). Identify if suitable deposits are present for Stage 3 works.
Stage 3: Palaeoenvironmental assessment	Sub-sample deposits of archaeological interest for palaeoenvironmental assessment (e.g. pollen, plant macrofossils, foraminifera, ostracod and diatoms) and associated scientific dating. Provide an outline interpretation of the archaeological and palaeoenvironmental context. Any recommendations for Stage 4 works will depend on the potential for further analysis and the project research objectives.
Stage 4: Palaeoenvironmental analysis	Full analysis of samples and additional scientific dating as specified in Stage 3, together with a detailed synthesis of the results, in their local, regional or wider archaeological and palaeoenvironmental context. Publication would usually follow from a Stage 4 report.
Stage 5: Publication	Publication of the results of Stage 1-4 works for submission in a peer reviewed journal, book or monograph, depending on the archaeological significance of the work. The scope and location of the final publication will be agreed in consultation with the client and regulatory bodies where appropriate.

Geotechnical coring strategy

- 3.3.3 A total of 54 vibrocores have been acquired within Area 1804 during two separate geotechnical survey campaigns in 2018 (CMS Geotech 2018) and 2019 (CMS Geotech 2019). An extensive suite of vibrocores from the wider East Anglian region were reviewed as part of the Palaeo-Yare catchment assessment (Wessex Archaeology 2013a; 2013b) but none are located directly within Area 1804 so have not been included in this assessment, although they have been used to provide a wider geological context.
- 3.3.4 Vibrocores were retrieved using a High Penetration Corer during both surveys and target depth was 6 m with an average penetration and recovery of 5.6 m and 4.8 m, respectively. Samples were split, logged and photographed and the full geotechnical report, including geotechnical descriptions, core photographs and the results of particle size distribution analysis, was provided to Wessex Archaeology for review.



- 3.3.5 The suitability of geotechnical samples for geoarchaeological purposes was assessed according to the drilling/coring strategy employed, using the criteria outlined in Table 3. Samples used in this assessment have been assigned Category A.

Table 3 Assessment criteria for suitability of geotechnical samples for geoarchaeological purposes

Category	Description
A	Continuous record of deposits recovered with minimal disturbance. Structure and stratigraphy is largely intact. Can be a whole round core or the preserved half of a split core. Cores of this quality are typically recovered using vibrocore or continuous coring methods.
B	Discontinuous record of deposits recovered with minimal disturbance, usually due to a combination of open hole drilling with intermittent coring (e.g. shelby tube), structure and stratigraphy largely intact.
C	Continuous record of deposits recovered. Low recovery or disturbance related to the nature of the deposit (e.g. loose sediment), or due to cores being extruded into bags. Structure and stratigraphy typically not fully preserved.
D	Discontinuous record of deposits recovered resulting from a combination of open hole drilling with intermittent coring, low recovery or disturbance related to the nature of the deposit (e.g. loose sediment), or due to cores being extruded into bags. Structure and stratigraphy typically not fully preserved.

3.3.1 A full list of boreholes/vibrocores included in this assessment is shown on Figure 3 and given in Appendix 3.

Stage 1 review of geotechnical logs

3.3.2 Each of the 54 geotechnical vibrocore logs were reviewed by a trained geoarchaeologist following the guidance set out in COWRIE (2011). Interpretations were made regarding the probable depositional environments and formation processes of the sampled deposits. This data is presented in Appendix 4.

3.3.1 Deposits recovered in vibrocores were interpreted in terms of their geoarchaeological potential. Of greatest geoarchaeological potential are sediments from former terrestrial depositional environments, as well as certain features or inclusions of possible archaeological and palaeoenvironmental interest, specifically:

- peat layers;
- deposits containing other organic material such as wood fragments, roots, dark organic staining etc.;
- clay or silt deposits, especially those containing laminated features such as lacustrine varves or tidal rhythmites;
- inorganic fossils (such as molluscs);
- concentrations of charcoal;
- individual artefacts such as pieces of flint or pottery (though finding these within core samples is rare), and;
- any other feature thought to indicate a terrestrial depositional environment.

3.3.2 The results of the Stage 1 geoarchaeological review were considered alongside the mapped extent of key deposits as outlined in the legacy deposit model (Figure 3) to refine understanding of the geological sequence within Area 1804 (Figure 4).



3.4 Geophysical methodology

Data sources

3.4.1 A number of data sources were consulted during this assessment, including:

- Client supplied previous archaeological assessment undertaken by MSDS Marine (MarineSpace 2015);
- Geophysical survey datasets (SSS and MBES) acquired by GEOxyz in 2014, and MBES datasets acquired by GEOxyz in 2016, partially covering the study areas;
- Recorded wreck and obstruction data acquired via the United Kingdom Hydrographic Office (UKHO);
- Relevant background mapping from the area (admiralty charts received from UKHO).

Geophysical data – technical specifications

3.4.2 The geophysical data were acquired by GEOxyz during 2014 and 2016 and comprises SSS and MBES data sets.

3.4.3 The coverage of the SSS and MBES data was not complete over the study areas (Figure 1).

3.4.4 The SSS deployed for the survey was an Edgetech 4200 dual frequency towfish operating simultaneously at 100 kHz and 400 kHz frequencies with a 100 m range and a line spacing of approximately 85 m. The SSS data were digitally recorded using EdgeTech Discover software, and provided to Wessex Archaeology as .xtf files and a georeferenced mosaic.

3.4.5 The MBES data were acquired using a Kongsberg Dual Head EM3002 system, operating at a frequency of 400 kHz in 2014. There is no information available on the data acquisition during 2016. The MBES data were provided to Wessex Archaeology as tidally-reduced ungridded .xyz files. The data were gridded using a cell size of 1 m.

3.4.6 Further details on the equipment used is in Table 4.

Table 4 Summary of survey equipment

Survey Company	Survey Vessel	Data Type	Equipment	Data Format
GEOxyz	Geosurveyor XI	MBES 2014	R2Sonic SONIC 2014	.xyz
		SSS	Edgetech 4200 (100 / 400 kHz, 75m range)	.xtf
		Positioning	Trimble BD690 GPS	N/A

Geophysical data – processing

3.4.7 The geophysical datasets were processed separately using the following software (Table 5).

Table 5 Software used for geophysical assessment

Dataset	Processing Software	Interpretation and rationalisation
MBES	QPS Fledermaus v7.8.12	ArcMap v10.6.1
SSS	CodaOctopus Survey Engine v5.11	

3.4.8 The MBES data were analysed to identify any unusual seabed structures that could be shipwrecks or other anthropogenic debris. The data were gridded at 1 m and analysed using QPS Fledermaus software, which enables a 3-D visualisation of the acquired data and geopicking of seabed anomalies.

3.4.9 The high frequency .*xtf* SSS data files were processed using CodaOctopus Survey Engine Sidescan+ software. This allowed the data to be replayed with various gain settings in order to optimise the quality of the images.

3.4.10 The data were consulted to assess wreck extents and identify any associated debris fields. Targets provided by the original survey were also checked to ensure positioning accuracy.

Geophysical data – data quality

3.4.11 Once processed, the geophysical data sets were individually assessed for quality and their suitability for archaeological purposes, and rated using the following criteria (Table 6).

Table 6 Criteria for assigning data quality rating

Data quality	Description
Good	Data which are clear and unaffected or only slightly affected by weather conditions, sea state, background noise or data artefacts. Seabed datasets are suitable for the interpretation of upstanding and partially buried wrecks, debris fields, and small individual anomalies. The structure of wrecks is clear, allowing assessments on wreck condition to be made. Subtle reflectors are clear within SBP data. These data provide the highest probability that anomalies of archaeological potential will be identified.
Average	Data which are moderately affected by weather conditions, sea state and noise. Seabed datasets are suitable for the identification of upstanding and partially buried wrecks, the larger elements of debris fields and dispersed sites, and larger individual anomalies. Dispersed and/or partially buried wrecks may be difficult to identify. Interpretation of continuous reflectors in SBP data is problematic. These data are not considered to be detrimentally affected to a significant degree.
Below Average	Data which are affected by weather conditions, sea state and noise to a significant degree. Seabed datasets are suitable for the identification of relatively intact, upstanding wrecks and large individual anomalies. Dispersed and/or partially buried wrecks, or small isolated anomalies may not be clearly resolved. Small palaeogeographic features, or internal structure may not be resolved in SBP data.
Variable	This category contains datasets where the individual lines range in quality. Confidence of interpretation is subsequently likely to vary within the study area.

3.4.12 The SSS data have been rated as ‘Average’ using the above criteria table. The data were acquired at a range of 100 m which should make the identification of most major features possible, although smaller, more subtle features may be difficult to detect at this range. Some of the data were subject to cable snatching and some positioning irregularities affected the data quality. Therefore, there was some obscuration of features, and some smaller features may have been hidden. Overall, these factors did not detrimentally affect the data to a significant degree, and the data were considered suitable for archaeological interpretation.

3.4.13 The MBES data were rated as ‘Good’ using the above criteria. The data was found to have some minimal data distortion. However, the resolution of 1 m was deemed suitable for the



positioning of anomalies over 5 m, as no primary archaeological assessment was undertaken.

Geophysical data – assessment and discrimination

- 3.4.14 This geophysical data assessment was undertaken primarily to reaffirm the results of an archaeological assessment that was undertaken in 2015 (MarineSpace 2015) and comprised targeting individual features identified during the previous assessment to add any additional description or discrimination if necessary. Therefore, no primary archaeological interpretation of the geophysical data was undertaken. Any previously unreported anomalies added during this assessment were to highlight the maximum potential area of debris surrounding wrecks, or to highlight distinct features that may pose an issue during works.
- 3.4.15 Once each anomaly had been identified in the appropriate dataset, a discrimination flag was added to the record. Only anomalies covered by a geophysical dataset were attributed a flag. These flags are ascribed as follows (Table 7).

Table 7 Criteria discriminating relevance of identified features to proposed scheme

Overview classification	Discrimination	Criteria
Seabed features	A1	Anthropogenic origin of archaeological interest.
	A2	Uncertain origin of possible archaeological interest.
	A3	Historic record of possible archaeological interest with no corresponding geophysical anomaly.
	A4	Position of geophysical anomaly at which no anthropogenic features were identified, either visually or on sensors, during subsequent ROV/diver survey.
Non-archaeological features	U1	Not of anthropogenic origin.
	U2	Known non-archaeological feature / Feature of non-archaeological interest.
	U3	Recorded loss.
Non-impact	O1	Outside horizontal footprint of study area.
	O2	Outside vertical footprint of proposed impact.
	O3	Area subsequently cleared after data acquired, anomaly/object recovered.
	O4	Anomaly/feature identified during previous assessments but since likely to have been disturbed or moved by natural seabed processes. Unlikely to be at original location. New location unknown.
	D	Anomaly/feature subsequently confirmed as UXO and detonated <i>in situ</i> .

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

3.4.17 Any anomalies located outside of the defined study areas, either previously recorded in known databases or identified during this geophysical assessment, are deemed beyond the scope of the current assessment and are subsequently not included in this report.

3.5 Assessment of setting

3.5.1 The NPPF (Ministry of Housing, Communities and Local Government 2012) defines setting as ‘the surroundings in which a heritage asset is experienced. Its extent is not fixed and may change as the asset and its surroundings evolve. Elements of a setting may make a positive or negative contribution to the significance of an asset, may affect the ability to appreciate that significance, or may be neutral.’

3.5.2 Currently, there is no specific guidance regarding the assessment of setting for offshore archaeological and cultural heritage assets. However, Historic England’s *The Setting of Heritage Assets – Historic Environment Good Practice Advice in Planning 3* (2015) provides general guidance, largely applicable to terrestrial sites, and notes that the importance of setting ‘lies in what it contributes to the significance of the heritage asset’ (Historic England, 2015: 4). With regards to significance for heritage policy, the *National Planning Policy Framework* notes that the interest of a heritage asset ‘may be archaeological, architectural, artistic or historic’ (Ministry of Housing, Communities and Local Government 2012).

3.5.3 Historic England states that setting depends on a ‘wide range of physical elements within, as well as perceptual and associational attributes pertaining to, the heritage asset’s surroundings’ (Historic England 2015, 4). One aspect that contributes to the setting of a heritage asset is referred to as ‘views’, which includes not only views that can contribute to its significance, but also intended views between heritage assets, and planned views. In addition, the guidance suggests that the appreciation of the setting of a site does not depend on the ability to access it (*ibid.*) Reference in the guidance is also made to the setting associated with buried heritage assets which may not be readily appreciated by a casual observer, but retains a presence in the landscape such as, for example, wreck sites that are periodically, partly or wholly submerged. In addition, the location and setting of historic battles, with otherwise no visible traces, may include important strategic views, routes by which opposing forces approached each other and a topography that played a part in the outcome (*ibid.* 4-5).

3.5.4 In order to assess whether, how and to what degree setting contributes to the significance of heritage assets, the following must be considered: the physical surroundings of the asset including its relationship with other heritage assets; the way the asset is appreciated, and the asset’s associations and patterns of use.

3.5.5 The assessment of setting in this document follows the guidance discussed in the paragraphs above, is based on the baseline assessment of the palaeogeography, maritime and aviation assets, and is described using the following two factors:

- physical surroundings and views – which includes the physical presence of the asset on the seabed, its surroundings, and relationship with other assets and navigational hazards in the immediate area. Views to and from the asset, and how the asset is experienced in its immediate physical surroundings are also considered; and;
- non-visual factors – including the way the asset is appreciated in a broader historical, artistic and intellectual capacity, and the asset’s associations.



- 3.5.6 It should be noted that for heritage assets offshore, sites are generally only experienced by divers, remotely operated vehicle (ROV) or by geophysical survey, and the views to the asset are often very limited due to reduced visibility in the water column. In addition, unlike many terrestrial sites, the position of the asset on the seabed has not been deliberately chosen, and although some sites may have reached their position through military action (e.g. hitting a mine within a known minefield or in a battle) or have been lost due to a particular navigational hazard (e.g. being stranded on a particular sandbank), many positions are entirely arbitrary, and even with military sinking events, an attack on the surface could lead to a wreck being deposited on the seabed miles from where the event took place. Non-visual factors may include associations with particular battles, wars, minefields and other historic events, as well as how the wreck can be appreciated in its wider context, for example through well-known trade routes, collisions or local industry. Association between the asset and the local social history is another important aspect of an asset's non-visual importance, including rescue attempts or losses occurring within modern memory.
- 3.5.7 It is not possible to ascertain the setting of currently unidentified marine heritage assets, where limited information is known, for example wrecks that have not been identified or characterised to determine their period of build, use or loss. Similarly, setting cannot be assessed for geophysical anomalies of archaeological potential or potential sites that have not yet been discovered.

3.6 Assumptions and limitations

Archaeological data

- 3.6.1 The records held by the UKHO, NMHR and the other sources used in this assessment are not a record of all surviving cultural heritage assets, rather a record of the discovery of a wide range of archaeological and historical components of the marine historic environment. The information held within these datasets is not complete and does not preclude the subsequent discovery of further elements of the historic environment that are, at present, unknown. In particular, this relates to buried archaeological features.

Geotechnical data

- 3.6.2 Data used to compile this report consists of primary geotechnical survey data and secondary information derived from a variety of sources. The assumption is made that the secondary data, as well as that derived from other secondary sources, is reasonably accurate.

Geophysical data

- 3.6.3 The geophysical data, while suitable for archaeological assessment, does not fully cover the study area so any anomalies outside the data coverage will not be identified. The methodology employed for this assessment was to specifically target anomalies identified during a previous phase of work (MarineSpace 2015). As such, Wessex Archaeology cannot comment on the archaeological potential of features located beyond the vicinity of the targeted anomalies.



4 HIGH-LEVEL ENVIRONMENTAL APPRAISAL CRITERIA

- 4.1.1 The perceived value of each marine archaeological asset is generally assessed and assigned on a site-by-site basis, depending on the criteria listed in Table 4. The UK MPS (DEFRA 2011, 90) describes a heritage asset as holding a degree of significance. Significance relates to the heritage interest of an asset that may be archaeological, architectural, artistic or historic.
- 4.1.2 The sensitivity of an asset is a function of its capacity to accommodate change and reflects its ability to recover if it is affected. The sensitivity of the asset will be assessed with regard to the following factors:
- adaptability - the degree to which an asset can avoid or adapt to an effect;
 - tolerance - the ability of an asset to accommodate temporary or permanent change without significant adverse impact;
 - recoverability - the temporal scale over and extent to which an asset will recover following an effect; and
 - value - a measure of the asset's importance, rarity and worth.
- 4.1.3 Archaeological and cultural heritage assets cannot typically adapt, tolerate or recover from physical impacts resulting in material damage or loss caused by development. Consequently, the sensitivity of each asset is predominantly quantified only by their value.
- 4.1.4 Based on Historic England's *Conservation Principles, Policies and Guidance for the Sustainable Management of the Historic Environment* (Historic England 2008, 21), the significance of a historic asset 'embraces all the diverse cultural and natural heritage values that people associate with it, or which prompt them to respond to it'.
- 4.1.5 Within this document, significance is weighed by consideration of the potential for the asset to demonstrate the following value criteria:
- evidential value - deriving from the potential of a place to yield evidence about past human activity;
 - historical value - deriving from the ways in which past people, events and aspects of life can be connected through a place to the present. It tends to be illustrative or associative;
 - aesthetic value - deriving from the ways in which people draw sensory and intellectual stimulation from a place; and
 - communal value - deriving from the meanings of a place for the people who relate to it, or for whom it figures in their collective experience or memory. Communal values are closely bound up with historical (particularly associative) and aesthetic values, but tend to have additional and specific aspects.
- 4.1.6 With regards to assessing the value of shipwrecks, the following criteria listed in Historic England's *Ships and Boats: Prehistory to Present - Designation Selection Guide* (Historic England 2012) can be used to assess an asset in terms of its value:
-



- period;
- rarity;
- documentation;
- group value;
- survival/condition; and
- potential.

4.1.7 These aspects help to characterise each asset whilst also comparing them to other similar assets. The criteria also enable the potential to contribute to knowledge, understanding and public engagement to be assessed.

4.1.8 The value of known archaeological and cultural heritage assets were assessed on a five-point scale using professional judgement informed by criteria provided in Table 4 below.

Table 8 Criteria to assess the archaeological value of marine heritage assets

Value	Definition
High	<ul style="list-style-type: none">• Best known or only example and/or significant potential to contribute to knowledge and understanding and/or public engagement. Assets with a demonstrable international dimension to their importance are likely to fall within this category.• Receptors with a demonstrable international dimension to their importance are likely to fall within this category.• Wrecked ships and aircraft that are protected under the <i>Protection of Wrecks Act 1973</i>, <i>Ancient Monuments and Archaeological Areas Act 1979</i> or <i>Protection of Military Remains Act 1986</i> with an international dimension to their importance, plus as-yet undesignated sites that are demonstrably of equivalent archaeological value.• Known submerged prehistoric sites and landscapes with the confirmed presence of largely <i>in situ</i> artefactual material.
Medium	<ul style="list-style-type: none">• Average example and/or moderate potential to contribute to knowledge and understanding and/or public engagement.• Receptors with a demonstrable district level dimension to their importance are likely to fall within this category.• Includes wrecks of ships and aircraft that do not have statutory protection or equivalent significance, but have moderate potential based on a formal assessment of their importance in terms of build, use, loss, survival and investigation.• Prehistoric deposits with moderate potential to contribute to an understanding of the palaeoenvironment.
Low	<ul style="list-style-type: none">• Below average example and/or low potential to contribute to knowledge and understanding and/or public engagement.• Receptors with a demonstrable local dimension to their importance are likely to fall within this category.• Includes wrecks of ships and aircraft that do not have statutory protection or equivalent significance, but have low potential based on a formal assessment of their importance in terms of build, use, loss, survival and investigation.• Prehistoric deposits with low potential to contribute to an understanding of the palaeoenvironment.
Negligible	<ul style="list-style-type: none">• Poor example and/or little or no potential to contribute to knowledge and understanding and/or public engagement. Assets with little or no surviving archaeological interest.
Unknown	<ul style="list-style-type: none">• There is not presently enough information available about the site to assess its value



- 4.1.9 Furthermore, *On the Importance of Shipwrecks* (Wessex Archaeology 2006) suggests importance can be assessed through the following criteria: build, use, loss, survival and investigation.
- 4.1.10 In general, the *Selection Guide on Boats and Ships in Archaeological Contexts* (Wessex Archaeology 2008b) drew some generalisations about importance based on the age of the wreck:
- Pre-1500 AD: this covers the period from the earliest Prehistoric evidence for human maritime activity to the end of the medieval period, circa 1508. 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 value;
 - 1501-1815: this encompasses 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 are also quite rare, and can be expected to be of special value;
 - 1816-1913: this period 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 value;
 - 1914-1945: this period encompasses the First World War, the Interwar years and the Second World War. 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; and
 - Post 1945: the final period extends from 1946 through the post-war years to the present day. Vessels from this date range would have to present a strong case if they are to be considered of special interest.
- 4.1.11 According to this composite timeline, vessels that pre-date 1816 are likely to be considered of special value on the basis of their rarity and subsequent national and international value in our understanding of maritime activity and shipping movements during these periods.



5 MARINE ARCHAEOLOGICAL ASSESSMENT: PALAEOGEOGRAPHY

5.1 Geological and Archaeological Background

- 5.1.1 The following provides an overview of the geological and archaeological history of the submerged East Anglia region from the Pleistocene to final submergence during Holocene marine transgression. This is based on a range of secondary sources, including academic papers, geological information (e.g. BGS mapping), and previous work undertaken by Wessex Archaeology in the East Anglia region and wider southern North Sea. Of particular relevance to Area 1804 is the extensive research (Wessex Archaeology 2013a; 2013b; Tizzard *et al.*, 2014; 2015) and operational sampling monitoring program (Wessex Archaeology 2021) that has been ongoing since 2007.
- 5.1.2 In 2007/2008, Palaeolithic artefacts, including handaxes, flakes and cores, as well as a series of animal bones (woolly mammoth, woolly rhino, bison, reindeer and horse) were discovered by Mr Jan Meulmeester in stockpiles of gravel at SBV Flushing Wharf (Firth 2011; Tizzard *et al.* 2014). The finds were identified from stockpiles and reject piles between 7 December 2007 and 18 March 2008, in aggregate that had been dredged from Licence Area 240. The fresh condition of some of the artefacts indicated that they came from relatively undisturbed deposits. Comparison of the dates when material was recovered with the movements of the dredgers supplying the wharf revealed that the finds had been dredged from a small area within Licence Area 240. In order to prevent any damage to remains within the area, Hanson Aggregate Marine Ltd. voluntarily implemented an AEZ covering this area.
- 5.1.3 Between 2008 and 2013, Wessex Archaeology undertook a series of multi-disciplinary projects in order to understand the palaeogeography and archaeology of the area and to improve the future management of the potential effects of aggregate dredging on the marine historic environment. The *Seabed Prehistory: Site Evaluation Techniques (Area 240)* project was undertaken between 2008 and 2011 (Wessex Archaeology 2011a), and it included the acquisition and interpretation of geophysical data, geotechnical data, seabed sampling, vibrocoreing, palaeoenvironmental assessment, analysis and dating. This was followed in 2011 by a programme of archaeological monitoring of aggregate dredging within Licence Area 240 and its subsequent processing in Holland, commissioned by HAML (Wessex Archaeology 2011b). The project trialled methods of bulk sampling the seabed using standard aggregate dredging plant in order to intercept and evaluate artefacts, and evaluate the presence/absence, distribution, character, quality and preservation of Palaeolithic artefacts in Licence Area 240.
- 5.1.4 The work carried out in Licence Area 240 highlighted the fact that the evaluation of the relationships between the archaeology and palaeogeography could not effectively be carried out on a licence-by-licence basis, and the industry and aggregate companies acknowledged that a regional approach was required. The *Palaeo-Yare Catchment Assessment* project was undertaken, aiming to map key Palaeo-Yare sediment deposits and develop hypotheses about the archaeological potential of the region in order to support decisions relating to the assessment and management of future marine aggregate operations (Wessex Archaeology 2013a; 2013b, Tizzard *et al.* 2014; 2015).
- 5.1.5 The assessment of prehistoric character of the region has revealed a complex history of deposition and erosion. Eight sediment units were identified, dating from the Late Pliocene/Early Pleistocene to marine deposits associated with the last transgression in the Holocene (section 5.4). Each stratigraphic unit was correlated to a geological epoch or sub-epoch using British nomenclature (e.g. Wolstonian). However, the terms have been updated in this report to reflect the North West European nomenclature, in order to align with the

internationally recognised formal time subdivision of the Quaternary Period. As a result, Wolstonian has been replaced with Saalian and Devensian replaced with Weichselian.

- 5.1.6 The flint artefacts recovered from Licence Area 240 were interpreted as being principally associated with a specific glaciofluvial sediment, Unit 3b (Wessex Archaeology 2015). Deposited during the Saalian, Unit 3b forms a floodplain deposit of the middle Pleistocene channel of the Palaeo-Yare.
- 5.1.7 Additional finds recovered throughout the region and reported through the Marine Aggregate Industry *Protocol for Reporting Finds of Archaeological Interest* (BMAPA and English Heritage 2005) further highlighted the potential for prehistoric artefacts to be recovered.
- 5.1.8 A provisional WSI was produced, the rationale for which is discussed in more detail elsewhere (i.e., Ward *et al.* 2014), followed by an updated WSI (Fjodr 2015), which proposed Operational Sampling events for archaeological assessment of aggregate at wharves. The Operational Sampling work was conceived in order to allow the development of a regional framework which would result in a better understanding of the prehistoric archaeological resource in the region in terms of its distribution, significance and the mitigation of effects from marine aggregate dredging.
- 5.1.9 The results of a series of Operational Sampling events carried out by the aggregate licence operators between May 2012 and December 2014 were summarised in the previous interpretative report (Wessex Archaeology 2015). This comprised 21 operational sampling events, in 9 of the 15 short-term licence areas (and sub-areas). Overall, 14 lithics and numerous faunal remains were recovered from c. 80,000 tonnes of aggregate. Although it was a relatively small number of finds, they furthered the archaeological understanding of the region and allowed for the assessment of a number of hypotheses. The discoveries included material reflecting Levallois flaking from Licence Areas 240 and 212, indicating a background level of hominin activity, at a low level based on the number of finds, broadly comparable in date to the previous finds from Licence Area 240. The artefacts had not undergone a significant degree of post-depositional disturbance and could be considered *in situ*. Other recovered Palaeolithic material was less diagnostic, but probably post-dated 400,000 BP. There was also evidence for a Late Upper Palaeolithic blade (with the date suggested by the lithic's size, type and suggestions of faceting) as well as other lithics associated with the early Holocene channel cutting into the Palaeo-Yare floodplain deposits. No artefacts of that age had previously been recovered in the region. The assessment concluded that Licence Area 240 remains a 'hot spot' for discoveries.
- 5.1.10 The discoveries from Licence Area 240 were assessed as of national significance, as they meet at least four of the criteria set out in *Identifying and Protecting Palaeolithic Remains* (Historic England 1998). The finds include material in fresh condition suggesting they were from an undisturbed primary context; the remains belong to a period and geographic area where evidence of human presence was particularly rare or was previously unknown; there are well-preserved indicators of the contemporary environment; and the sediment deposits have a clear stratigraphic relationship.
- 5.1.11 In addition, Historic England's *Sites of Early Human Activity: Scheduling Selection Guide* (Historic England 2018) notes that the discoveries from Licence Area 240 are of comparable significance to the prehistoric sites of Boxgrove and Happisburgh, where rare *in situ* deposits were discovered, dating to over 800,000 BP (Parfitt *et al.* 2005; 2010, Lewis *et al.* 2019).

- 5.1.12 The significance of the Licence Area 240 discoveries has been shared widely through journal articles (such as Tizzard *et al.* 2014) and a monograph (Tizzard *et al.* 2015).
- 5.1.13 Evidence from the Palaeo-Yare can contribute to the research questions set out in the following Research Frameworks:
- *Research and Conservation Framework for the British Palaeolithic* (English Heritage and the Prehistoric Society 2008a);
 - *North Sea Prehistory Research and Management Framework* (Peeters *et al.* 2009);
 - *Research and Archaeology Revisited: a revised framework for the East of England* (Medlycott 2011); and
 - *People and the Sea: A Maritime Research Agenda for England* (Ransley *et al.* 2013)

5.2 Legacy deposit model

- 5.2.1 A deposit model was constructed as part of the Palaeo-Yare Catchment Assessment (Wessex Archaeology 2013a; 2013b) by integrating over 2,500 line km of sub-bottom profiler data from 22 surveys that occurred between 1989 and 2011, and geotechnical information from 1,171 vibrocore logs acquired between 1988 and 2011. This vast data set was used to define the stratigraphy of key deposits in the region and map their extent (Table 9; Figure 2).
- 5.2.2 Each stratigraphic unit was correlated to a geological epoch or sub-epoch using British nomenclature (e.g. Devensian). However, here we adopt North West European nomenclature to align with the internationally recognised formal time subdivision of the Quaternary Period (Cohen and Gibbard 2019). As a result, the terms Wolstonian and Devensian have been replaced with Saalian and Weichselian.
- 5.2.3 Eight stratigraphic units were identified, dating from the Late Pliocene/Early Pleistocene to the Holocene (**Error! Reference source not found.**Table 9). The area is dominated by two palaeochannel features: Channel A which is interpreted to have formed during the Late Anglian (~430 ka), and Channel B, which is a younger, shallow channel that dates to the Early Holocene. Although these channels are of different ages, they both represent an offshore extension of the Palaeo-Yare river system (Figure 2).
- 5.2.4 The Palaeo-Yare valley developed at the end of the Anglian Glaciation ~430 ka and has continued to develop through to the present day. During cooler periods when sea-levels were lower, sands and gravels were deposited and during warmer climatic periods, when the sea-level was higher, the lower reaches of the Palaeo-Yare valley was slowly inundated, changing from fluvial, to estuarine and where sea-levels were high enough, shallow marine environments.
- 5.2.5 During these times of high sea level, the upper reaches of the Yare would have remained a river but with some tidal influence. The main phase of development of the floodplain occurred during the cooling period from Marine Isotope Stage (MIS) 9 interglacial to the MIS 8 glacial (~300 to ~250 ka) and the floodplain continued to develop during this cold phase. It is these sediments, classified as Unit 3b, from which the Middle Palaeolithic Assemblage was dredged in Area 240.

5.2.6 Assessment of the geophysics and geotechnical data indicate that Unit 3b sediments are regionally extensive and are associated with a wide floodplain deposit orientated east-west and 12 km wide (Figure 2). Although Unit 3b does not occur throughout the entire block of Marine Aggregate Licence Areas, its distribution does extend across a number of individual licence areas within the region. Generally, the floodplain deposits in the west and south are thinner than elsewhere (~2 m to 4 m thick). Within the channel and to the east the units are typically 2 m to 6 m thick.

Table 9 Lithostratigraphy of the offshore Palaeo-Yare catchment

Unit	Interpretation	Age	Description
8	Marine deposits associated with the last transgression in the Holocene	Holocene	Shelly, gravelly medium to coarse sand.
7	Basal fill of a shallow under-filled channel feature (equivocal to onshore lower Breydon Formation)	Early Holocene	Only observed to the northwest of Area 240 and also a small patch in the south western corner. It comprises a basal unit of peat approximately 0.2 m thick overlain by a unit of sandy or shelly clay. Infilling of Channel B.
6	Glaciofluvial alluvium	Possibly mid-Weichselian	Sandy gravel.
5	Possibly represents an estuarine or near coastal depositional environment	Unknown, possibly contemporary with unit 6	Slightly gravelly, slightly silty, fine to medium grained sand infilling depressions.
4	Brown Bank Formation	Early Weichselian	Unit 4 is a very distinctive unit generally associated with the buried channel feature in the north of Area 240 interpreted as the infilling of a cut sequence. It is comprised of fine-grained sediments (sands, silts and clays) deposited in a low-energy environment such as river or estuary.
3b	Reworked glaciofluvial outwash	Saalian	Unit 3b overlies Unit 3a in the channel and directly overlies Unit 2 throughout the central and western area. It is comprised of sands and gravels.
3a	Reworked glaciofluvial outwash	Saalian	A channel (Channel A) infill deposit that is associated with a channel feature probably cut into Unit 2 during the Late-Anglian glaciation. Unit 3a is the deepest, and oldest, fill primarily associated with the channel feature in the northeast and comprises gravel and sand.
2a/b	Yarmouth Roads Formation	Cromerian	Unit 2a generally comprises silty, gravelly, fine to coarse sands. Observed throughout the majority of Area 240 and generally overlies Unit 1. To the south of Area 240 Unit 2b comprises silty sand with very frequent thin beds and laminae of firm to stiff clay and peaty organic clay.
1	Westkapelle Ground Formation	Pliocene/Early Pleistocene	The deepest unit and is observed across Area 240

5.3 Geoarchaeological review of vibrocores

5.3.1 A total of 54 vibrocore logs were reviewed as part of the Stage 1 geoarchaeological assessment works, with the aim of identifying deposits of potential geoarchaeological interest with recommendations for further geoarchaeological work, if necessary. Outline

descriptions based on geotechnical logs are presented in Appendix 4, accompanied by an initial interpretation of the deposits in relation to the lithostratigraphic scheme for the Palaeo-Yare catchment (Table 9). No sub-bottom profiler data were assessed for Area 1804 (1 and 2). This assessment relates only to the vibrocore logs.

- 5.3.2 The lowermost unit recovered in 28 vibrocores is characterised by a medium dense to dense, brownish grey, fine sand that is often silty and occasionally clayey in places and can comprise pockets of black silt and/or fragments of organic matter and shell. These deposits correlate to Yarmouth Roads Formation (Unit 2). In places, Unit 2 is buried below overlying sediments (see Unit 3b below) but in five vibrocores (VC-T01, VC-T05, VC-T05A, VC-T24 and T26) it was recorded as outcropping at seabed (Figure 4).
- 5.3.3 The legacy deposit model in this region shows there are areas where Unit 2 outcrops at seabed within a large underfilled Holocene palaeochannel (Channel B) (Figure 4) and it is expected that incision and erosion of this channel removed overlying deposits thus exposing Unit 2 at seabed. However, there are some discrepancies between the vibrocores assessed here and the legacy deposit model; Unit 2 does not outcrop in Channel B in the south as expected whereas in northern part of Channel B, Unit 2 appears to outcrop across a broader area beyond the margins of Channel B.
- 5.3.4 In the eastern region of Area 1804/2, Unit 2 does not outcrop at seabed but removal of overlying Unit 3b means it subcrops below a thin veneer of seabed sediments (Unit 8). The absence of Unit 3b in this region was considered to reflect historical dredging activity (Wessex Archaeology 2013a; 2013b). The results here suggest the footprint of this historical dredging is less than expected (see discussion of 3b below) and Unit 2 subcrops at shallow depths only in the very eastern part of Area 1804/2.
- 5.3.5 At one location (VC-T20) in the eastern part of Area 1804/2, a 0.37 m thick laminated to finely bedded grey black silty sand and silty peat was described at the base of the core. The deposit was overlain by Unit 3b (see below for overview) providing a stratigraphic context that suggests it predates formation of the Palaeo-Yare floodplain (between MIS 9 to 6). Organic deposits of this age are rare within the wider catchment but were previously recognised by Tizzard *et al.* (2014) and assigned to Unit 2b which is a sub unit of Yarmouth Roads Formation, characterised by silty sand with thin beds and laminae of clay and peaty organic clay. The organic deposits in VC-T20 are therefore correlated to Unit 2b. Unit 2b is not an extensive deposit and may not always be recognised in seismic data. Its presence in the Palaeo-Yare catchment is therefore acknowledged; but it cannot be mapped across wide areas.
- 5.3.6 Overlying Unit 2 (including Unit 2b) a medium dense red to brown sandy gravel and gravelly sand was recovered in 43 vibrocores (Figure 4). This deposit is the most extensive in Area 1804 and shows characteristics of Unit 3b (Table 5) which formed in a cold climate floodplain setting and is the target aggregate resource within the East Anglia region. Unit 3b typically outcrops at seabed (at 33 locations) or is overlain by a thin veneer of seabed sediments (Unit 8) which have a patchy distribution across Area 1804.
- 5.3.7 By comparing the results of this assessment with the legacy deposit model, the extent of Unit 3b is much broader than previously thought and it covers the majority of Area 1804 with the exception of the northern part of Area 1804/1 and the most eastern part of Area 1804/2 (Figure 4). Of interest, Unit 3b appears to be preserved within Channel B which suggests more recent (Holocene) processes have not fully removed Unit 3b within this channel. Furthermore, historical dredging in the eastern part of Area 1804/2 did not fully remove Unit 3b as it is present in areas where it was previously considered to be absent.

5.3.8 In two vibrocores (VC-T09 and a repeat attempt VC-T09A), a black to dark brown, laminated, silty, sandy, fibrous peat was recorded ranging in thickness from 0.11 m to 0.18 m. Vibrocores VC-T09 and VC-T09A are located within the Holocene age Channel B in the south of Area 1804/1 (Figure 4) and Unit 7 characterises a basal peat deposit (up to 0.2 m thick) at the base of this channel. The deposits in VC-T09 and VC-T09A are therefore correlated to Unit 2 and likely formed in or along the margins of a palaeochannel during the early Holocene. The distribution of Unit 7 is sporadic but confined to Channel B and the results here support that observation.

5.3.9 The uppermost deposits recovered in 15 vibrocores were occasionally clayey, silty, gravelly, sand with frequent shell fragments. These deposits represent seabed sediments and correlate to Unit 8. Seabed sediment thickness across Area 1804 is relatively thin and varies between 0.13 m and 0.65 m with a patchy distribution.

5.4 Geoarchaeological and archaeological potential

5.4.1 The oldest deposits in Area 1804 correlate to Yarmouth Roads Formation (Unit 2) which formed in a deltaic environment during the Early Pleistocene (Cameron *et al.* 1992). OSL dating of Yarmouth Roads Formation sediments within the East Anglian region has returned dates of 577 ± 65 ka (MIS 14) (Wessex Archaeology 2008a) and 735 ± 134 ka (MIS 18) (Tizzard *et al.* 2015) suggesting deposition over a period of known occupation of Britain during the Cromerian (MIS 13-21; 478-866 ka). However, given these deposits formed in a shallow marine deltaic environment, the potential for minimally disturbed archaeological material or sites is considered low although there is potential for the deposits to contain reworked archaeological material which has been evidenced through the reporting of faunal remains through the MAI protocol from Unit 2 in the neighbouring licence area, Area 511 (Wessex Archaeology 2021).

5.4.2 The Yarmouth Roads Formation correlates stratigraphically to Crag Group onshore (Moorlock *et al.* 2000) and the upper parts of Yarmouth Roads may correlate to the Cromer Forest-bed Formation which is associated with the key Lower Palaeolithic finds at Happisburgh and Pakefield (Parfitt *et al.* 2005). Organic mud, peat or fragments of organic matter can be preserved in Yarmouth Roads Formation representing shallowing of the deltaic environment. The recovery of Unit 2b (silty peat) in VC-T20 suggests there is potential for organic beds of Yarmouth Roads Formation to be present in Area 1804. However, the age, and stratigraphic and palaeogeographic relationship between organic beds of the Yarmouth Roads Formation (Unit 2b) and the Cromer Forest-bed Formation is unknown making it difficult to determine the archaeological significance of these deposits. These organic deposits do however have the potential to preserve palaeoenvironmental material which can be used as a biostratigraphic marker or provide information on climate and environmental conditions at the time of deposition. Given their expected age (Cromerian; MIS 16-22), these deposits cannot be radiocarbon dated and their organic nature makes them unsuitable for luminescence dating.

5.4.3 Overlying Unit 2 are coarse grained gravelly sand deposits (Unit 3b) which form the principal floodplain deposits of the offshore extents of the Palaeo-Yare (Wessex Archaeology 2013a; 2013b; Tizzard *et al.* 2014; 2015). Unit 3b does not correlate directly to the broader southern North Sea lithostratigraphic framework (Stoker *et al.* 2011) as they are local in extent, limited to the Palaeo-Yare catchment.

5.4.4 Unit 3b is the most widespread deposit within the submerged Palaeo-Yare valley system and comprises gravelly sand, and sand and gravel, interpreted to have been deposited in a cold-climate glaciofluvial floodplain setting. Deposition of Unit 3b occurred between MIS 9-MIS 7 according to Optical Stimulated Luminescence (OSL) dating (Wessex Archaeology

2011a; Limpenny *et al.* 2011), although recent chronological modelling suggests a MIS 7 age (Marshall *et al.* 2020). The archaeological potential of Unit 3b is high with hundreds of lithics and faunal remains reported to date from Unit 3b across the wider East Anglia marine aggregate licence areas (Tizzard *et al.* 2014; Wessex Archaeology 2021). Archaeological and faunal assemblages broadly agree with the OSL dates and suggest an Early Middle Palaeolithic occupation of the Palaeo-Yare floodplain.

- 5.4.5 A silty, sandy, fibrous peat (Unit 7) was recovered in two vibrocores located within Channel B, a large palaeochannel that represents the Late Weichselian (MIS 2; 115-11.7 ka) to Early Holocene (MIS1; 11.7 ka to present day) offshore extension of the Palaeo-Yare. Unit 7 deposits reflect infilling of Channel B under the influence of rising sea level during the Early Holocene and correlate to the Breydon Formation onshore (Moorlock *et al.* 2000). Organic deposits of this age have high potential to preserve palaeoenvironmental material that can be used for radiocarbon dating and to reconstruct environmental history in the context of human activity. A small number of Mesolithic age lithics have been recovered from Channel B in neighbouring marine aggregate licence areas providing evidence of Mesolithic occupation of the Palaeo-Yare floodplain. These finds were not associated directly with Unit 7 but they do indicate there is potential for archaeological material to be present within Channel B.

Setting

- 5.4.6 The setting of seabed prehistory features is integral to their value and importance. Although there are no views to the features nor ways they can be experienced on the seabed, their position is critical to how palaeolandscapes were experienced by past peoples, and their non-visual setting includes international research into the Palaeolithic and Mesolithic periods across Europe. If further relevant information regarding these features becomes available in the future, then an assessment of their setting may be undertaken.

6 MARINE ARCHAEOLOGICAL ASSESSMENT: MARITIME AND AVIATION SITES

6.1 Introduction

- 6.1.1 The following assessment of the maritime and aviation marine archaeological baseline resource is based on records of known shipwrecks, aircraft crash sites and obstructions combined with Recorded Loss information and findspots recorded via the *Protocol for Reporting Finds of Archaeological Interest* (BMAPA and English Heritage 2005). Geophysical seabed features identified within the Area 1804 study area from the Pre-Dredge Review for areas 511, 512 and 513 (MarineSpace 2015) have also been incorporated in this assessment. Additional seabed features identified from the SSS and MBES survey data have also been included where relevant.
- 6.1.2 It should be noted that the 2014 geophysical data assessed for the Pre-Dredge Review does not cover the entirety of Area 1804 (1 and 2), as shown in Figure 1. As there has not yet been an archaeological geophysical assessment of geophysical survey data for the entire study area, there is potential for the discovery of previously unidentified shipwreck and aircraft crash sites on or below the seabed (Section 6.4).
- 6.1.3 As well as summarising the known archaeological resource, the baseline assessment underlines the potential for encountering unknown shipwreck and aircraft crash sites within the study area. Relevant primary and secondary source material has also been utilised to understand the nature of maritime and aviation activity across the region.



6.1.4 Any future geophysical or geotechnical data that is undertaken within the study area should be subject to archaeological review in order to establish a more accurate and up to date ground truthing of the proposed aggregate areas.

6.2 Designated maritime and aviation sites

6.2.1 There are currently no sites within Area 1804/1 or 1804/2 that are subject to statutory protection from the *Protection of Wrecks Act 1973*, the *Protection of Military Remains Act 1986* or the *Ancient Monuments and Archaeological Areas Act 1979*; the three legislative acts that could be used to protect marine archaeological sites.

6.3 Known maritime and aviation sites

6.3.1 Compiling records from the UKHO and NMHR, and following assessment of the geophysical survey datasets (SSS and MBES) acquired by GEOxyz in 2014 and MBES datasets acquired by GEOxyz in 2016 over MarineSpace's 2015 geophysical anomalies produced the following results:

- nine sites (**2001-2006** and **2026-2028**) are located within the boundary of Area 1804/1 and a further six sites (**2007-2012**) are located within the 500 m buffer that forms the extent of the study area for Area 1804/1; and
- four sites (**2013-2016**) are located within the boundary of 1804/2 and a further ten sites (**2017-2025** and **2029**) are within the 500 m buffer that forms the study area for Area 1804/2.

6.3.2 The locations of these records are shown on Figure 5. Further details regarding these 29 records are presented below and in Appendix 5.

Area 1804/1 boundary

6.3.3 Within the boundary of Area 1804/1, there are nine seabed features. Details of their archaeological discrimination and probable type are presented in Table 10 below.

Table 10 Features located within the boundary of Area 1804/1

Archaeological discrimination	Interpretation	Number of features	Anomaly type
A1	Anthropogenic origin of archaeological interest	1	Wreck (2001)
A2	Uncertain origin of possible archaeological interest	7	Obstruction (2002) Rope/chain (2004) Mound (2005, 2026) Seabed disturbance (2006) Dark reflector (2027, 2028)
U1	Not of anthropogenic origin	1	Dark reflector (2003)

6.3.4 Interpreted as a wreck, **2001** is identified in the SSS data as an elongate area of numerous dark reflectors that appears unclear and distinct in some areas, believed to be debris. The site is observed in the MBES data as a sub-rounded mound covering an uneven area. There are two distinct rounded mounds in the centre measuring 8.1 x 7.0 x 3.0 m. A sand wave is visible partially covering the anomaly and so further buried material is likely to be present within the vicinity. This site corresponds with an unidentified dangerous wreck described by the UKHO (10430) as being almost entirely buried in a sand wave. The mast/funnel is reported as being visible amidships from a survey undertaken in 1982, which are potentially

represented by the central mounds visible in the data. The wreck will be avoided by the implementation of an AEZ.

- 6.3.5 One record (**2002**) discriminated as an A2 is interpreted as debris and was identified in the SSS data as a rounded dark reflector with a bright shadow. Observed in the MBES data as a rounded mound situated in encircling scour that extends predominantly to the south for 38.8 m. This feature corresponds with a UKHO record (10677) that relates to an obstruction identified as a substantial rock measuring 30 m x 12 m x 4.7 m. At present, the feature is considered to be of uncertain origin of possible archaeological interest and therefore should be avoided.
- 6.3.6 The remaining A2 records relate to a length of rope or chain (**2004**) and five sites of possible debris, visible on the geophysical survey data as mounds (**2005** and **2026**), seabed disturbance (**2006**) and dark reflectors (**2027** and **2028**). It is recommended that these sites are avoided.
- 6.3.7 Anomaly **2003** was identified in the SSS data and interpreted as a natural feature and, as such, there is no recommended mitigation for this site. However, best-practice would recommend avoidance of the site.

Area 1804/1 500 m buffer

- 6.3.8 Within the 500 m buffer of Area 1804/1 forming the extent of the study area, there are six seabed features. Details of the archaeological discrimination and probable type of the five sites identified in the geophysical survey data are presented in Table 11 below. The remaining site (**2008**) was not covered by the geophysical survey and refers to a UKHO and NMHR record. None of these sites are located within 100 m of the boundary of Area 1804/1 and therefore any exclusion zone placed around the site will most likely not extend into the dredging area.

Table 11 Features located within the 500 m buffer of Area 1804/1

Archaeological discrimination	Interpretation	Number of features	Anomaly type
A1	Anthropogenic origin of archaeological interest	1	Wreck (2007)
A2	Uncertain origin of possible archaeological interest	3	Dark reflector (2009, 2011, 2012)
U1	Not of anthropogenic origin	1	Dark reflector (2010)

- 6.3.9 *Castle Galleon* (**2007**) is recorded by the UKHO (10446) as a substantial dangerous wreck site. The highly broken-up shipwreck was identified in SSS data as an elongate area of irregular dark reflectors, many with shadows. There are some parallel dark reflectors at right angles to the wreck orientation that indicate some structural elements remain cohesive. Some irregular areas of immediately adjacent seabed may indicate further buried debris. The wreck lies on an approximate east to west alignment and measures 54.4 x 13.7 x 5 m. The British merchant steamship, *Castle Galleon*, was built in 1927 and was lost en route between Newcastle-Upon-Tyne and Dieppe whilst carrying a cargo of coal. The ship sunk following a collision with the Swedish steamship, *SS Oscar Garthon* on the 2nd of June 1932. It is recommended that the site, given the archaeological discrimination of A1, is avoided by the implementation of an AEZ.
- 6.3.10 An unidentified dangerous wreck (**2008**) is described by the UKHO as a broken wreck, intact and upright measuring 1.7 m long, 9.7 m wide and 4.3 m high. The NMHR's record



describes the site as being entirely buried. This site was not covered by the geophysical survey. It is recommended that this site be avoided by the implementation of a 100 m AEZ around the UKHO's position.

- 6.3.11 The remaining three A2 features relate to areas of possible debris, visible on the geophysical data as dark reflectors (**2009**, **2011** and **2012**). Record **2009** is located approximately 80 m to the north of wreck site **2007** and may be related. It is recommended that these sites are avoided.
- 6.3.12 Feature **2010** was identified in the SSS data and interpreted as a natural feature and, as such, there is no specific mitigation for this site. However, best-practice would recommend avoidance of the site.

Area 1804/2 boundary

- 6.3.13 Within the boundary of Area 1804/1, there are four seabed features. Details of their archaeological discrimination and probable type are presented in Table 12 below.

Table 12 Features located within the boundary of Area 1804/2

Archaeological discrimination	Interpretation	Number of features	Anomaly type
A1	Anthropogenic origin of archaeological interest	1	Wreck (2013)
A2	Uncertain origin of possible archaeological interest	2	Debris (2015) Dark reflector (2016)
A3	Historic record of possible archaeological interest with no corresponding geophysical anomaly	1	Dark reflector (2014)

- 6.3.14 Interpreted as the remains of a broken-up wreck with some clear structural elements still intact, feature **2013** was identified in SSS data as a distinct area of irregular dark reflectors with distinct shadows. Debris is visible particularly along the west side of the wreck. Observed in the MBES data as an elongate mound, oriented NNW-SSE that appears to decrease in size towards the north. There are a series of sand waves that interact with anomaly, particularly towards the south, and indicate the potential for buried material. This site corresponds with the UKHO record (11029) for *Pluton*, a steamship that foundered after hitting a mine on 9 November 1914 whilst travelling from London to Christiania with a cargo of corn. The UKHO records this site as a dangerous wreck. It is recommended that the site, given the archaeological discrimination of A1, is avoided by the implementation of an AEZ.
- 6.3.15 A seabed anomaly interpreted as debris was identified in both the SSS and MBES data as a mound (**2015**). There is no clear source, which may indicate the potential for further buried material. It is recommended that this feature is avoided.
- 6.3.16 One area interpreted as possibly being debris or a natural feature relates to a dark reflector only visible in SSS data (**2016**) and it is recommended that this feature is avoided.
- 6.3.17 The remaining anomaly interpreted as possibly being debris or a natural feature (**2014**) was initially recorded by the UKHO (11026) in 1945 as an obstruction, but was not identified in subsequent surveys, the most recent of which was in September 2016. Furthermore, no clear associated feature was identified in the geophysical data. It is possible that the feature is buried and may still exist in the area, therefore at present it should still be included as a potential seabed feature, and it is recommended that the area is avoided.

Area 1804/2 500 m buffer

- 6.3.18 Within the 500 m buffer of Area 1804/2 forming the extent of the study area, there are ten seabed features. Details of the archaeological discrimination and probable type of the seven sites identified in the geophysical survey data are presented in Table 13 below. The remaining three sites (**2018**, **2019** and **2020**) were not covered by the geophysical survey and refer to UKHO and NMHR records for a dispersed wreck.

Table 13 Features located within the 500 m buffer of Area 1804/1

Archaeological discrimination	Interpretation	Number of features	Anomaly type
A1	Anthropogenic origin of archaeological interest	3	Wreck (2017 , 2021) Debris (2029)
A2	Uncertain origin of possible archaeological interest	3	Dark reflector (2023) Rope/chain (2024) Seabed disturbance (2025)
U1	Not of anthropogenic origin	1	Dark reflector (2022)

- 6.3.19 Three of the seabed features (**2018**, **2021**, and **2029**) are located within 100 m of the boundary of Area 1804/2 and their exclusion zones extend inside the dredging area.
- 6.3.20 Interpreted as the remains of a wreck, feature **2017** was identified in the SSS data as a large, poorly defined dark reflector with some shadow and observed in the 2016 MBES data as an irregularly shaped elongate mound on an approximate east to west alignment. Located in an area of sand waves and is partially obscured by a smaller sand wave, indicating the higher potential for buried material. Also visible in the 2014 dataset as a slightly more irregular mound with some smaller adjacent mounds visible, likely indicating debris. It measures 31.7 x 9.4 x 5.5 m in the 2014 dataset. The site corresponds with the UKHO record (11031) for the wreck of *Cormead*, considered a dangerous wreck. The UKHO describes the site as largely intact and partially buried measuring 28.7 m x 10 m x 4.8 m. Built in 1939, this British cargo vessel struck a mine on 25 December 1941 whilst travelling from London for the Tyne in ballast. It is recommended that the site, given the archaeological discrimination of A1, is avoided by the implementation of an AEZ. Seabed feature **2024** is located just over 80 m to the north-east and may be related. This feature is interpreted as a length of rope or chain and was identified in the SSS data as a curved linear dark reflector with a sub-rounded dark reflector at the north end. The feature measures 4.1 x 2.0 x 0.3 m. This feature is located within the AEZ for **2017** and will therefore also be avoided.
- 6.3.21 Interpreted as the remains of a broken-up wreck with some coherent structural elements still visible, **2021** was identified in the SSS data as an irregular area of irregular dark reflectors, many with distinct shadows. The site was also observed in the MBES data as being more cohesive at the southern end and potentially more intact and appears to be a collapsed part of the hull. The northern end appears more irregular and broken up. Evidence of debris is visible to the east of the site as small irregular mounds. The site corresponds with the UKHO record (11024) for the dangerous wreck of the British steamship, *Rogate*. The ship was torpedoed and lost on 19 March 1945 whilst en route from Sunderland to London with a cargo of coal. It is recommended that the site is avoided by the implementation of an AEZ around the extent of the site, as identified from the MBES data AEZ. Seabed feature **2029** is interpreted as possible debris and is located 15 m to the north-west of **2021** and considered to be related. Identified in the SSS data as an angular dark reflector with some shadow. This feature is located within the AEZ for **2029** and will therefore also be avoided.



- 6.3.22 Records **2018**, **2019** and **2020** all relate to the wreck of the British cargo ship *Knitsley*, which was lost on 12 December 1942 following a torpedo attack by an E-boat. The three records are located within 270 m of each other and may relate to different elements of the ship and associated debris. These sites were not covered by the geophysical survey and these records relate to UKHO and NMHR records. It is recommended that each of these sites be avoided by the implementation of a 100 m AEZ around the UKHO's positions.
- 6.3.23 The two A2 records have been interpreted as either natural features or debris, visible on the geophysical data as a dark reflector (**2023**) and a seabed disturbance (**2025**). It is recommended that these features are avoided.
- 6.3.24 Feature **2022** was identified in both the SSS and MBES data and interpreted as a possible natural feature and, as such, there is no recommended mitigation for this site. However, best-practice would be to avoid the site.

Setting

- 6.3.25 The setting of the known, named wrecks can be taken into consideration. All of the sites have limited views due to being underwater, although some have been explored by divers.
- 6.3.26 Four of the named vessels were lost during the First or Second World War, and therefore their nonvisual setting is within the wider First World War and Second World War military landscape of the study area and beyond. The specific loss events also provide information to how their position setting can be understood: two vessels (**2018/2019/2020** and **2021**) were sunk by German submarines, while one of the vessels (**2013**) was lost having struck a mine. While it is possible that the vessels could have drifted before sinking, it is also possible that the position on the seabed is in close proximity to the wrecking event. Each of these losses is very much a product of its location at the time of loss. For example, the vessel lost due to striking a mine (**2013**), was lost due to its unfortunate position within a mine field, and therefore reflects not only the circumstances of the war, but also the specific methods being used to target ships, and, depending on whether the ship drifted following the event, its position on the seabed could even still be in relatively close proximity to the mine or mine field.
- 6.3.27 One vessel was lost during the war due to collision (**2007**), indicating the high level of vessel traffic in the area, and therefore has setting in the wider navigational routes.
- 6.3.28 It is not possible to assess the setting of the three unidentified wrecks, 16 sites of possible debris, two possible lengths of rope or chain and two natural features. However, should further information come to light regarding their character, their settings should be reviewed.

6.4 Maritime and aviation archaeological potential

Introduction

- 6.4.1 The assessment of potential for the discovery of shipwreck, shipwreck-derived, aircraft and aircraft-derived material within the study area draws on the results of the desk-based research combined with further research of the wider area.
- 6.4.2 Area 1804/1 will be a new aggregate dredging area and as such there is a much higher potential for the discovery of archaeological material from the seabed. This is also the case for much of Area 1804/2. However, dredging activities have already occurred in elements of Area 1804/2 when it was licenced as dredging areas 242, 361B and 361C and it is possible that those areas could have lower archaeological potential. The reporting of archaeological material through the Marine Aggregates Industry Protocol for Reporting

Finds of Archaeological Interest (Appendix 8) have indicated that there is still potential for further discoveries.

- 6.4.3 There is potential for discoveries of maritime craft from the Mesolithic to the modern period. Post-medieval and modern wrecks, as they were generally made of more substantial material, are more likely to have been discovered through surveys undertaken by the UKHO and others, and thus recorded in the archaeological record. However, there is still potential for the discovery of previously unrecorded wreck sites, particularly of wooden wrecks, broken up wrecks or partially buried wrecks that are more difficult to detect through geophysical survey.
- 6.4.4 There is also potential for 20th century aircraft, particularly in relation to the Second World War. Aircraft crash sites are also difficult to identify through archaeological assessments of geophysical survey, although experience indicates material from the site, such as engines or other material may be recorded as small obstructions or anomalies.

Navigational hazards

- 6.4.5 A project entitled Enhancing our Understanding: Mapping Navigational Hazards as areas of Maritime Archaeological Potential, undertaken by Bournemouth University (Merritt *et al.*, 2007) assessed historical records of navigational hazards to interpret and characterise the marine historic environment. Areas assessed to be hazardous were considered alongside a model of the preservation potential of marine sediments with the purpose of identifying areas where there was not only a high potential for ship losses, but where there was also a high potential for the preservation of archaeological remains. These areas were coined as Areas of Maritime Archaeological Potential (AMAPs).
- 6.4.6 The north-west tip of the 500 m buffer of the 1804/1 study area is truncated by two AMAPs that are defined as having a high percentage of fine-grained sediments and therefore a high potential of preservation. This area is a known sand bank called Cross Sands.
- 6.4.7 Two sandbanks, recorded as navigational hazards within the assessment, are located within 4 km to the west of Area 1804/1 and evidence of maritime sinkings caused by these features could exist in their proximity and potentially within Area 1804/1 or 1804/2.
- 6.4.8 Area 1804/1 and 1804/2 are predominantly located within areas of low and medium potential for navigational hazards that are exposed offshore areas, exposed to all wind directions, which could potentially lead to shipping casualties. This is proven by the number of collisions that have occurred in the past, which have been recorded by the NMHR as Recorded Losses (Appendix 6).

Seabed (or potential for preservation)

- 6.4.9 The seabed of Area 1804/1 has been described as mainly sand, gravel with mud in areas, whilst the seabed for Area 1804/2 has been described as mainly gravelly sand.
- 6.4.10 Area 1804/1 has a high percentage of coarse-grained sediments, whilst Area 1804/2 has a high percentage of fine-grained sediments – both of which are targeted during aggregate dredging. Areas of coarse-grained sediments are less likely to provide protection for organic remains, however there is still potential for aluminium and other metal wreckage to be present along with potentially derived or mobile material. Alternatively, a seabed of fine-grained sediments provides very high potential for the preservation of all types of archaeological material.

Marine Aggregate Industry Protocol for the Reporting of Finds of Archaeological Interest

- 6.4.11 Dredging activities have previously occurred within Area 1804/2 when it was licensed as a different area. Discoveries of material reported under the MAI Protocol (Appendix 8) indicates that there is still potential for further discoveries. This is especially true for Area 1804/1 which has not previously been dredged.
- 6.4.12 Co-ordinates have not been provided for the MAI Protocol discoveries listed in Appendix 8 as they are often generated from the centre point of the dredger's trackplot during which the discovery was made, or in more vague cases, the position is the centre point of the licence area. Therefore, these discoveries provide more information about the potential of the area than what is actually located on the seabed.
- 6.4.13 A majority of the discoveries recovered from around the study area relate to prehistoric material including predominantly faunal remains, a sample of peat and one piece of worked flint (e.g. Cemex_0284, Cemex_0296 and Cemex_0340). Considering the proximity of this material to Area 240, there is potential for similar material to be discovered during dredging of Area 1804/1 and 1804/2.
- 6.4.14 Some recovered material has also been identified as having originated from ships including a timber, cannonball, two pulley sheaves and a fishing float, most likely during the post-medieval and modern periods (e.g. Cemex_0600 and Hanson_0008). Although these may be isolated finds, and in the case of the cannonball could be evidence of the Battle of Lowestoft, they could also be associated with wreck sites.
- 6.4.15 Fragments of aircraft have also been reported through the MAI Protocol having been recovered from area 251 (later 511) and 242 (Cemex_0290 and Hanson_0118). These are likely to have come from aircraft that have either crashed or ditched and subsequently there may be an aircraft crash site or more debris located in the vicinity. In the case of Cemex_0290, which are the remains of a McDonnell-Douglas F-4 Phantom flown during the mid-1960s, it is possibly that these elements fell off the plane and a crash site may not exist.

Recorded Losses

- 6.4.16 As discussed in section 3.2, Recorded Losses refer to ships and aircraft that are recorded as having been lost, but for which the exact locations are not known. The records for these losses provide additional documentary evidence for the potential discovery of sites and material relating to maritime and aviation activity within the study area.
- 6.4.17 A list of all maritime and aircraft Recorded Losses in the vicinity of the study area are presented in Appendix 6 and 7. All 19 losses are located within a Named Location that is located to the east of Area 1804/1 within the 500 m buffer of the study area. The losses include 18 ships and one aircraft.
- 6.4.18 All the ships date to the 19th century and modern periods when more accurate records were being maintained and archived. However, there is also potential for earlier vessels whose loss was simply not recorded.
- 6.4.19 Of the 17 vessels that were lost between 1883 and 1912, all but one foundered following a collision with another vessel in poor weather conditions. This clearly indicates both the density of maritime traffic present off the East Anglian coast and also the dangerous nature of maritime travel at this time. The various trade routes are also indicated from these losses and show that vessels were predominantly travelling domestically around the coast but were

also travelling further afield, for example to Norway. The remaining record relates to a vessel that was lost during the First World War having been torpedoed (NMHR_1458077).

- 6.4.20 The final Recorded Loss refers to a Wellington Mk. IC aircraft whose engine cut out en route to Bremen and was forced to ditch into the sea (NMHR_1354147).

Potential for unrecorded maritime archaeology

- 6.4.21 A maritime site may comprise an articulated or partially articulated shipwreck and/or associated debris or infrastructure. Debris can comprise a single artefact through to an entire scatter of material that was either accidentally or deliberately lost from a vessel. As an island nation, the UK has a long maritime history and as such there is potential for archaeological evidence of maritime sites since the area started to become inundated during the Mesolithic period through to the present day within the study area.
- 6.4.22 Many vessels were lost without a record being made and sometimes even records that were created have since been lost (Cant 2013). Consequently, in addition to the charted maritime sites and Recorded Losses, there is also the considerable potential for the discovery of archaeological material of a maritime nature, currently uncharted, to exist within Area 1804 (1 and 2) spanning from the Mesolithic period to the present day.
- 6.4.23 The exploitation of the marine environment could have begun in the Mesolithic, as the landscape of the study area would have been inundated from a terrestrial surface over multiple transgressions until the final gradual inundation mid-way through the Mesolithic when the study area would have become completely submerged.
- 6.4.24 The evidence for Mesolithic maritime craft is very sparse with the earliest example in Northern Europe coming in the form of a logboat from Pesse, Netherlands (c. 7,920 - 6,740 BC; McGrail 2004, 173). Towards the end of the Mesolithic period, it is likely that these types of craft could have been used on the ever-increasing water levels within the study area and the wider region. The landscape of the study area would have been subject to a great change during the inundation of the Mesolithic period and undoubtedly would have provided a wetland/seascape suitable for logboats.
- 6.4.25 Although generally believed to be used for transport and fishing in inland and sheltered waters, ethnographic evidence suggests that logboats have been modified for sea journeys in calm conditions (Wessex Archaeology 2010, 50). 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.
- 6.4.26 The marine transgression of the Mesolithic period saw the 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.
- 6.4.27 The study area has produced no evidence for maritime activity from either the Neolithic or the Bronze Age periods to date. Logboats provide the only archaeological evidence in the UK directly relating to watercraft during the Neolithic period (Wessex Archaeology 2010, 50). However, the lack of finds to date does not suggest a sterile time for maritime activity. The maritime connections between Britain and the rest of Europe that later flourished were being forged during these early periods.

- 6.4.28 By the Neolithic, the coastline and sea-level was very similar to that of the present day. Marine traffic passing through the study area would most likely have been related to trade and the movement of people, using such craft as logboats and hide boats. The comparatively low frequency of this activity compared with later periods, together with the rate of survival of these vessels built from organic materials, would suggest that the likelihood for archaeological remains to survive within the study area is low; however, there is still potential for the preservation of Neolithic watercraft to exist buried within seabed sediments, although the discovery of such material would be exceptionally rare.
- 6.4.29 The Bronze Age saw greater technological advances within Britain and North-west Europe, that brought 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). The maritime industry and boat building technology also advanced significantly during this period. The development from simple dugout boats into modified dugouts and plank-built boats is an example of this. The evidence for continental trade during this period is vast and widespread suggesting that regular organised crossings of the open ocean around Britain occurred during this time. It is suggested that the Bronze Age sewn plank boat recovered from Dover, Kent is an example of the type of vessel that could have been involved within this seafaring trade network (Clark 2004, 210). Equally, the discovery of a small jet plaque object from a multi-period occupation site at South Lowestoft suggests that large scale trade networks already existed with the north of England (Wessex Archaeology 2010, 52).
- 6.4.30 No evidence of Iron Age material has been discovered to date within the study area. Despite the lack of material from this period it is not possible to discount the potential for future discoveries from within the study area. There is very little evidence for seafaring within Britain during the Iron Age, however, the distribution of artefact types and the variety of examples found across North-West Europe suggests a high level of cross-channel trade and it is clear that from at least the Iron Age onwards, seagoing vessels passed through the southern North Sea.
- 6.4.31 The Romano-British period brought with it considerable changes in many aspects of life within Britain. The evidence of this is widespread and can be seen in the archaeological record by way of the influx of new styles and materials. This is also believed to be the case in terms of maritime technology, which included the development of more substantial wooden vessels (see Nayling and McGrail 2004). The more substantial construction would have a better chance of survival in harsher ocean environments. This coupled with the increase in maritime traffic, visiting the developed ports on the Suffolk and Norfolk coasts and rivers, would suggest that there is certainly a higher potential for Romano-British material to be recovered from within the study area than from previous periods. However, no Romano-British remains have been discovered within the study area to date.
- 6.4.32 There are no archaeological evidence dating to the Anglo Saxon or medieval periods from the study area. Along with the scale and variety of maritime activity that was being undertaken within North-West Europe, some of the most important maritime technological advances occurred during these periods. The key advances within the region during these periods were the development of several phases of specialised boat building techniques, each of which came from the influence of foreign technologies and ideas. For example, the Saxon settlers that succeeded the Roman occupation introduced a network of trade and migration routes that extended throughout the southern North Sea, as evidenced by Scandinavian-style clinker-built vessels during the early medieval period.

- 6.4.33 The sewn plank building techniques were soon surpassed by the clinker planking of the Scandinavian region. This new style can be seen in the remains of the Sutton Hoo burial ship. It is an early example of Saxon shipbuilding and clearly shows the adoption of the clinker planking techniques mentioned previously. The Sutton Hoo site, in Suffolk, shows the emphasis that the Saxon people in the region of the Study Area put on boats and seafaring (Evans 1986). The Sutton Hoo burial site is similar to a continental ship find, the Kvalsund Ship, of AD 700, found in western Norway (McGrail 2004).
- 6.4.34 The archaeological record also suggests another introduction into Northern European shipbuilding by the Saxon people and later the Vikings. This comes by way of specialised vessels for specific tasks. Larger boats with the capability of carrying more cargo 50-60 tons sometimes became prevalent within the Hanseatic trading league. At this same time sleeker, shallow drafted and quicker vessels were used for aggressive actions on other boats and even the invasion of coastal settlements across Europe and the British Isles. There is a very low level of maritime finds from this period within the British Isles which is surprising given the amount of international trade that was passing through Britain. The rarity of the remains means that any maritime material deemed to be of this period discovered within the study area would be considered to be of special interest.
- 6.4.35 The medieval period brought with it further advances in shipbuilding technology to the British Isles. The carvel planking technique, believed to have originated from Iberian shipbuilders, allowed for stronger hulled vessels capable of taking a variety of full-rigged sail plans, which meant longer ocean voyages and more cargo carrying capacity. These maritime advances meant vessels could transport goods, people and ideas to new colonies around the world, creating the first real global trade network. The only evidence for this new style of ship within Northern Europe is the iconographic evidence of cogs and hulcs depicted on town seals and coins along with the extremely rare examples of partial timbers.
- 6.4.36 During the medieval period, the southern North Sea and many of the seas around Europe were quickly becoming exploited to a level approaching that of the early modern period. The level of international trade coming into the east coast of England caused the towns and ports which acted as the nodes for new trade to flourish. The growth of these towns and ports indicates the high level of trade and the influence this had on the wider region. It is, therefore, likely that some of this traffic would have intersected parts of the study area. In fact, Norfolk and Suffolk established larger fleets than any other region of England at this time (Williams 1988, 257). With the more substantial ships more frequently crossing the study area comes the heightened potential for remains from this period to survive today than in any period prior to it.
- 6.4.37 The scarcity of evidence for maritime losses during the medieval period is mostly due to the lack of accurate navigation records being taken when and where losses occur. This is why there is an apparent gap in the records given by shipping registers of the time. It goes without saying that with the amount of traffic using the seas for trade and transport at the time that losses of vessels would have occurred, but the inaccuracies in positioning made it impossible to map where and when these occurred with the necessary accuracy to locate them today. This, coupled with the time period that any shipwrecks would have to survive within the harsh ocean environment, is why very few examples of medieval vessels survive within the archaeological record to date. Therefore, if any remains of a medieval date were discovered within the study area they would be of special interest.
- 6.4.38 The ports on the east coast of England, such as Lowestoft and Yarmouth, that were established in the medieval period continued to flourish with smaller coastal ports also seeing increases in shipping due to the higher levels of offshore fishing within the Southern

North Sea in this period (Wilcox 2009). The vessels involved in this trade are likely to have greatly increased maritime activity within the wider region. As a result, the study area is likely to have seen very high levels of shipping traffic passing through which brings with it a higher potential for wreck sites of this period to be discovered than any previous period.

- 6.4.39 Within a century the advance in shipbuilding technological capabilities and cheap ordnance meant that conflicts at sea became organised, larger in scale and more destructive. During the 17th century, two significant naval battles occurred over and in proximity to the 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 during the battle. 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.
- 6.4.40 Towards the end of the post-medieval period, East Anglia was at the forefront of the 'Agricultural Revolution', with grain being the principal export of Norfolk and Suffolk's diverse trade. A number of Parliamentary Acts were passed in order to further expand trade communications that served the farming economy (Gilman 1997). The developed quays of Lowestoft and Southwold and the established ports of Great Yarmouth and King's Lynn played particular roles during this time, along with the Icelandic cod fishing fleets during the mid-seventeenth and eighteenth centuries (Gould 1997).
- 6.4.41 The recording of vessel losses became much more reliable during the modern period which is why the weighting of vessel losses for this period is so high, and not surprisingly, there are numerous vessels in the NMHR dataset for Recorded Losses dating to the 19th century and modern periods.
- 6.4.42 Additionally, all the known charted shipwreck sites date to the modern period. They show that there is considerable potential for wrecks from this period to survive, especially from the 20th century when metal wrecks became more prevalent. The lists of Known Wrecks (Appendix 5) and Recorded Losses (Appendix 6) are by no means definitive as smaller vessels and other ships could easily have been lost without record, and as such could be preserved in seabed sediments within the study area.
- 6.4.43 The modern period is undoubtedly one of the most dramatic in terms of development in shipbuilding. It was during this period that metal became prevalent in ship construction, starting as composite vessels where metal replaced some of the wooden parts to vessels built entirely of iron or steel. In parallel to this physical development, was the change from sail to firstly steam power then later diesel engines as new technologies provided the means of propulsion that powered the vessels of the Industrial Revolution. During this time, the Broads of Norfolk and Suffolk transformed into a patchwork of model farms. Local industries of ironworks, lime works (for building and fertilising) and brickworks emerged in order to supply the demand for local developments. Much of this had to be transported by water, until a reliable railway network was developed by the 1860s (Gould 1997). Additionally, most of the goods being traded around the UK were associated with the industrial output and included bulk cargos of fuel and raw materials. The East coast was especially prevalent within the coal trade as the towns and cities of the North East supplied London with its coal. The study area lay within the parameters of these trade routes (Wessex Archaeology 2003). This is seen by the examples of cargo vessels that make up the known wreck losses (**2007, 2013, 2017 and 2021**).
- 6.4.44 The modern period is also characterised by the two World Wars of the 20th century, which saw a sudden rise in military activity for two relatively short periods. As the region

encompassing the study area had trade from London passing through it, it attracted intensive enemy action throughout both wars. This took the form of attacks by submarine, aircraft and most commonly mines.

- 6.4.45 Both conflicts developed separate strategies with which to disrupt shipping, based around the available technologies of the time, with the East Coast witnessing a large proportion of maritime wartime casualties during both conflicts. For instance, great defensive belts of mines were laid during both World Wars to defend the east coast and coastal shipping and the entrance to the Thames estuary. Additionally, the First World War saw the introduction of coastal convoys, whereby steaming merchant vessels were escorted in groups by warships (Hewitt 2008, 17). The first convoys began on the east coast, and their use continued into the Second World War to transform the east coastal trade route into an indestructible highway (Hewitt 2008, 17-23). The East Coast War Channels were also created during both the First and Second World War (see Fjodr 2014). These were carefully defined routes that were swept clear of mines allowing the movement of civilian shipping and local fishing vessels to move around the country to meet the UK's domestic requirements.
- 6.4.46 The combination of more accurate casualty recordings and the more favourable preservation potential of metal hulled vessels mean that the confidence level that can be ascribed to this assessment of the modern period on the basis of the known resource is higher than that of preceding periods. However, for much of the 19th century and to some extent, the early to mid-20th century (particularly the two World Wars) the quality of positional information being recorded was variable. Additionally, the partial use of wooden hulled vessels, particularly of small local craft which are unlikely to have been viewed to merit recording when lost, may also be present in the study area.

Potential for unrecorded aviation archaeology

- 6.4.47 Within the study area, there is considerable potential for the presence of aircraft crash sites and associated aviation material and debris dating from the early 20th century until more recent times, with a concentration dating to the World Wars and in particular the Second World War, 1939-45.
- 6.4.48 Aircraft which crash over the sea tend to break up on impact, spreading wreckage over a wider area. Similarly, where two aircraft collide in mid-air, and both are subsequently lost at sea, the recorded site of the loss can incorporate a larger debris field, stretching hundreds of metres in diameter. However, controlled ditching or sunken aircraft (such as flying boats lost at their moorings) may remain considerably more intact. An aircraft crash site in the marine zone may comprise an articulated or partially articulated aircraft and/or associated debris or infrastructure. Debris can comprise a single artefact through to an entire scatter of material.
- 6.4.49 Prior to the First World War there was limited commercial civil aviation, however the First World War saw the early development of military aviation and the beginnings of naval aviation. During this period, aircraft were lightweight, and made of wood and other light materials. In the inter-war years, there was increasing cross-channel services to various European and worldwide destinations, and metal largely replaced wood in airframe construction.
- 6.4.50 By the Second World War, aircraft technology had developed considerably. Luftwaffe attacks on the UK early in the war were the predominant reason for flights over the English Channel. By the middle of the war, this emphasis had shifted and the Allies were attacking Continental Europe, principally by bomber fleets based in eastern England and maritime

patrols. There was mass production of aircraft, leading to considerable quantities of aircraft, and a significant amount of flying occurred over the sea.

- 6.4.51 Most aircraft losses at sea are attributed to military aircraft and date from the Second World War, most of which occurred along the south and east coasts of England. The proximity of the study area to the approaches to the River Thames, which would have been a natural navigation marker to pilots, suggests that the activity close by and possibly directly over the study area would have been intense. As the study area is located within a known war time shipping route, from the North of England to London, it is likely that this would have added to the level of aircraft activity in the area. The likely intensity of aviation activity highlights the high potential for aircraft remains to be recovered from within the study area, which is also highlighted by analyses of UK-wide records (Wessex Archaeology 2008c).
- 6.4.52 From the end of the war to the present, civilian air travel has increased. Military aircraft was, until the 1990s, dominated by the Cold War. These aircraft crash events are more likely to have been accurately recorded and positioned, however there is still potential for material.
- 6.4.53 The positions of aircraft crash sites at sea are rarely recorded with any degree of accuracy and the vast majority were based solely on eyewitness estimations or the discovery of wreckage on the surface of the sea, both of which can lead to erroneous assumptions. Records relating to aircraft within the study area relate to one Recorded Loss and two discoveries of aircraft material reported through the MAI Protocol. Consequently, the presence and distribution of aircraft wrecks within Area 526 should not be underestimated.
- 6.4.54 All aircraft that crashed while in military service are automatically protected under the *Protection of Military Remains Act 1986*. If present, such sites would represent statutory constraints upon the proposed development. This legislation means any activities impacting upon the aircraft remains must cease pending assessment by the Ministry of Defence.

7 ASSESSMENT OF HISTORIC SEASCAPE CHARACTER

- 7.1.1 The assessment of the HSC within the study area was undertaken using the results of Oxford Archaeology's *Historic Seascape Characterisation: Newport to Clacton and Adjacent Waters* (2011).
- 7.1.2 When the HSC was undertaken in 2011, it characterised the study area as having the following elements:
- fishing – comprising bottom trawling and demersal trawling;
 - navigation – comprising navigation routes and hazards (submerged rocks); and
 - industry – in the form of aggregate extraction.
- 7.1.3 One of the case studies undertaken for the project seeks to demonstrate the roles of HSC in informing the marine aggregates dredging licensing process (Oxford Archaeology 2011, 43). The case study explains the necessity for aggregate, actively encouraged by the UK government, and the sheer quantity that is recovered from the East Coast.



8 HIGH-LEVEL ENVIRONMENTAL APPRAISAL AND MITIGATION RECOMMENDATIONS

8.1 Summary of value and sensitivity

Introduction

- 8.1.1 The value of the archaeological resource has been assessed based on the criteria identified in section 3.5. The value of the setting of each marine heritage asset is integral to the value of each asset, and therefore this assessment includes both the asset itself and its setting.
- 8.1.2 Based on information available to date, the marine archaeological baseline environment for the study area can be considered to comprise 24 known sites, together with the potential for discovering material relating to palaeogeography, maritime archaeology and aviation archaeology. This section identifies the value of the known and potential heritage assets summarised in the baseline assessments above (sections 5-7).
- 8.1.3 The nature of the archaeological resource is such that there is a high level of uncertainty concerning the distribution of potential, unknown archaeological remains on the seabed. It is often the case that data concerning the nature and extent of sites is out of date, extremely limited or entirely lacking. As a precautionary measure, unknown potential cultural heritage assets are therefore considered to be of high value.

Palaeogeography

- 8.1.4 Although there are no records of any known prehistoric sites within the study area, there is moderate potential for the presence of as yet undiscovered *in situ* prehistoric sites and finds, and a high potential for isolated derived finds in a secondary context.
- 8.1.5 Deposits of high archaeological and geoarchaeological potential were recorded in vibrocores within Area 1804. These include coarse-grained gravelly sands of Unit 3b that are known across the wider Palaeo-Yare catchment to contain internationally significant Palaeolithic archaeological and faunal assemblages (Wessex Archaeology 2013a; 2013b; Tizzard *et al.* 2014; 2015; Wessex Archaeology 2021) and organic peat deposits of Unit 7 that have high potential to preserve organic remains that can provide a palaeoenvironmental and chronological record in relation to Upper Palaeolithic and Mesolithic activity in the East Anglia region. Archaeology that may be associated with these deposits would be considered as high value.
- 8.1.6 An organic deposit of much earlier age (Cromerian; MIS 16-22) was identified at one location and correlated to Unit 2b which are organic beds within Yarmouth Roads Formation. The archaeological significance of this deposits is unknown and largely depends on its age in relation to the archaeologically significant Cromer Forest-bed Formation preserved onshore at Happisburgh and Pakefield (Parfitt *et al.* 2005). Given its expected age, this deposit is not suitable for radiocarbon dating but it may preserve pollen and plant microfossils that will provide a biostratigraphic age. Archaeology that may be associated with these deposits would be considered as high value.

Maritime seabed features

- 8.1.7 The perceived value of an individual asset is generally assessed and assigned on a site-by-site basis, depending on various criteria discussed in section 0. Those regarded as being of special interest may further be designated under relevant legislation applicable to England. At present there are no wrecks with statutory designations located within the study area.



- 8.1.8 Of the wrecks that have been identified and named, there are no known wrecks dating to prior 1900. The oldest wreck, *Pluton* (**2013**), was built in 1901 and the remaining known wrecks date up to 1944. These ships belong to a period when there were great changes being made to the way in which vessels were built and used, and although examples of vessels from this period are generally more numerous in the archaeological record, those that contribute to an understanding of these changes would be considered as having increased value. It is likely that these vessels are considered to be of medium value.
- 8.1.9 The wrecks related to the two World Wars, are amongst the highest volume of recorded vessel losses. However individual examples could be considered of increased value, based on individual histories, associations, whether the vessel illustrates technological changes, and particularly if either build or loss is attributable to military action. One of the vessels, *Pluton*, was lost during the First World War (**2013**) and three were lost during the Second World War, *Cormead*, *Knitsley* and *Rogate* (**2017/2024**, **2018/2019/2020** and **2021/2029** respectively). In general, it is likely that these vessels would be of medium value however, they could be considered to have increased group value, due to their association with international events, and it is possible that vessels lost while in military service could be designated under the *Protection of Military Remains Act* 1986, particularly if associated with loss of life. Therefore, some of these vessels and any associated debris could be considered to be of very high value.
- 8.1.10 One ship, *Castle Galleon* (**2007**), was lost between the wars and is considered to be of low to medium value.
- 8.1.11 For the two wrecks that have not been named and that are of unknown date (**2001** and **2008**), their value is presently unknown, but should be considered as high until proven otherwise.
- 8.1.12 Additionally, the value of any wrecks discovered during dredging activities would also be unknown and would need to be evaluated on a case-by-case basis.
- 8.1.13 Based on the archaeological assessment of the geophysical data the remaining sites interpreted as debris or rope/chain are considered to be of low to medium value, however the value may change if further information is obtained regarding these seabed features.
- 8.1.14 At present it is not possible to assess the value of the remaining obstruction (**2014**) and, as such, it is considered to be of medium to high value until proven otherwise. Should further evaluation reveal them to be wreck-related material, their value will need to be reassessed on a case-by-case basis.
- Aviation seabed features*
- 8.1.15 There are no known aircraft crash sites in the study area. Nonetheless, there is the potential for aircraft or aircraft-related debris to exist on the seafloor within the study area, as evidenced by records of aircraft material reported through the MAI Protocol (Cemex_0290 and Hanson_0118).
- 8.1.16 Given the identified potential of the area for military aircraft crashes, particularly relating to the Second World War, the likelihood would be for any aircraft crash to be of military origin, which would be protected under *Protection of Military Remains Act* 1986 and therefore would be of **high value**.
- 8.1.17 This would include both Allied and Axis aircraft and would relate to both complete aircraft wrecks and debris scatters.

Historic Seascape Character

- 8.1.18 The seascape character of the Study Area is considered to be of medium value due to the area's important and prolonged maritime history and its continued use today.
- 8.1.19 As the HSC already comprises marine aggregate dredging, the application for an additional licence for Area 1804 (1 and 2) since the time of the assessment (Oxford Archaeology 2011) will result in no change to the historic character of the seascape.

Overall sensitivity

- 8.1.20 All archaeological receptors have the potential to be physically damaged, destabilised or destroyed if they are directly or indirectly impacted. Furthermore, all damage to archaeological sites or material is permanent and recovery is limited to stabilisation or re-burial to limit further impact. Archaeological receptors have no recoverability if they are affected by a direct or indirect physical impact. As such, all potential receptors should be regarded as having high sensitivity to direct and indirect physical impacts.

8.2 Mitigation recommendations

- 8.2.1 Archaeological assets relating to the palaeogeography, maritime and aviation archaeology have been identified within the study area, as has the potential for further assets to be discovered. Marine aggregate dredging activities within licence Area 1804 (1 and 2) have the potential to both physically and adversely impact known and potential archaeological receptors within the boundary of the licence area and also cause indirect physical effects such as changes in seabed sediment regimes, scour etc within Area 1804 (1 and 2) and in adjacent dredging areas.
- 8.2.2 Typically, adequate and appropriate mitigation is required to ensure that the archaeological value of the baseline within this report is maintained. Recommendations for appropriate mitigation are set out below.
- 8.2.3 Guidance for mitigation measures relating to marine aggregate dredging are presented in *Marine Aggregate Dredging and the Historic Environment: Assessing, evaluating, mitigating and monitoring the archaeological effects of marine aggregate dredging: Guidance Note* (Wessex Archaeology 2003b). In general, mitigation measures are considered under three main categories: avoidance, reduction of impact, and remedying and offsetting.

Avoidance

- 8.2.4 Government policy recommends the preservation of nationally important archaeological sites *in situ*. Therefore, avoidance is generally considered as the primary option, and appropriately sized AEZs would be established for sites of higher archaeological value. If an archaeologically important site is subsequently discovered during dredging works, a temporary exclusion zone (TEZ) could be established to allow for further investigation to take place. The TEZ would then be re-evaluated, removed or expanded, based on the results of further investigations.
- 8.2.5 For archaeological features of lower archaeological value, AEZs will not be proposed, however avoidance of these features is still recommended. Further work may be necessary to ascertain the precise nature and archaeological potential of individual features should avoidance prove unfeasible.
- 8.2.6 It is recommended that each of the nine wreck sites are given an AEZ of 100 m, either around the extent of the site as recorded in the SSS or MBES data or around the UKHO point (where no geophysical survey data exists) (Table 14).

Table 14 Archaeological Exclusion Zones recommend for Area 1804/1 and 2

ID	Anomaly type	Exclusion zone	Area
2001 (including 2027 and 2028)	Wreck (and possibly associated debris)	100 m around the extent of 2001	1804/1
2007 (including 2009)	Wreck (and possibly associated debris)	100 m around the extent of 2007	1804/1
2008	Wreck	100 m around the UKHO position	1804/1 500 m buffer
2013	Wreck	100 m around the extent of 2013	1804/2
2017 (including 2024)	Wreck (and possibly associated rope/chain)	100 m around the extent of 2017	1804/2 500 m buffer
2018	Wreck	100 m around the UKHO position	1804/2 500 m buffer (AEZ extends into Area 1804/2)
2019	Wreck	100 m around the UKHO position	1804/2 500 m buffer
2020	Wreck	100 m around the UKHO position	1804/2 500 m buffer
2021 (including 2029)	Wreck (and possibly associated debris)	100 m around the extent of 2021	1804/2 500 m buffer (AEZ extends into Area 1804/2)

Reduction

- 8.2.7 Reduction of impact can occur if archaeological material is encountered during the course of dredging by promptly receiving archaeological advice and by recording and conserving any objects that have been disturbed.
- 8.2.8 Furthermore, additional investigation of features with an uncertain identity or archaeological value can often mean their true nature and value can be better understood. Any additional marine geophysical survey, diver or ROV survey footage that takes place within the area should be assessed by a suitably qualified marine geophysicist or marine archaeologist, as appropriate.
- 8.2.9 Appropriate mitigation in this way should mean that these anomalies can either have their archaeological value removed, if they prove to be of non-anthropogenic nature or modern, or their value as archaeological assets confirmed, in which case mitigation in the form of either avoidance (which may be enacted by the implementation of an AEZ) or through remedying or offsetting (through targeted removal such as archaeological excavation or lifting) and reporting of the find through mechanisms such as a MAI's Protocol for Archaeological Discoveries. Details of the protocol are presented in the *Marine Aggregate Industry Protocol for the Reporting of Finds of Archaeological Interest* (Wessex Archaeology 2005). This Protocol reduces the impact of dredging on the marine historic environment by enabling dredging staff to report their finds in a manner that is convenient and effective.

Remedying and offsetting

- 8.2.10 No individual palaeogeographic features of archaeological potential have been identified across the study area. However, deposits of high archaeological and geoarchaeological potential were recorded in vibrocores within Area 1804. These include coarse-grained gravelly sands of Unit 3b that are known across the wider Palaeo-Yare catchment to contain internationally significant Palaeolithic archaeological and faunal assemblages (Wessex Archaeology 2013a; 2013b; Tizzard *et al.* 2014; 2015; Wessex Archaeology 2021) and organic peat deposits of Unit 7 that have high potential to preserve organic remains that



can provide a palaeoenvironmental and chronological record in relation to Upper Palaeolithic and Mesolithic activity in the East Anglia region.

- 8.2.11 An organic deposit of much earlier age (Cromerian; MIS 16-22) was identified at one location and correlated to Unit 2b which are organic beds within Yarmouth Roads Formation. The archaeological significance of this deposits is unknown and largely depends on its age in relation to the archaeologically significant Cromer Forest-bed Formation preserved onshore at Happisburgh and Pakefield (Parfitt *et al.* 2005). Given its expected age, this deposit is not suitable for radiocarbon dating but it may preserve pollen and plant macrofossils that will provide a biostratigraphic age.
- 8.2.12 Organic deposits are typically avoided as part of the resource assessment. However, if dredging occurs within the vicinity of VC-T20 (Unit 2b) VC-T09 and VC-T09A (Unit 7) (Figure 3) any impact may be mitigated by undertaking palaeoenvironmental assessment (pollen and plant macrofossil assessment and associated radiocarbon dating) of the organic deposits recovered in these cores. Therefore, it is recommended these cores are retained for potential further work.
- 8.2.13 As Unit 3b is the target aggregate resource and will therefore be impacted by dredging activity, mitigation during active dredging activities can be delivered through the MAI Protocol and targeted operational wharf monitoring, full details of which will be outlined in a Written Scheme of Investigation through consultation with relevant regulatory bodies and stakeholders.
- 8.2.14 Furthermore, the potential damage to palaeogeographic features can be offset by undertaking future geoarchaeological assessment and sampling of geotechnical vibrocores, which should be completed under the supervision of an appropriately qualified and experienced marine geoarchaeologist and subsequently archaeologically assessed. Method Statements, approved by the Archaeological Curator, should be prepared prior to any such works.



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APPENDICES

Appendix 1: Terminology

Glossary

The terminology used in this assessment follows definitions contained within the Annex 2 of the UK's *National Planning Policy Framework* (Department for Communities and Local Government 2021, 64-73).

Archaeological interest	There will be archaeological interest in a heritage asset if it holds, or potentially may hold, evidence of past human activity worthy of expert investigation at some point. Heritage assets with archaeological interest are the primary source of evidence about the substance and evolution of places, and of the people and cultures that made them.
Conservation (for heritage policy)	The process of maintaining and managing change to a heritage asset in a way that sustains and, where appropriate, enhances its significance.
Designated heritage asset	A World Heritage Site, Scheduled Monument, Listed Building, Protected Wreck Site, Registered Park and Garden, Registered Battlefield or Conservation Area designated under the relevant legislation.
Development Plan	This includes adopted Local Plans, neighbourhood plans and the London Plan, and is defined in section 38 of the <i>Planning and Compulsory Purchase Act 2004</i> .
Environmental Impact Assessment	A procedure to be followed for certain types of projects to ensure that decisions are made in full knowledge of any likely significant effects on the environment.
Heritage asset	A building, monument, site, place, area or landscape identified as having a degree of significance meriting consideration in planning decisions, because of its heritage interest. Heritage asset includes designated heritage assets and assets identified by the local planning authority (including local listing).
Heritage coast	Areas of undeveloped coastline which are managed to conserve their natural beauty and, where appropriate, to improve accessibility for visitors.
Historic environment	All aspects of the environment resulting from the interaction between people and places through time, including all surviving physical remains of past human activity, whether visible, buried or submerged, and landscaped and planted or managed flora.
Historic environment record	Information services that seek to provide access to comprehensive and dynamic resources relating to the historic environment of a defined geographic area for public benefit and use.
Setting of a heritage asset	The surroundings in which a heritage asset is experienced. Its extent is not fixed and may change as the asset and its surroundings evolve. Elements of a setting may make a positive or negative contribution to the significance of an asset, may affect the ability to appreciate that significance or may be neutral.
Significance (for heritage policy)	The value of a heritage asset to this and future generations because of its heritage interest. That interest may be archaeological, architectural, artistic or historic. Significance derives not only from a heritage asset's physical presence, but also from its setting.
Strategic environmental assessment:	A procedure (set out in the Environmental Assessment of Plans and Programmes Regulations 2004) which requires the formal environmental assessment of certain plans and programmes which are likely to have significant effects on the environment.



Chronology

Where referred to in the text, the main archaeological periods in Britain are broadly defined by the following date ranges.

Prehistoric	
Palaeolithic	900,000/800,000 – 10,000 BC
Lower Palaeolithic	900,000/800,000 – 300,000 BC
Middle Palaeolithic	300,000 – 40,000 BC
Upper Palaeolithic	40,000 – 10,000 BC
Late Upper Palaeolithic	12,000 – 10,000 BC
Mesolithic	10,000 – 4000 BC
Neolithic and Early Bronze Age	4,000-1,500 BC
Middle Bronze Age to end of Pre-Roman Iron Age	1,500 BC – AD 43
Historic	
Romano-British	AD 43 - 410
Saxon	AD 410 – 1066
Medieval	AD 1066 – 1500
Post-medieval	AD 1500 – 1800
19th Century	AD 1800 – 1899
Modern	AD 1900 – present day

The geological periods and associated Marine Isotope Stages (MIS) are defined by the following date ranges:

Period	Date range	MIS
Holocene	11,700 – present day	1
Weichselian	115,000 – 11,700 BP	5d – 2
Eemian	130,000 – 115,000 BP	5e
Saalian	374,000 – 130,000 BP	10 – 6
Holsteinian	424,000 – 374,000 BP	11
Elsterian	478,000 – 424,000 BP	12
Cromerian	>478,000 BP	>12

Appendix 2: Legislative, policy and guidance

Global policy and legislation

Legislation/Policy	Summary
The World Heritage Convention 1972	The Convention provides for the identification, protection, conservation and presentation of cultural and natural sites of 'outstanding universal value' for inscription on the World Heritage List. The Convention sets out the duties of States Parties in identifying potential sites and their role in protecting and preserving them. By signing the Convention, each country pledges to conserve not only the World Heritage sites situated on its territory, but also to protect its national heritage. The 1972 UNESCO World Heritage Convention was ratified by the UK in 1984 and the UK currently has 33 World Heritage Sites.
The United Nations Convention on the Law of the Sea 1982	The United Nations Convention on the Law of the Sea 1982 was ratified by the UK in 1997. Article 149 applies only to those archaeological and historical objects that lie outside national jurisdiction and stipulates that 'all objects of an archaeological and historical nature found in the Area shall be preserved or disposed of for the benefit of mankind as a whole, particular regard being paid to the preferential rights of the State or country of origin, or the State of cultural origin, or the State of historical and archaeological origin'. Article 303 stipulates that 'states have the duty to protect objects of an archaeological and historical nature found at sea and shall co-operate for this purpose'. Article 303 also provides for coastal states to exert a degree of control over the archaeological heritage to 24 nm, though the UK has not introduced any measures to implement this right.
International Council of Monuments and Sites Charter on the Protection and Management of Underwater Cultural Heritage 1996 (the Sofia Charter)	The Charter upon which the Annex of the UNESCO Convention is largely based includes a series of statements regarding best practice, intending 'to ensure that all investigations are explicit in their aims, methodology and anticipated results so that the intention of each project is transparent to all'. The UK is a member of the International Council of Monuments and Sites.
UNESCO Convention on the Protection of the Underwater Cultural Heritage (2001)	The UNESCO Convention was concluded in 2001, and is a comprehensive attempt to codify the law internationally with regards to underwater archaeological heritage. The UK abstained in the vote on the final draft of the Convention, however, it has stated that it has adopted the Annex of the Convention, which governs the conduct of archaeological investigations, as best practice for archaeology. Although the UK is not a signatory, the convention entered into force on 2nd January 2009 having been signed or ratified by 40 member states.

European policy and legislation

Legislation/Policy	Summary
The European Convention on the Protection of the Archaeological Heritage (Revised) 1992 (The Valletta Convention)	<p>The Articles of the Valletta Convention tackle various aspects. Article 1 deals with the inventorying and protection of sites and areas; Article 2 deals with the mandatory reporting of chance finds and providing for 'archaeological reserves' on land or underwater; Article 3 promotes high standards for all archaeological work undertaken by suitably qualified people; Article 4 requires the conservation of excavated sites and the safe-keeping of finds; and Article 5 is concerned with consultation that should take place between planning authorities and developers to avoid damage to archaeological remains.</p> <p>The Valletta Convention was ratified by the UK Government in 2000 and came into force in 2001. The convention binds the UK to implement protective measures for the archaeological heritage within the jurisdiction of each party, including sea areas. Insofar as the UK exerts jurisdiction over the Continental Shelf, then it would appear that the provisions of the Valletta Convention apply to that jurisdiction.</p>



The European Landscape Convention 2000	The European Landscape Convention 2000 became binding in the UK from 1 March 2007. Its principal clauses require the Government to protect and manage landscapes and to integrate landscape into regional and town planning policies including its cultural, environmental, agricultural, social and economic policies. The Convention applies to the entire territory of the UK and includes land, inland water and marine areas. It is not regarded as applying to sea areas regulated by the UK that lie beyond territorial waters.
European Directives for Environmental Impact Assessments (2014/52/EU)	The EIA Directive entered into force on 15 May 2014 to simplify the rules for assessing the potential effects of projects on the environment. The newly amended directive replaces former directives (85/337/EEC; 97/11/EC; 2003/35/EC; 2009/31/EC; 2011/92/EU). It is in line with the drive for smarter regulation and so reduces the administrative burden. It also improves the level of environmental protection with greater attention to threats and challenges that have emerged including resource efficiency, climate change and disaster prevention.

United Kingdom policy and legislation

Legislation/Policy	Summary
Protection of Wrecks Act 1973: Section One	Wrecks and wreckage of historical, archaeological or artistic importance can be protected by way of designation. It is an offence to carry out certain activities in a defined area surrounding a wreck that has been designated, unless a licence for those activities has been obtained.
Protection of Wrecks Act 1973: Section Two	This provides protection for wrecks that have been designated as dangerous due to their contents and is administered by the Maritime and Coastguard Agency through the Receiver of Wreck.
Ancient Monuments and Archaeological Areas Act 1979 (as amended)	This Act is primarily land based, but in recent years it has also been used to provide some level of protection for underwater sites. Scheduled Monuments and Areas of Archaeological Importance (AAs or their equivalent) are afforded statutory protection by the Secretary of State, and consent is required for any major works. The law is administered by Historic England and the Department of Culture, Media and Sport.
Merchant Shipping Act 1995	This Act sets out the procedures for determining the ownership of underwater finds classified as 'wreck'; defined as any flotsam, jetsam, derelict and lagan found in or on the shores of the sea or any tidal water. It includes ship, aircraft, hovercraft, parts of these, their cargo or equipment. If any such finds are brought ashore, the salvor is required to give notice to the Receiver of Wreck that he/she has found or taken possession of them and, as directed by the Receiver, either hold them pending the Receiver's order or deliver them to the Receiver.
Protection of Military Remains Act 1986	Under the Protection of Military Remains Act 1986, all aircraft that have crashed whilst in military service are automatically protected. Maritime vessels (e.g. ships and boats) lost during military service are not automatically protected, although the Ministry of Defence (MoD) has powers to protect any vessel that was in military service when lost. The MoD can designate wrecks whose position is known as 'controlled sites' and can designate named vessels whose location is unknown 'protected places'. It is not necessary to demonstrate the presence of human remains for wrecks to be designated as either 'controlled sites' or 'protected places'. The Act is administered by the Maritime and Coastguard Agency. Beyond the 12 nm limit, the Merchant Shipping Act 1995 covers wreck found or taken into possession outside UK waters, and stipulates that if brought into UK waters, finds must be reported to the Receiver of Wreck. The provisions of the Protection of Military Remains Act 1986 regarding Controlled Sites are applicable in international waters, though they are only enforceable with respect to British-controlled ships, British citizens and British companies.



Legislation/Policy	Summary
Marine and Coastal Access Act 2009	In England, marine licensing and marine planning made the responsibility of the Marine Management Organisation (MMO). England's inshore and offshore waters have been divided into 11 plan areas for which marine plans are to be produced by the Marine Management Organisation. The planning process officially began on 1st April 2011. Marine plans for the East Inshore and East Offshore were published in April 2014. The South Coast marine plans were released on 17 July 2018. Marine plans for the north west, north east, south west and south east are under development.
Marine Policy Statement 2011	The Marine Policy Statement (MPS) was jointly published by all UK Administrations in March 2011 as part of a new system of marine planning being introduced across UK seas. The MPS sets out the framework for preparing Marine Plans and making decisions affecting the marine environment. The MPS also states that Marine Plans must ensure a sustainable marine environment that will protect heritage assets.
National Planning Policy Framework 2021	The National Planning Policy Framework is a key part of reforms to make the planning system less complex and more accessible, to protect the environment and to promote sustainable growth. A core planning principle is to 'conserve heritage assets in a manner appropriate to their significance, so that they can be enjoyed for their contribution to the quality of life of this and future generations'. The 2021 revised Framework replaces the previous National Planning Policy Framework published in March 2012, revised in July 2018 and updated in February 2019 and sets out the government's planning policies for England and how these are expected to be applied
NPPF: Conserving and enhancing the historic environment. Para. 189	In determining applications, local planning authorities should require an applicant to describe the significance of any heritage assets affected, including any contribution made by their setting. The level of detail should be proportionate to the assets' importance and no more than is sufficient to understand the potential impact of the proposal on their significance. As a minimum the relevant historic environment record should have been consulted and the heritage assets assessed using appropriate expertise where necessary. Where a site on which development is proposed includes or has the potential to include heritage assets with archaeological interest, local planning authorities should require developers to submit an appropriate desk-based assessment and, where necessary, a field evaluation.
NPPF: Conserving and enhancing the historic environment. Para. 191	When considering the impact of a proposed development on the significance of a designated heritage asset, great weight should be given to the asset's conservation (and the more important the asset, the greater the weight should be). This is irrespective of whether any potential harm amounts to substantial harm, total loss or less than substantial harm to its significance.
NPPF: Conserving and enhancing the historic environment. Para. 192	Local planning authorities should identify and assess the particular significance of any heritage asset that may be affected by a proposal (including by development affecting the setting of a heritage asset) taking account of the available evidence and any necessary expertise. They should take this assessment into account when considering the impact of a proposal on a heritage asset, to avoid or minimise conflict between the heritage asset's conservation and any aspect of the proposal.
NPPF: Conserving and enhancing the historic environment. Para. 197	The effect of an application on the significance of a non-designated heritage asset should be taken into account in determining the application. In weighing applications that affect directly or indirectly non designated heritage assets, a balanced judgement will be required having regard to the scale of any harm or loss and the significance of the heritage asset.
NPPF: Conserving and enhancing the historic environment. Para. 199	Local planning authorities should look for opportunities for new development within Conservation Areas and World Heritage Sites and within the setting of heritage assets to enhance or better reveal their significance. Proposals that preserve those elements of the setting that make a positive contribution to or better reveal the significance of the asset should be treated favourably.
NPPF: Conserving and enhancing the historic environment. Para. 200	Local planning authorities should require developers to record and advance understanding of the significance of any heritage assets to be lost (wholly or in part) in a manner proportionate to their importance and the impact, and to make this evidence (and any archive generated) publicly accessible. However, the ability to record evidence of our past should not be a factor in deciding whether such loss should be permitted. (footnote: Copies of evidence should be deposited with the relevant historic environment record, and any archives with a local museum or other public depository.)



Legislation/Policy	Summary
Overarching National Policy Statement for Energy (EN-1) (Department of Energy and Climate Change 2011a)	This National Policy Statement (NPS) sets out national policy for energy infrastructure, and the importance of archaeological assessment in the development process.
National Policy Statement for Renewable Energy Infrastructure (EN-3) (Department of Energy and Climate Change 2011b)	This NPS, taken together with the overarching NPS (EN-1), provides the primary basis for decisions by the Planning Inspectorate on renewable energy infrastructure development applications. It sets out the importance of the historic environment and the ways it can be impacted by development, outlines guidance for application assessments, Planning Inspectorate decision making and mitigation measures.
National Policy Statement for Electricity Networks Infrastructure (EN-5) (Department of Energy and Climate Change 2011c)	This NPS, taken together with the overarching NPS (EN-1) provides for decision making on above ground electricity lines of 132kV and over and other electricity networks associated with a Nationally Significant Infrastructure Project e.g. substations and converted stations.
The East Marine Plans (2014)	This was a development of the Marine Plans which apply the MPS framework at a national, regional and area specific level. It includes the East Inshore and Offshore Areas in a process of Marine Plan development.

Guidance

Code of Practice for Seabed Developers, Joint Nautical Archaeology Policy Committee (Joint Nautical Archaeology Policy Committee 2006)	This voluntary Code provides a framework for seabed developers similar to the principles found in current policy and practice on land. The aim of the Code is to ensure a best practice model for seabed development. The Code offers guidance to developers on issues such as risk management and legislative implications.
Standard and guidance for historic environment desk-based assessment (Chartered Institute for Archaeologists 2014)	This guidance seeks to define good practice for the execution and reporting of desk-based assessment, in line with the by-laws of the Chartered Institute for Archaeologists. The standard and guidance was formally adopted as approved practice at the Annual General Meeting of the Institute held on 14 October 1994. This revision recognises the new Chartered status of the Institute.



Appendix 3: Vibrocore locations

Hole id	Easting (m)	Northing (m)	Water depth (m)
VC-T01	422104.92	5824527.13	27.1
VC-T02	422342.02	5824058.79	33.1
VC-T03	422160.51	5823000.61	31.5
VC-T04	422144.82	5821831.61	30.3
VC-T06	422298.05	5818380.58	31.8
VC-T07	422288.90	5817172.68	34.1
VC-T08	422261.67	5815328.55	32.3
VC-T09	422238.11	5814452.95	32.2
VC-T09A	422233.65	5814460.15	32.6
VC-T10	434549.06	5820902.24	31.6
VC-T10	434541.71	5820909.67	24.4
VC-T11	435211.54	5821976.03	30.6
VC-T12	435169.46	5821484.73	33.5
VC-T13	435948.52	5822000.46	32
VC-T13	435941.76	5822008.62	34.5
VC-T14	435920.48	5821470.57	25.1
VC-T15	435714.53	5822811.64	30.7
VC-T16	436267.42	5821766.76	32.2
VC-T17	436234.98	5821260.72	36.3
VC-T18	436277.15	5822246.56	31.9
VC-T18	436270.48	5822256.78	7.6
VC-T18	436317.97	5822261.74	33
VC-T19	436581.01	5822024.95	31.1
VC-T2	422367.02	5824071.36	32.6
VC-T20	436842.18	5822354.96	24.1
VC-T21	436975.15	5821684.33	31.4
VC-T21	436985.93	5821690.76	30.4
VC-T22	436602.47	5820568.05	23.2
VC-T23	437151.53	5821033.62	32.6
VC-T24	437453.18	5821942.84	34.6
VC-T25	437467.67	5821384.94	33.1
VC-T26	437889.69	5821615.44	34.8
2018-VC-01A	422401.8	5823318.2	na
2018-VC-02	422258.6	5822339.5	na



Hole id	Easting (m)	Northing (m)	Water depth (m)
2018-VC-03	422345	5821197.1	na
2018-VC-04	422307.4	5819789.8	na
2018-VC-05	422263	5819002.7	na
2018-VC-06	422288	5817738.2	na
2018-VC-07A	422215.8	5816481.8	na
2018-VC-08	434075.2	5820811.8	na
2018-VC-09	434048.1	5821279.2	na
2018-VC-10	434402.3	5821411.3	na
2018-VC-11	434787.4	5821286.6	na
2018-VC-12	434790.5	5821682.5	na
2018-VC-12A	434785.1	5821694	na
2018-VC-13B	434845.4	5822141	na
2018-VC-13C	434839.5	5822159.8	na
2018-VC-14	435190.9	5822488.4	na
2018-VC-14A	435196.4	5822478.5	na
2018-VC-15	435916.1	5822471.4	na
2018-VC-15A	435912.1	5822489.3	na
2018-VC-16	435598.4	5822234.3	na
2018-VC-17A	435592.9	5821757.6	na
2018-VC-18B	435644	5821176.4	na
2018-VC-19	436541.1	5821410.2	na
2018-VC-20A	436315.8	5820880.7	na
2018-VC-21	436070	5820390.2	na



Appendix 4: Results of Stage 1 geoaerchaeological review

ID	Depth from (m)	Depth to (m)	Description	Interpretation/ Unit
VC-T01	0	0.35	Medium dense orange brown fine SAND	Unit 2
VC-T01	0.35	1.1	Medium dense grey slightly gravelly SAND	Unit 2
VC-T01	1.1	3.94	Medium dense silty fine SAND with occasional black silt patches or thin beds of clay	Unit 2
VC-T02	0	0.3	Loose, light brown slightly shelly fine to coarse SAND	Unit 8
VC-T02	0.3	1.06	Dense to very dense dark brown grey slightly silty slightly gravelly SAND with patches of black silt	Unit 2
VC-T03	0	0.26	Loose slightly gravelly SAND	Unit 8
VC-T03	0.26	1.7	Medium dense grey slightly clayey slightly silty SAND with broken shell and occasional patches of silty SAND	Unit 2
VC-T04	0	0.27	Loose light brown slightly gravelly SAND with broken shell	Unit 8
VC-T04	0.27	1.61	Medium dense grey slightly silty slightly gravelly SAND with some broken shell	Unit 2
VC-T05	0	0.8	Medium dense grey silty clayey laminated SAND with broken shell	Unit 2
VC-T05A	0	0.3	Loose grey brown silty gravelly fine sand with shell and pockets of sandy clay (shoe sample only)	Unit 2
VC-T06	0	0.59	Loose to medium dense brown slightly gravelly fine to coarse SAND	Unit 8
VC-T06	0.59	1.19	Loose to medium dense slightly sandy GRAVEL of mixed lithologies with some broken shell	Unit 3b
VC-T07	0	2.87	Loose light grey to brown shelly gravelly SAND with band of shell fragments at 2.87 m	Unit 3b
VC-T08	0	1.92	Medium dense light brown fine to coarse sandy GRAVEL with occasional broken shell	Unit 3b
VC-T08	1.92	2.02	Dense brown silty SAND	Unit 2
VC-T09	0	0.3	Dense grey brown slightly silty slightly gravelly fine medium SAND with rare broken shell	Unit 8
VC-T09	0.3	0.48	Dark brown to black laminated slightly sandy fibrous PEAT	Unit 7
VC-T09A	0	0.59	Loose greyish brown slightly gravelly silty fine to coarse SAND becoming silty SAND at base	Unit 8
VC-T09A	0.59	0.7	Firm black slightly silty slightly sandy PEAT	Unit 7
VC-T10	0	0.15	Light brown fine SAND	Unit 8
VC-T10	0.15	0.8	Loose becoming dense slightly sandy fine to coarse GRAVEL	Unit 3b
VC-T10A	0	0.2	Loose light brown fine SAND	Unit 8
VC-T10A	0.2	1.3	Medium dense dark brown medium coarse sandy GRAVEL	Unit 3b
VC-T10A	1.3	1.45	Dense grey fine SAND	Unit 3b
VC-T10A	1.45	2.51	Dense grey slightly silty slightly gravelly fine to medium SAND	Unit 3b
VC-T11	0	0.86	Medium dense brown fine to medium sandy GRAVEL	Unit 3b
VC-T11	0.86	1.32	Medium dense grey slightly clayey silty fine SAND	Unit 2
VC-T12	0	0.9	Medium dense light brown slightly gravelly fine to medium SAND becoming silty with depth	Unit 3b
VC-T12	0.9	1.46	Dense grey black slightly silty SAND	Unit 2
VC-T13	0	0.41	Medium dense brown to grey slightly silty gravelly fine to coarse SAND	Unit 3b
VC-T13A	0	0.58	Loose becoming dense light brown slightly silty gravelly fine SAND	Unit 3b



ID	Depth from (m)	Depth to (m)	Description	Interpretation/ Unit
VC-T13A	0.58	0.69	Dense dark grey silty shelly fine to medium SAND	Unit 2
VC-T14	0	0.78	Dense fine to medium sandy GRAVEL with occasional fine broken shell	Unit 3b
VC-T14	0.78	0.96	Medium dense grey fine SAND	Unit 3b
VC-T14	0.96	1.15	Medium dense medium to coarse sandy GRAVEL	Unit 3b
VC-T14	1.15	2.3	Dense slightly silty grey fine SAND with occasional patches of black silt	Unit 2
VC-T15	0	0.85	Dense red brown slightly shelly fine to coarse sandy GRAVEL	Unit 3b
VC-T15	0.85	1.2	Medium dense grey slightly silty fine SAND	Unit 3b
VC-T15	1.2	2.68	Medium dense light brown to grey slightly silty gravelly fine SAND	Unit 3b
VC-T15	2.68	3.04	Loose grey black medium coarse sandy GRAVEL with broken shell	Unit 3b
VC-T16	0	0.67	Medium dense light brown slightly shelly gravelly medium SAND	Unit 3b
VC-T16	0.67	1.16	Medium dense grey slightly silty slightly gravelly fine to medium SAND with small pockets of black silt	Unit 3b
VC-T16	1.16	2.88	Medium dense grey brown fine SAND	Unit 2
VC-T17	0	1.76	Medium dense brown or grey fine sandy GRAVEL with occasional fine broken shell	Unit 3b
VC-T17	1.76	2.55	Medium dense light grey brown fine to coarse SAND with thin pocket of sandy SILT	Unit 2
VC-T18B	0	1.19	Medium dense red brown grey medium sandy GRAVEL	Unit 3b
VC-T18B	1.19	2.24	Dense grey slightly silty fine SAND with occasional medium GRAVEL and fine broken shell	Unit 3b
VC-T19	0	0.75	Loose to medium dense yellowish brown very shelly slightly gravelly SAND	Unit 8
VC-T19	0.75	1.06	Medium dense brown grey slightly silty fine SAND with broken shell	Unit 2
VC-T19	1.06	1.9	Medium dense brown becoming grey very slightly shelly slightly gravelly fine SAND	Unit 2
VC-T19	1.9	2.52	Medium dense grey brown slightly gravelly slightly silty shelly fine SAND	Unit 2
VC-T19	2.52	3.2	Firm/dense bedded brown grey silty CLAY/sandy SILT with traces of black SILT	Unit 2
VC-T20	0	1.06	Medium dense orange brown sandy GRAVEL with rare finely broken shell	Unit 3b
VC-T20	1.06	1.43	Soft to loose laminated an bedded grey black silty fine SAND/ silty PEAT	Unit 2b
VC-T21A	0	2.5	Medium dense to dense orange brown grey slightly shelly fine to medium sandy GRAVEL becoming gravelly SAND	Unit 3b
VC-T21A	2.5	2.71	Medium dense grey fine SAND	Unit 2
VC-T22	0	0.4	Medium dense yellow brown SAND with occasional fine broken shell	Unit 8
VC-T22	0.4	1.95	Dense orange brown fine sandy GRAVEL with occasional fine broken shell	Unit 3b
VC-T22	1.95	2.18	Medium dense red brown fine SAND with gravel	Unit 3b
VC-T23	0	0.65	Loose to medium dense yellow brown fine SAND with occasional fine broken shell	Unit 8
VC-T23	0.65	1.95	Dense orange brown to medium sandy GRAVEL with occasional small cobbles	Unit 3b
VC-T23	1.95	2.95	Dense grey brown fine SAND with rare isolated fine to medium gravel	Unit 2
VC-T24	0	0.7	Medium dense orange brown and grey very slightly gravelly fine to medium SAND	Unit 2
VC-T24	0.7	2.12	Medium dense grey fine SAND	Unit 2



ID	Depth from (m)	Depth to (m)	Description	Interpretation/ Unit
VC-T24	2.12	2.85	Dense grey very shelly fine SAND	Unit 2
VC-T24	2.85	3.18	Medium dense grey slightly shelly fine SAND	Unit 2
VC-T24	3.18	3.82	Dense grey white very shelly fine SAND	Unit 2
VC-T24	3.82	4.25	Medium dense grey slightly shelly clayey fine SAND	Unit 2
VC-T24	4.25	4.34	Loose medium dense medium coarse SAND	Unit 2
VC-T25	0	3.4	Dense orange brown sandy GRAVEL	Unit 3b
VC-T26	0	1.35	medium dense orange brown silty slightly shelly slightly gravelly Sand with broken shell	Unit 2
VC-T26	1.35	2.22	Dense grey fine SAND	Unit 2
VC-T26	2.22	3.58	Firm grey very clayey fine SAND becoming silty SAND with pockets of black sandy SILT	Unit 2
2018-VC-01A	0.00	0.04	Silty gravelly SAND w/ shell frags	Unit 8
2018-VC-01A	0.04	0.25	Silty SAND	Unit 3b
2018-VC-01A	0.25	1.60	V. gravelly SAND	Unit 3b
2018-VC-01A	1.60	3.32	SAND. Gravelly band w/ shell frags 2.20-2.40m	Unit 3b
2018-VC-01A	3.32	4.30	V. gravelly SAND w/ shell frags	Unit 3b
2018-VC-02	0.00	0.44	Gravelly SAND w/ shell frags	Unit 3b
2018-VC-02	0.44	0.49	SAND. Gravelly band w/ shell frags 2.20-2.40m	Unit 3b
2018-VC-02	0.49	1.54	Silty gravelly SAND w/ shell frags	Unit 3b
2018-VC-02	1.54	2.80	Gravelly SAND w/ shell frags	Unit 3b
2018-VC-02	2.80	4.50	Silty gravelly SAND w/ shell frags	Unit 3b
2018-VC-02	4.50	5.18	SAND w/ rare gravel, shell frags.	Unit 2
2018-VC-03	0.00	0.42	Silty v. gravelly SAND	Unit 8
2018-VC-03	0.42	0.44	Soft grey CLAY	Unit 8
2018-VC-03	0.44	2.44	Silty SAND w/ occ. 0.10m bands of gravel + clay/shell	Unit 2
2018-VC-03	2.44	2.76	Silty gravelly SAND w/ shell frags	Unit 2
2018-VC-03	2.76	4.35	Silty SAND w/ rare gravel + shell frags	Unit 2
2018-VC-03	4.35	4.69	Silty SAND	Unit 2
2018-VC-03	4.69	4.96	Silty SAND	Unit 2
2018-VC-04	0.00	0.20	Clayey, silty, gravelly SAND w/ shell frags	Unit 8
2018-VC-04	0.20	0.36	Silty SAND w/ occ. Thin beds of clay	Unit 3b
2018-VC-04	0.36	0.91	Silty SAND w/ rare gravel + shell frags + 0.02m band of clay @0.54m.	Unit 3b
2018-VC-04	0.91	2.90	Interbedded silty CLAY and silty SAND	Unit 3b
2018-VC-04	2.90	3.47	Gravelly silty SAND w/ shell frags + 0.01m band of CLAY @3.16m.	Unit 2
2018-VC-05	0.00	1.52	Silty v. gravelly SAND w/ shell frags	Unit 3b
2018-VC-05	1.52	3.31	Interbedded silty CLAY + silty SAND	Unit 3b
2018-VC-05	3.31	3.40	Gravelly silty SAND w/ shell frags	Unit 2
2018-VC-06	0.00	0.30	Silty v. gravelly SAND w/ shell frags	Unit 3b
2018-VC-06	0.30	4.23	V. gravelly SAND w/ shell frags	Unit 3b
2018-VC-07A	0.00	0.69	V. gravelly SAND w/ shell frags	Unit 3b
2018-VC-07A	0.69	1.00	SAND and GRAVEL	Unit 3b
2018-VC-07A	1.00	2.71	V. gravelly SAND	Unit 3b



ID	Depth from (m)	Depth to (m)	Description	Interpretation/ Unit
2018-VC-07A	2.71	2.97	Silty gravelly SAND w/ shell frags	Unit 3b
2018-VC-07A	2.97	3.64	Silty SAND w/ rare gravel + irregularly spaced thin beds of silty CLAY	Unit 2
2018-VC-08	0.00	0.21	V. gravelly SAND. Thick laminae of silty CLAY @base	Unit 3b
2018-VC-08	0.21	1.78	Silty SAND	Unit 3b
2018-VC-08	1.78	2.72	V. gravelly SAND w/ shell frags	Unit 3b
2018-VC-08	2.72	3.51	SAND. Slightly gravelly after 3.25m	Unit 3b
2018-VC-08	3.51	3.62	SAND	Unit 3b
2018-VC-08	3.62	4.36	V. gravelly SAND	Unit 3b
2018-VC-09	0.00	0.92	Silty v. gravelly SAND	Unit 3b
2018-VC-09	0.92	1.84	Silty v. gravelly SAND w/ shell frags	Unit 3b
2018-VC-10	0.00	0.58	V. gravelly SAND	Unit 3b
2018-VC-10	0.58	0.81	Silty SAND	Unit 3b
2018-VC-10	0.81	1.28	Silty gravelly SAND	Unit 3b
2018-VC-11	0.00	0.47	V. gravelly SAND	Unit 3b
2018-VC-11	0.47	0.58	SAND	Unit 3b
2018-VC-11	0.58	1.56	Silty v. gravelly SAND	Unit 3b
2018-VC-12	0.00	0.15	Gravelly SAND w/ shell frags	Unit 3b
2018-VC-12	0.15	0.30	SAND	Unit 3b
2018-VC-12	0.30	0.77	V. gravelly SAND	Unit 3b
2018-VC-12A	0.00	1.44	V. gravelly SAND	Unit 3b
2018-VC-12A	1.44	1.58	SAND	Unit 3b
2018-VC-12A	1.58	3.19	V. gravelly SAND	Unit 3b
2018-VC-12A	3.19	3.91	Silty SAND	Unit 2
2018-VC-13B	0.00	0.60	Gravelly - v. gravelly SAND w/ shell frags	Unit 3b
2018-VC-13B	0.60	0.80	Gravelly SAND	Unit 3b
2018-VC-13B	0.80	0.88	V. gravelly SAND w/ shell frags	Unit 3b
2018-VC-13B	0.88	0.99	Silty gravelly SAND w/ shell frags	Unit 3b
2018-VC-13C	0.00	0.52	Silty v. gravelly SAND w/ shell frags	Unit 3b
2018-VC-13C	0.52	0.67	Silty SAND	Unit 2
2018-VC-13C	0.67	1.28	Gravelly silty SAND	Unit 2
2018-VC-14	0.00	0.57	V. gravelly SAND	Unit 3b
2018-VC-14A	0.00	0.41	V. gravelly SAND	Unit 3b
2018-VC-14A	0.41	0.53	SAND	Unit 3b
2018-VC-14A	0.53	1.29	Gravelly SAND becoming siltier towards base.	Unit 3b
2018-VC-15	0.00	0.23	V. gravelly SAND	Unit 3b
2018-VC-15	0.23	0.74	V. gravelly SAND	Unit 3b
2018-VC-15	0.74	1.07	Silty v. gravelly SAND	Unit 3b
2018-VC-15A	0.00	0.48	V. gravelly SAND	Unit 3b
2018-VC-15A	0.48	0.70	Gravelly silty SAND	Unit 3b
2018-VC-15A	0.70	1.93	Silty gravelly SAND w/ shell frags	Unit 3b
2018-VC-15A	1.93	2.27	Silty gravelly SAND w/ shell frags	Unit 3b



ID	Depth from (m)	Depth to (m)	Description	Interpretation/ Unit
2018-VC-15A	2.27	2.72	Silty gravelly SAND	Unit 3b
2018-VC-15A	2.72	3.44	V. gravelly SAND	Unit 3b
2018-VC-15A	3.44	4.81	Silty SAND w/ occ. Gravel, peat + shell frags. Pocket of fibrous PEAT 3.79-3.90m	Unit 3b
2018-VC-16	0.00	0.15	Silty gravelly SAND	Unit 3b
2018-VC-16	0.15	0.45	Silty gravelly SAND	Unit 3b
2018-VC-16	0.45	1.85	Gravelly silty SAND w/ closely spaced thin beds of shell 1.30-1.80m	Unit 2
2018-VC-16	1.85	2.24	Silty SAND w/ rare gravel	Unit 2
2018-VC-17A	0.00	1.20	Silty v. gravelly SAND	Unit 3b
2018-VC-18B	0.00	1.95	V. gravelly SAND w/ shell frags	Unit 3b
2018-VC-19	0.00	0.13	SAND	Unit 8
2018-VC-19	0.13	1.58	Silty v. gravelly SAND w/ shell frags	Unit 3b
2018-VC-19	1.58	3.56	V. gravelly SAND	Unit 3b
2018-VC-19	3.56	3.98	Silty SAND w/ irregular thin laminae of fibrous PEAT	Unit 3b
2018-VC-19	3.98	4.28	Silty SAND w/ rare gravel (gravel = flint, sandstone + peat)	Unit 3b
2018-VC-19	4.28	4.36	Silty SAND	Unit 2
2018-VC-20A	0.00	0.82	Gravelly SAND w/ shell frags	Unit 3b
2018-VC-20A	0.82	0.91	SAND	Unit 3b
2018-VC-20A	0.91	1.11	Gravelly SAND	Unit 3b
2018-VC-20A	1.11	2.03	Gravelly SAND	Unit 3b
2018-VC-20A	2.03	5.24	Silty v. gravelly SAND	Unit 3b
2018-VC-20A	5.24	5.40	Silty v. gravelly SAND	Unit 3b
2018-VC-20A	5.40	5.50	SAND	Unit 2
2018-VC-21	0.00	1.33	Silty v. gravelly SAND w/ shell frags	Unit 3b



Appendix 5: Seabed features of archaeological potential

Coordinates are in WGS84 UTM31N.

Anomaly number	Anomaly type	Easting	Northing	Length (m)	Width (m)	Height (m)	Least depth (m)	Description	Dataset	Section	Archaeological discrimination	External references
2001	Wreck	422404	5815661	45.5	26.6	4.4	-26	Identified in the SSS data as an elongate area of numerous dark reflectors that appears unclear and indistinct in some areas, interpreted as an area of debris. Sediment accumulation is visible throughout and the feature appears partially buried. Observed in the MBES data as a sub-rounded mound covering an uneven area. There are two distinct rounded mounds in the centre, measuring 8.1 x 7.0 x 3.0 m. A sand wave is visible partially covering the anomaly and so further buried material is likely present within the vicinity. Scour is visible extending to the west, east, and south for a maximum of 60 m. Corresponds with UKHO_10430, an unknown dangerous wreck almost entirely buried within a sandwave. The mast/funnel is reported as being visible amidships from a survey undertaken in 1982, which are potentially represented by the central mounds visible in the data. Interpreted as a wreck.	2014 MBES, 2014 SSS	1804/1	A1	UKHO_10430, NMHR_879995, MS_1062
2002	Obstruction	422060	5817146	19.8	17.8	3.5	-30.8	Identified in the SSS data as a rounded dark reflector with a bright shadow. The anomaly appears fairly indistinct with a surface of varying reflectivity. Observed in the MBES data as a rounded mound situated in encircling scour that extends predominantly to the south for 38.8 m. There is some slight irregular seabed to the south of the scour, but this may be natural. This corresponds with UKHO_10677, an obstruction which was identified as a large rock during a 1982 survey, although on the most recent survey in 2017 it is recorded as having not been located. Interpreted as debris.	2014 MBES, 2014 SSS	1804/1	A2	UKHO_10677, MS_1008



Anomaly number	Anomaly type	Easting	Northing	Length (m)	Width (m)	Height (m)	Least depth (m)	Description	Dataset	Section	Archaeological discrimination	External references
2003	Dark reflector	422356	5819658	51.6	11.8	0.4	-	Identified in the SSS data as an area of indistinct elongate dark reflectors with a slight shadow. Five distinct individual features, of approximately 5.7 x 1.2 x 0.1 m, can be determined. However, these appear on an approximate east to west alignment and follow the same axis as the surrounding sand ripples. No anomalous features were identified in the MBES data at this location. Interpreted as a natural feature.	2014 SSS	1804/1	U1	MS_1059
2004	Rope/chain	422023	5823453	14.3	0.6	0.2	-	Identified in the SSS data as a curvilinear dark reflector with a slight shadow. It appears less distinct towards the northern end and has a larger shadow at the southern end, possibly indicating attachment to the seabed. No anomalous features were identified in the MBES data at this location. This is located within an area of sand ripples. Interpreted as a length of rope or chain.	2014 SSS	1804/1	A2	MS_1119
2005	Mound	422220	5820774	12.4	6.6	0.8	-	Identified in the SSS data as a rounded dark reflector with a bright shadow. Observed in the MBES dataset as an irregularly shaped mound, potentially localised sediment accumulation. Interpreted as a possible natural feature or may be possible debris.	2014 SSS, 2016 MBES	1804/1	A2	MS_1007
2006	Seabed disturbance	421941	5815880	9.8	4.3	0.6	-32.2	Identified in the SSS data as an area of irregular dark reflectors, with some areas of shadow. There appears to be some scour visible. Observed in the MBES dataset as an indistinct mound with scour that extends to the south for 5.8 m. Interpreted as a possible natural feature or may be possible debris.	2014 SSS, 2016 MBES	1804/1	A2	MS_1118



Anomaly number	Anomaly type	Easting	Northing	Length (m)	Width (m)	Height (m)	Least depth (m)	Description	Dataset	Section	Archaeological discrimination	External references
2007	Wreck	422876	5820298	53.7	19.6	3.4	-35.1	Identified in the SSS data as an elongate area of irregular dark reflectors, many with shadows, interpreted as a highly broken-up wreck. There are some parallel dark reflectors at right angles to the wreck orientation which indicate some structural elements remain cohesive. Some irregular areas of immediately adjacent seabed may indicate further buried debris. Observed in the 2016 MBES data as an area of irregular seabed visible as a series of mounds - some round some elongate, with the largest individual mound measuring 6.8 x 6.0 x 1.4 m. The wreck lies on an approximate east to west alignment and there is distinct encircling scour, with a particularly deep section towards the eastern edge extending to the north for 31.4 m and 1.5 m deep. A sand wave is visible to the south and the feature is visible in a wider area of sediment movement, suggesting it may be periodically buried. This anomaly is also visible in the 2014 MBES dataset where it is more distinct and measures 54.4 x 13.7 x 5.0 m. There is distinct scour to the north and east, extending for 22.7 m and 1.5 m deep. Corresponds with UKHO_10446, the wreck of the <i>Castle Galleon</i> , a British merchant steamship that was built by Cochrane & Sons Ltd in 1927 and lost following a collision in 1932 with the Swedish steamship <i>SS Oscar Garthon</i> . The 852 gross ton ship had one boiler, a triple expansion engine and single shaft and was lost en route between Newcastle-Upon-Tyne and Dieppe whilst carrying a cargo of coal. It was last surveyed by Gardline in 2017 and was reported to measure 30.5 m in length and was broken up, indicating further exposure or dispersal. Interpreted as the remains of this wreck.	2014 SSS, 2014 MBES, 2016 MBES	1804/1 500 m buffer	A1	UKHO_10446, NMHR_912972, NMHR_1340249, MS_1010
2008	Wreck	421817	5821125	-	-	-	-	No geophysical data coverage for this feature. This unidentified dangerous wreck was last surveyed in September 2016 and is described by the UKHO as a broken wreck, intact and upright measuring 1.7 m long, 9.7 m wide and 4.3 m high. The NMHR record records it as being entirely buried.	-	1804/1 500 m buffer	-	UKHO_10449, NMHR_880008



Anomaly number	Anomaly type	Easting	Northing	Length (m)	Width (m)	Height (m)	Least depth (m)	Description	Dataset	Section	Archaeological discrimination	External references
2009	Dark reflector	422872	5820384	5.7	0.7	0	-	Identified in the SSS data an elongate dark reflector with no clear shadow, however this does appear distorted in the data and may not represent the true form of the feature. There is some possible scour visible, and the anomaly is potentially situated within a small depression. No anomalous features were identified in the MBES data at this location. This anomaly is located in an area of sediment movement approximately 80 m north of wreck 2007 and may be related. Interpreted as a possible natural feature or may be possible debris.	2014 SSS	1804/1 500 m buffer	A2	MS_1011
2010	Dark reflector	422917	5818301	1.3	0.4	0.1	-	Identified in the SSS data as an elongate dark reflector, curved at one end with some small shadow. There is possible scour visible to the west. No anomalous features were identified in the MBES data at this location. This anomaly is located in an area of sediment movement. Interpreted as a natural feature.	2014 SSS	1804/1 500 m buffer	U1	MS_1009
2011	Dark reflector	422994	5817759	4.5	0.8	0.3	-	Identified in the SSS data as a curved elongate dark reflector with a bright shadow. Some scour appears visible to the west. No anomalous features were identified in the MBES data at this location. This anomaly is located in an area of sediment movement. Interpreted as a possible natural feature or may be possible debris.	2014 SSS	1804/1 500 m buffer	A2	MS_1037
2012	Dark reflector	422769	5815710	18.7	2.7	0.5	-	Identified in the SSS data as an elongate, irregularly shaped dark reflector with bright shadow (although in this case the shadow may indicate a depression). Observed in the MBES data as an elongate mound within a depression. Scour is visible to the north-east, and more prominently to the south-west where it extends for 6.3 m and is 0.2 m deep. Located in an area of sand ripples. Interpreted as a possible natural feature or may be possible debris.	2014 SSS, 2014 MBES	1804/1 500 m buffer	A2	MS_1025



Anomaly number	Anomaly type	Easting	Northing	Length (m)	Width (m)	Height (m)	Least depth (m)	Description	Dataset	Section	Archaeological discrimination	External references
2013	Wreck	436276	5822953	59.6	16.5	3.9	-25.1	Identified in the SSS data as a distinct area of irregular dark reflectors with distinct shadows, interpreted as a broken-up wreck with some clear structural elements still intact. There appears to be some fragmentation of the wreck as a whole into separate sections. Debris is visible particularly along the west side of the wreck. Observed in the MBES data as an elongate mound oriented NNW-SSE that appears to decrease in size towards the north. The southern end is the most distinct and appears the most irregular with some irregular sections towards the base possibly indicating smaller items of debris. There are a series of sand waves that interact with anomaly, particularly towards the south, and indicate the potential for buried material. There is scour visible extending to the north, partially covered by sand waves, and extending for 33.5 m, and some scour to the immediate south extending for 6.5 m. Corresponds with UKHO_11029, the dangerous wreck of the steamship <i>Pluton</i> . Built in 1901 by Wood, Skinner & Co. Ltd, Newcastle-upon-Tyne, this steamship was owned at the time of its loss by Chr. Hannevig Borre/Horten and sailed under the Norwegian flag. The 1507 gross tonnage vessel measured 76.2 x 11.3 x 4.9 m. On 9th November 1914, whilst traveling from London for Christiania with a cargo of corn, the ship hit a mine and foundered. Last surveyed in September 2017, the UKHO describes the wreck site as largely intact and partially buried. Interpreted as the remains of this wreck.	2014 SSS, 2014 MBES	1804/2	A1	UKHO_11029, NMHR_912981, MS_1114
2014	Obstruction	433860	5821413	-	-	-	-	No clear associated feature in the geophysics data. Location of UKHO_11026, a recorded obstruction that has not been located since 1945. Retained as a precaution. May represent a natural feature or possible buried debris, or may be erroneously positioned and be located elsewhere.	2014 SSS, 2014 MBES, 2016 MBES	1804/2	A3	UKHO_11026



Anomaly number	Anomaly type	Easting	Northing	Length (m)	Width (m)	Height (m)	Least depth (m)	Description	Dataset	Section	Archaeological discrimination	External references
2015	Debris	436073	5821362	17.6	5.1	1.8	-29.6	Identified in the SSS data as an indistinct irregularly shaped mound with variable reflectivity and a bright shadow. Observed in the MBES data as an elongate mound. It is located in an area of sand ripples and larger sand waves, and there is no clear scour as any may be obscured by sediment movement. This also indicates the potential for further buried material. Interpreted as possible debris.	2014 SSS, 2014 MBES	1804/2	A2	MS_1109
2016	Dark reflector	436352	5821487	9.1	2.9	0.8	-	Identified in the SSS data as an elongate dark reflector with a bright short shadow. At the north end there appears to be a larger area of shadow, however this may be the result of the surrounding sand ripples. No anomalous features were identified in the MBES data at this location. This anomaly is located in an area of sediment movement. Interpreted as a possible natural feature or may be possible debris.	2014 SSS	1804/2	A2	MS_1110



Anomaly number	Anomaly type	Easting	Northing	Length (m)	Width (m)	Height (m)	Least depth (m)	Description	Dataset	Section	Archaeological discrimination	External references
2017	Wreck	435976	5823543	34.5	12	6	-26	Identified in the SSS data as a large, poorly defined dark reflector with some shadow. The edges appear diffuse and there is little distinct structure, except a small group of parallel dark reflectors at the north-east end which may indicate structural elements. Observed in the 2016 MBES data as an irregularly shaped elongate mound on an approximate east to west alignment. There is a section that protrudes on the south side that extends west, parallel to the main mound. To the immediate north is a distinct narrow parallel bathymetric low that measures 6.5 m in width and extends the length of the anomaly. There is a slight mound on the north of this and it is unclear if this low is scour or a trough adjacent to an isolated sand wave. There is scour visible to the west, north and east; it extends predominantly to the north-west for 74.4 m and is 5 m deep. Located in an area of sand waves and is partially obscured by a smaller sand wave, indicating the higher potential for buried material. Also visible in the 2014 dataset as a slightly more irregular mound with some smaller adjacent mounds visible, likely indicating debris. It measures 31.7 x 9.4 x 5.5 m in the 2014 dataset. The sand wave pattern in the earlier dataset is different and may indicate the further burial of the anomaly in the 2016 dataset. Corresponds with UKHO_11031, the dangerous wreck of the British cargo vessel <i>Cormead</i> . Built in 1939 for Cory Colliers by Burntisland Shipbuilding Co Ltd, this 2848 gross tonnage vessel measures 96.01 x 13.53 x 6.01 m. The steel ship had a 3-cylinder triple expansion engine, two Scotch boilers and six corrugated furnaces. Whilst travelling from London for the Tyne carrying only ballast, the ship hit a mine on the 25th December 1941 and despite efforts to tow the ship to safety it sank the following day. No lives were lost. Interpreted as the remains of this wreck.	2014 SSS, 2014 MBES, 2016 MBES	1804/2 500 m buffer	A1	UKHO_11031, NMHR_912986, MS_1113



Anomaly number	Anomaly type	Easting	Northing	Length (m)	Width (m)	Height (m)	Least depth (m)	Description	Dataset	Section	Archaeological discrimination	External references
2018	Wreck	436807	5822774	-	-	-	-	No geophysical data coverage for this feature. Location of UKHO_11028, possible remains of <i>Knitsley</i> . Built in 1923 by Wood, Skinner & Co. Ltd at Newcastle-Upon-Tyne and owned at the time of loss by the Consett Iron Co. Ltd, this British cargo vessel had two boilers and a triple expansion engine. Whilst on passage from London for the Tyne in ballast, the ship was torpedoed by an E-boat with the loss of 12 crew and one gunner. The dimensions of the ship were 89.6 x 12.5 x 5.5 m with a gross tonnage of 2272. This record refers to the main element of the ship that, according to the UKHO report, has damage to the hull, is broken and partially buried. The bow/stern section is missing and could be anomaly 2019 , located 270 m to the north-east. The UKHO records the site as measuring 69.1 m long by 21 m wide by 6.2 m high. The NMHR record indicates that the site has not been formally identified as <i>Knitsley</i> . See 2019 and 2020 for more details.	-	1804/2 500 m buffer	-	UKHO_110 28, NMHR_912 979
2019	Wreck	436872	5823036	-	-	-	-	No geophysical data coverage for this feature. Location of UKHO_11230, part of the remains of <i>Knitsley</i> . The NMHR records the material as being either the bow or stern section of the vessel. The UKHO records the wreck as dangerous and is broken and partially buried. Its dimensions are 18.9 m long, 10.2 m wide and 4.9 m high. The main section of the ship is recorded by the UKHO as lying 270 m to the south-west (2018). See anomaly 2018 for details regarding the larger element of the ship and its history and 2020 for a possibly associated record.	-	1804/2 500 m buffer	-	UKHO_112 30, NMHR_145 7019
2020	Wreck	436846	5822972	-	-	-	-	No geophysical data coverage for this feature. Location of UKHO_87130, possibly debris associated with the wreck of <i>Knitsley</i> (see 2018 and 2019). The UKHO records the site as being a dangerous wreck described as a small contact and measuring 7.6 m long by 6.2 m wide and 3 m high.	-	1804/2 500 m buffer	-	UKHO_871 30



Anomaly number	Anomaly type	Easting	Northing	Length (m)	Width (m)	Height (m)	Least depth (m)	Description	Dataset	Section	Archaeological discrimination	External references
2021	Wreck	433827	5820668	98.7	48.5	5.3	-25.4	Identified in the SSS data as an irregular area of irregular dark reflectors, many with distinct shadows, interpreted as the remains of a vessel that appears broken up with some coherent structural elements still visible. Groups of parallel dark reflectors indicate large fragments of hull or deck still cohesive. Observed in the MBES data as an elongate, irregular mound on an approximate north to south alignment. The southern end appears to be more cohesive and may be more intact, and appears to be a collapsed part of the hull. The northern end appears more irregular and indicates that it is more broken up. At the north-west corner there is a taller rounded section. The eastern side of the wreck has a number of smaller irregular mounds that is likely related debris. There is some encircling scour that extends primarily to the north for 66.5 m and to the south for 29 m. Corresponds with UKHO_11024, the dangerous wreck of the British cargo ship <i>Rogdate</i> . Built in 1944 by S. P. Austin & Son Ltd., this ship was torpedoed and foundered on 19 March 1945 with the loss of one crew member and one gunner. The ship had a gross tonnage of 2871 and its dimensions were 100.1 x 13.6 x 6.1 m and it had one three-cylinder triple expansion steam engine, single shaft, one screw and a cruiser stern. The ship was lost whilst en route from Sunderland to London with a cargo of coal. Interpreted as the remains of this wreck.	2014 SSS, 2014 MBES	1804/2 500 m buffer	A1	UKHO_11024, NMHR_912975, MS_1097
2022	Dark reflector	434594	5822309	25.5	1.2	1.3	-28.9	Identified in the SSS data as an indistinct linear dark reflector with a bright shadow, not clearly separate from surrounding sand ripples. Observed as an elongate mound in the 2014 MBES dataset. It is on a north-west to south-east alignment. There is some scour visible to the north-east extending for 4.0 m. The north-west end appears obscured by a sand wave and so may be partially buried. This feature is not completely visible in the 2016 MBES data as it is completely covered by a sand wave. Interpreted as a possible natural feature.	2014 SSS, 2014 MBES, 2016 MBES	1804/2 500 m buffer	U1	MS_1106



Anomaly number	Anomaly type	Easting	Northing	Length (m)	Width (m)	Height (m)	Least depth (m)	Description	Dataset	Section	Archaeological discrimination	External references
2023	Dark reflector	435610	5823567	7	3.3	0.2	-	Identified in the SSS data as a short elongate dark reflector with a bright shadow. No anomalous features were identified in the MBES data at this location. This anomaly is located in an area of sediment movement. Interpreted as a possible natural feature or may be possible debris.	2014 MBES, 2016 MBES	1804/2 500 m buffer	A2	MS_1111
2024	Rope/chain	436031	5823606	45.3	2	0.3	-	Identified in the SSS data as a curved linear dark reflector with a sub-rounded dark reflector at the north end which measures 4.1 x 2.0 x 0.3 m. The linear appears indistinct in the centre. No anomalous features were identified in the MBES data at this location. This anomaly is located in an area of sediment movement. Located 80 m north-west of wreck 2017 and may be related. Interpreted as possible long length of rope or chain.	2014 MBES, 2016 MBES	1804/2 500 m buffer	A2	MS_1115
2025	Seabed disturbance	433080.00	5820799.00	31	6.7	0.3	-30.6	Identified in the SSS data as an area of irregular seabed with a darker section towards the north end and some areas of bright reflectivity possibly indicating shadow. Identified in the 2016 MBES data as an elongate mound. There is scour visible extending to the north-west and south-east for a maximum of 4.9 m. Located in an area of sand ripples and may be partially buried. This is also visible in the 2014 data, but does not appear as distinct, which may highlight sediment movement over the feature. Interpreted as a possible natural feature or may be possible debris.	2014 SSS, 2014 MBES, 2016 MBES	1804/2 500 m buffer	A2	-
2026	Mound	422027.00	5818845.00	17	11.8	1.3	-27.2	Identified in the SSS data as an area of irregular seabed with some unusual reflectivity. There is some shadow visible. Observed in the MBES data as a rounded mound. There is encircling scour visible, extending primarily to the north for 39.5 m. Interpreted as a possible natural feature or may be possible debris.	2014 SSS, 2014 MBES	1804/1	A2	-
2027	Dark reflector	422393	5815596	12	3	0	-	Identified in the SSS data as an elongate dark reflector that has no distinct shadow. It bends north at the east end. Some possible scour visible to the north-west. No anomalous features were identified in the MBES data at this location. Likely related to wreck	2014 SSS	1804/1	A2	-



Anomaly number	Anomaly type	Easting	Northing	Length (m)	Width (m)	Height (m)	Least depth (m)	Description	Dataset	Section	Archaeological discrimination	External references
								2001 located 40 m north. Interpreted as possible debris.				
2028	Dark reflector	422420	5815599	9.8	6.9	0.1	-	Identified in the SSS data as an indistinct dark reflector with shadow. Some scour is visible to the west. No anomalous features were identified in the MBES data at this location. Likely related to wreck 2001 located 40 m north-west. Interpreted as possible debris.	2014 SSS	1804/1	A2	-
2029	Debris	433796	5820711	5.5	3.4	0.3	-	Identified in the SSS data as an angular dark reflector with some shadow. No anomalous features were identified in the MBES data at this location. Located 15 m north-west of wreck 2021 and likely related. Interpreted as possible debris.	2014 SSS	1804/2 500 m buffer	A1	-



Appendix 6: Maritime recorded losses

NRHE ID	Name	Lost	Description
NMHR_1338604	<i>Ann</i>	1883	Built in 1876, this English dandy vessel foundered following collision with the Caernarvon registered schooner <i>Cordelin</i> in poor weather conditions.
NMHR_913963	<i>Maggie</i>	1885	Built in 1862, this English schooner foundered five miles east of the Corton Light Vessel following a collision with the steamer <i>Lizzie</i> . She was a wooden sailing vessel, en route from Grays to Middlesbrough with a cargo of loam.
NMHR_913976	<i>Aberfeldy</i>	1887	Built in 1884, this Scottish barque foundered following collision with SS <i>Mascotte</i> of Middlesbrough in windy conditions.
NMHR_1338667	<i>Young Alice</i>	1890	Built in 1890, this English ketch foundered during a SE gale following collision with an unidentified barque, presumed foreign.
NMHR_1339213	<i>Competitor</i>	1895	Built in 1851, this English cutter was stranded and lost near the lightship in windy conditions.
NMHR_914503	<i>Eustace</i>	1895	Built in 1879 by T Turnbull and Son in Whitby, this English cargo vessel of a crew of 20, foundered following a collision with SS <i>Skeffington</i> in poor weather conditions.
NMHR_914525	<i>S And A</i>	1897	Built in 1885, this English dandy foundered and was lost during a fishing trip following a collision with SS <i>T E Foster</i> of Newcastle-on-Tyne in calm conditions.
NMHR_1339358	<i>Laura</i>	1899	Built in 1875, this English dandy foundered and was lost following collision in windy conditions with the Grangemouth registered steamship <i>Edda</i> .
NMHR_1339621	<i>Reaper</i>	1901	Built in 1867, this English pilot vessel sank following a collision with the steam tug <i>Advance</i> , in windy conditions.
NMHR_1339651	<i>Strathaven</i>	1902	This British lugger foundered following collision with the steamship <i>Edward Eccles</i> of Newcastle-upon-Tyne in windy conditions.
NMHR_1339666	<i>Alice</i>	1903	Built in 1891, this British cutter was stranded and lost in windy conditions.
NMHR_1339683	<i>Lurline</i>	1903	Built in 1884, this English ketch with a crew of five foundered following a collision with the steamship <i>Perth</i> of Dundee in poor weather conditions.
NMHR_1339688	<i>Queen Mab</i>	1904	Built in 1894, this English dandy foundered following collision with the German steamship <i>Alice</i> in windy conditions.
NMHR_914014	<i>Breadwinner</i>	1905	Built in 1901, this British lugger foundered in the wind during a return fishing voyage out of Great Yarmouth.
NMHR_914047	<i>Successful</i>	1909	Built in 1902, this Scottish lugger sank following a collision with the tug SS <i>Dewan</i> of South Shields.
NMHR_914058	<i>Mare</i>	1911	This English cargo vessel foundered whilst under tow of a tug.
NMHR_914068	<i>Industry</i>	1912	Built of wood in 1891, this British lugger sailing vessel foundered three-quarters of a mile ESE of the Corton Light Vessel en route from Lowestoft for Haugesund in ballast.
NMHR_1458077	<i>Skodsborg</i>	1916	A Danish cargo vessel which foundered after being torpedoed five miles SSW of the Corton Light Vessel, while en route from New Orleans for Helsingborg with cotton seed cake and/or oil cake. The remains of the ship are believed to be located around 5 km to the SSE of Area 1804/1.



Appendix 7: Aviation recorded losses

NRHE ID	Name	Lost	Description
NMHR_1354147	Wellington Mk IC X9634	13/07/1941	Recorded loss for a Wellington Mk. IC standard heavy night bomber, whose engine cut out en route to Bremen and was forced to ditch off Corton, Suffolk

Appendix 8: Finds reported through the Marine Aggregates Protocol for Reporting Finds of Archaeological Interest

MAI ID	NMHR ID	Description	Area
CEMEX_0296	NMHR_1524492	A sample of peat was discovered during dredging activities in Licence area 251 in the East Coast region. During palaeo-environmental investigations seeds of white water-lily, bogbean and sedge were discovered in the sample. Also fragments of wood, small flakes of charcoal and the remains of common reeds. This evidence suggests that the peat sample comes from a once boggy area situated next to a river or stream.	1804/1 500 m buffer
CEMEX_0600	NMHR_1593012	A ships's timber found in material dredged from Licence Area 551, approximately 4.6 nautical miles east of Hopton-on-Sea, Norfolk. It is possible that the object has migrated from another wreck site in the locality or is part of a structure such as a breakwater built along the shore to protect the coastline. The timber is most likely post-medieval or modern in date.	1804/1 500 m buffer
CEMEX_0483	NMHR_1592031	A varied assemblage of finds discovered in material dredged from Licence Area 319, approximately 4.59 nautical miles east of Hopton-on-Sea, Norfolk. The finds included: seven fossilised bone fragments (potentially teeth); two long bones from an unknown species; a single stone object with a metallic concretion on one side; a single fragment of a wrought iron object, probably from a tool lost overboard from a vessel; a single cork fishing net float dated to the 20th century. These objects are not believed to be related to each other and do not indicate the presence of a site of archaeological interest.	1804/1 500 m buffer
CEMEX_0290	NMHR_1524538	Fragments of an aircraft wreckage were discovered during dredging activities in January 2010 in Licence area 251. The fragments originate from the United States Air Force and they are believed to come from a McDonnell-Douglas F-4 Phantom plane. This type of aircraft was flown from the mid 1960s and is still in use in 2010.	1804/1 500 m buffer
Hanson_0008	NMHR_1441945, NMHR_1500206	A block wheel or sheave and a cannonball found within material dredged in Licence Area 361, off Great Yarmouth. The wooden block wheel or sheave is designed to have a metal coak fitted to it. This indicates that the object can be dated post 1850s. The sheave is well worn around the outer edge. The cannonball is of late medieval or post-medieval date, recorded in the range 1500 to 1900. Thought to have been iron, the cannonball was recorded as about 80mm in diameter and may be evidence of a shipwreck, which in this position would have foundered, or evidence of material expended during a sea battle, for example, the Battle of Lowestoft, 1665.	1804/2
CEMEX_0284	NMHR_1524380	A fragment of elephant atlas fragment dating to the Palaeolithic or earlier was found during dredging activities in Licence area 360, which is situated in the East Coast Region, approximately 20 kilometres north-east of Lowestoft. It was dredged in late 2009 or early 2010.	1804/2 500 m buffer



MAI ID	NMHR ID	Description	Area
CEMEX_0340	NMHR_1550435	A woolly mammoth forelimb bone dating to the Palaeolithic was found in material dredged in October 2010 from Licence area 251, which lies off the coast of Lowestoft. The bone was identified as the right proximal radius.	1804/2 500 m buffer
CEMEX_0039	NMHR_1499946	A collection of organic and inorganic remains were found in an aggregated load dredged from Licence Area 360 in 2006. The assemblage comprises 256 large fragments of waterlogged and mineralised wood, four fragments of fibrous herbaceous peat, twelve fragments of mineralised bone, three fragments of antler and one fragment of worked flint.	1804/2 500 m buffer
CEMEX_0265	NMHR_1514739	A mammoth tooth and antler fragment were found in material dredged from licence area 360, 20km east of Lowestoft, Suffolk. The tooth has been identified as possibly originating from the <i>Mammuthus meridionalis</i> , the so-called "Southern Mammoth". The small size of the antler fragment means it is hard to identify, but its thickness indicates it could come from <i>Megaloceros</i> , the giant deer. Neither of the artefacts show signs of having been rolled by the sea and are thought to have come from an in situ deposit.	1804/2 500 m buffer
Hanson_0118	NMHR_1496385	Eleven small fragments of bone, the back of an aircraft fuel gauge and two wooden artefacts, one of which is a pulley sheave, the other unidentifiable, were found in material dredged by Hanson from licence area 242, approximately 24km east of Lowestoft. These artefacts are unlikely to have a direct association with one another in either context or location. The context of the aircraft gauge suggests the wreck of an aircraft which ditched in the sea, cause unknown, whilst the pulley sheave may be associated with the remains of a wooden sailing vessel which may have foundered in this offshore location, although this is conjectural.	1804/2 500 m buffer
CEMEX_0405	NMHR_1591678	A horse metacarpal, a bone from the front foot, found in material dredged by Cemex UK Marine Ltd from Licence Area 360, approximately 11.31 nautical miles east of Great Yarmouth. The age of the find is unknown, and there are no obvious signs of butchery.	1804/2 500 m buffer
CEMEX_0501	NMHR_1591811	Fragment of animal bone found in material dredged from Licence Area 360, approximately 10.8 nautical miles ESE of Great Yarmouth. The bone was identified by Wessex Archaeology as either part of a vertebra (a bone from the spine) or the proximal end of a femur (the upper rear limb bone). It was not possible to identify the species of animal, although the size of the fragment indicates that it comes from a large animal, most likely from a cow.	1804/2 500 m buffer



Appendix 9: OASIS record form

OASIS ID	wessexar1-505791
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Activity Type	
Project identifier	252080
Activity type	Desk Based Assessment
Reason for investigation	Planning requirement
Development type	Land management > Dredging
Planning reference	n/a

Location	
Site name	Aggregate Extraction Area 1804 (1 and 2)
Site code	252080
Land use	Marine
Geology	Marine sediments, Holocene (undifferentiated) - slightly gravelly sand (sea bed sediment, based on folk)

Reviewers / Admin Area	
Historic Environment Record(s)	Historic England National Marine Heritage Record
Archive type	Digital Archive
Museum/archive	Archives: no repository
National organisation	Historic England
HER identifiers	n/a
National organisation identifiers	n/a

Work Undertaken		
Title	Aggregate Extraction Area 1804 (1 and 2): Marine Archaeological Desk-Based Assessment	
Description / Methodology	Wessex Archaeology was commissioned by ABPmer, on behalf of CEMEX UK Marine, Southampton, to prepare a marine archaeological desk-based assessment, that includes an assessment of geotechnical vibrocores and available geophysical survey data, and a high-level Environmental Impact Assessment for marine aggregate extraction Area 1804 (1 and 2). The area is located in the Anglian dredging region ENE of Lowestoft, Suffolk.	
Previous / Future work	Yes	Yes
Start Date / End date	29/10/2021	31/05/2022
Scientific dating	No	
Environmental sampling	No	
Associated identifiers	UKHO_10430, UKHO_10446, UKHO_10449, UKHO_10677, UKHO_11024, UKHO_11026, UKHO_11028, UKHO_11029, UKHO_11031, UKHO_11230, UKHO_87130	

Report Details



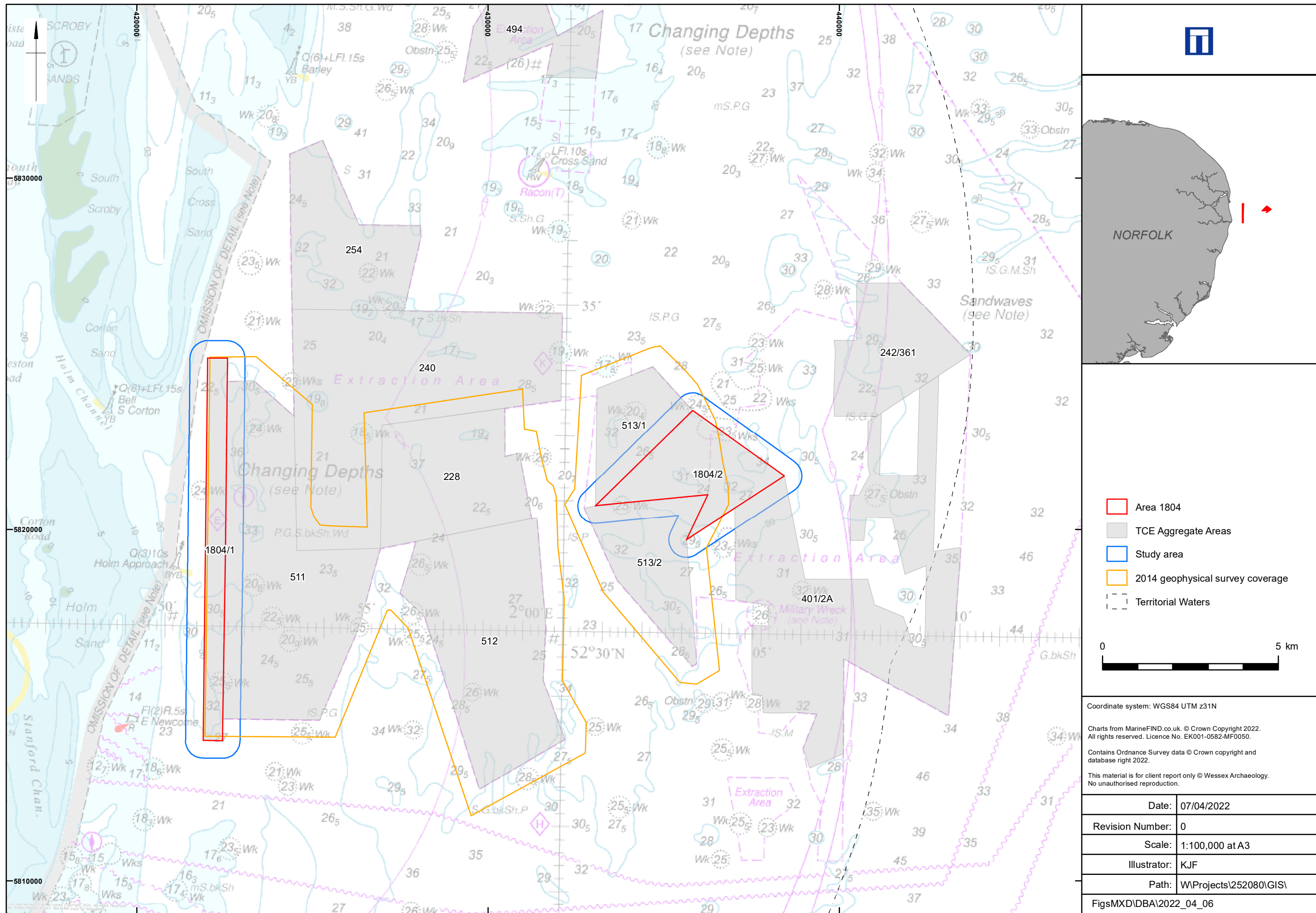
Title	Aggregate Extraction Area 1804 (1 and 2): Marine Archaeological Desk-Based Assessment
Author	Victoria Lambert and Claire Mellett
Publication date	2022
Publisher or Producer	Wessex Archaeology
Place of publication or production	Salisbury
Other bibliographic Information – report number	252080.01
Report release delay	3 months

People	
Organisation	Wessex Archaeology
Project Manager	Andrew Bicket
Expert/Project Officer	Claire Mellett, Victoria Lambert and Robyn Pelling
Funder	Private or public corporation > Aggregates

Keywords	
Significant monuments or artefacts	Yes
Keyword	Wreck
Period	Modern; Uncertain

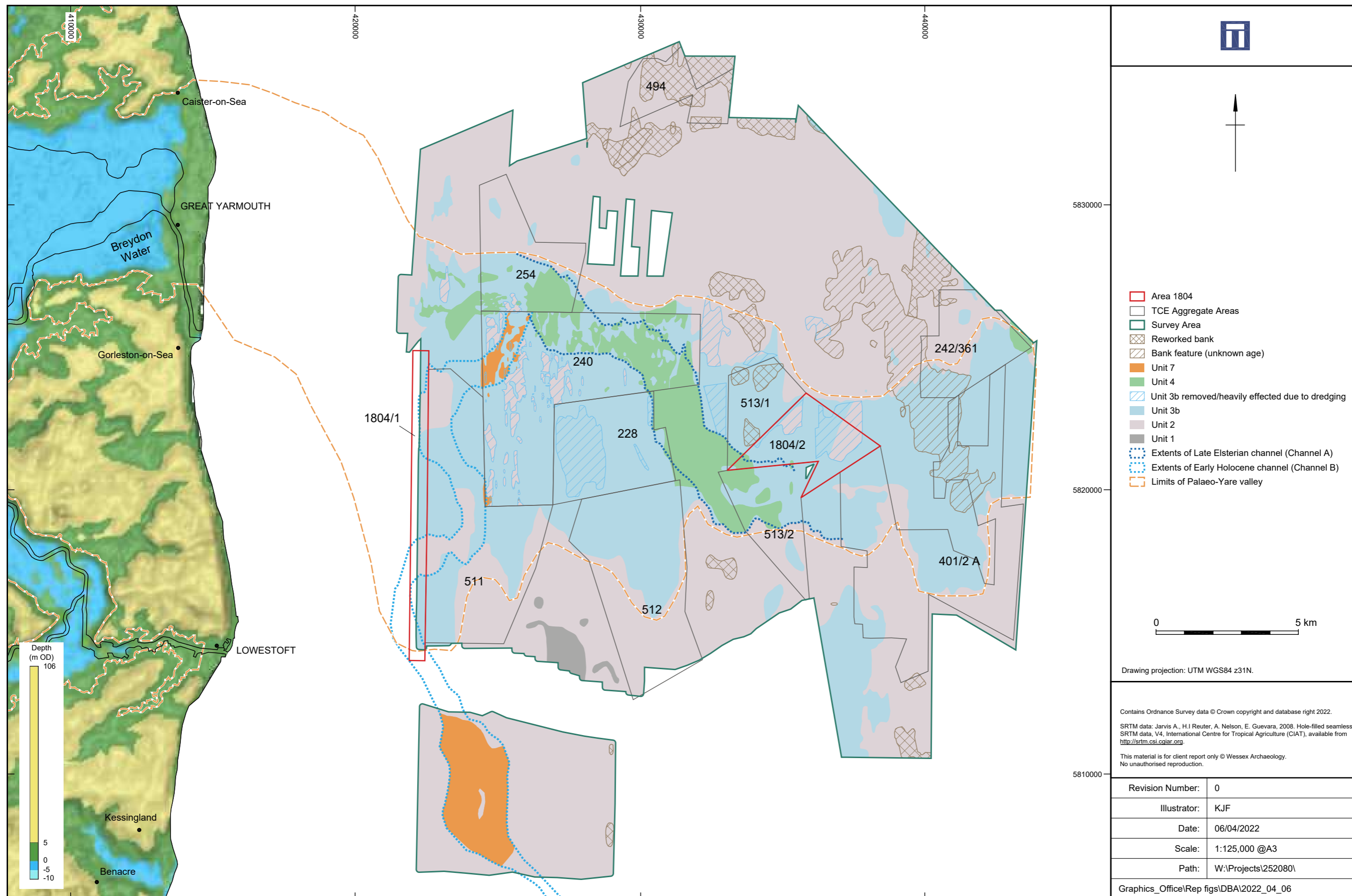
Results	
Description - outcomes	The known and potential archaeological resource within Area 1804 (1 and 2) is summarised as comprising: the potential for organic deposits containing material of palaeogeographical interest across the study area; 29 seabed features comprising five named shipwrecks (across seven records), two unidentified wreck sites, five areas of debris (three of which area may be associated with wreck sites), two linear features interpreted as rope/chain (one of which may be associated with a wreck site), ten areas of possible debris/natural features (one of which may be associated with a wreck site), and three natural features; the potential for additional currently unknown maritime and aviation seabed features to exist; and a Historic Seascape Character that includes, fishing, navigation and industry. There is potential for the proposed dredging activities to impact as yet unknown archaeological sites related to palaeogeography, shipwrecks and aircraft crash sites.
Research framework sections	Marine

Archives	
Physical archive / Documentary archive / Digital Archive	No physical / documentary / digital archive
Additional Information	
Project website	n/a
Large area scheme	n/a
Related OASIS projects	n/a



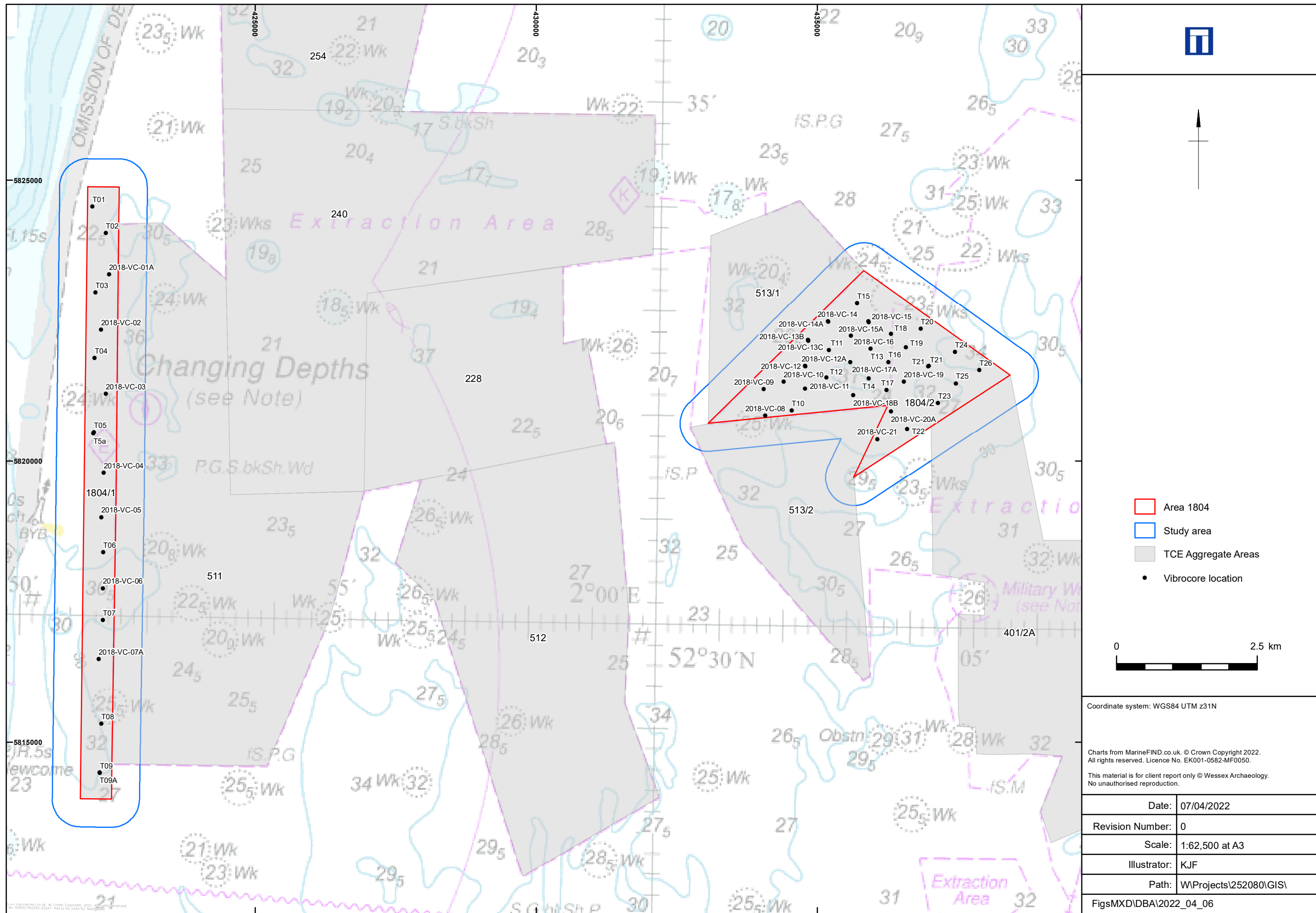
Location of Marine Aggregate Area 1804

Figure 1



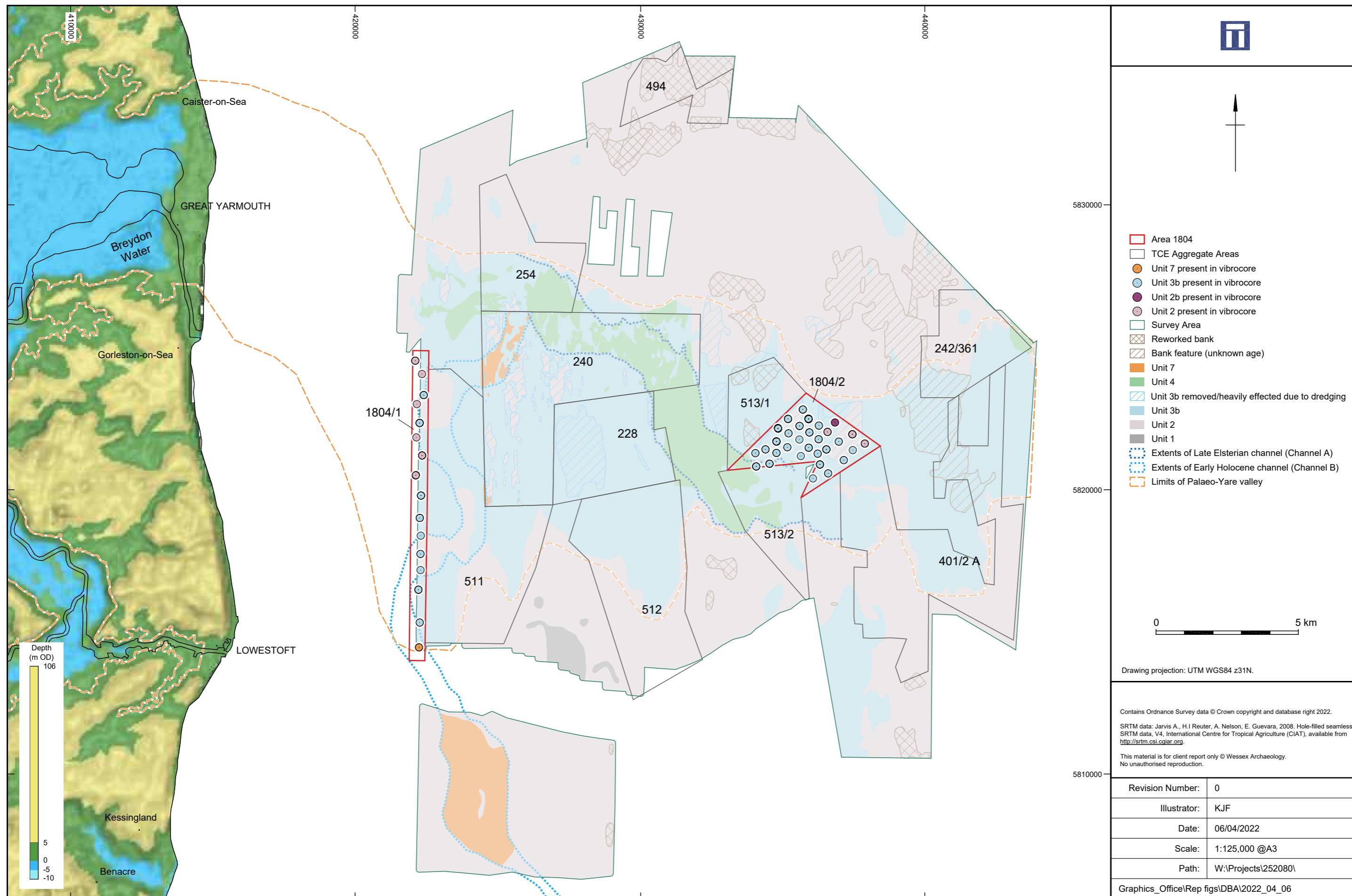
Palaeo-Yare Catchment Assessment

Figure 2



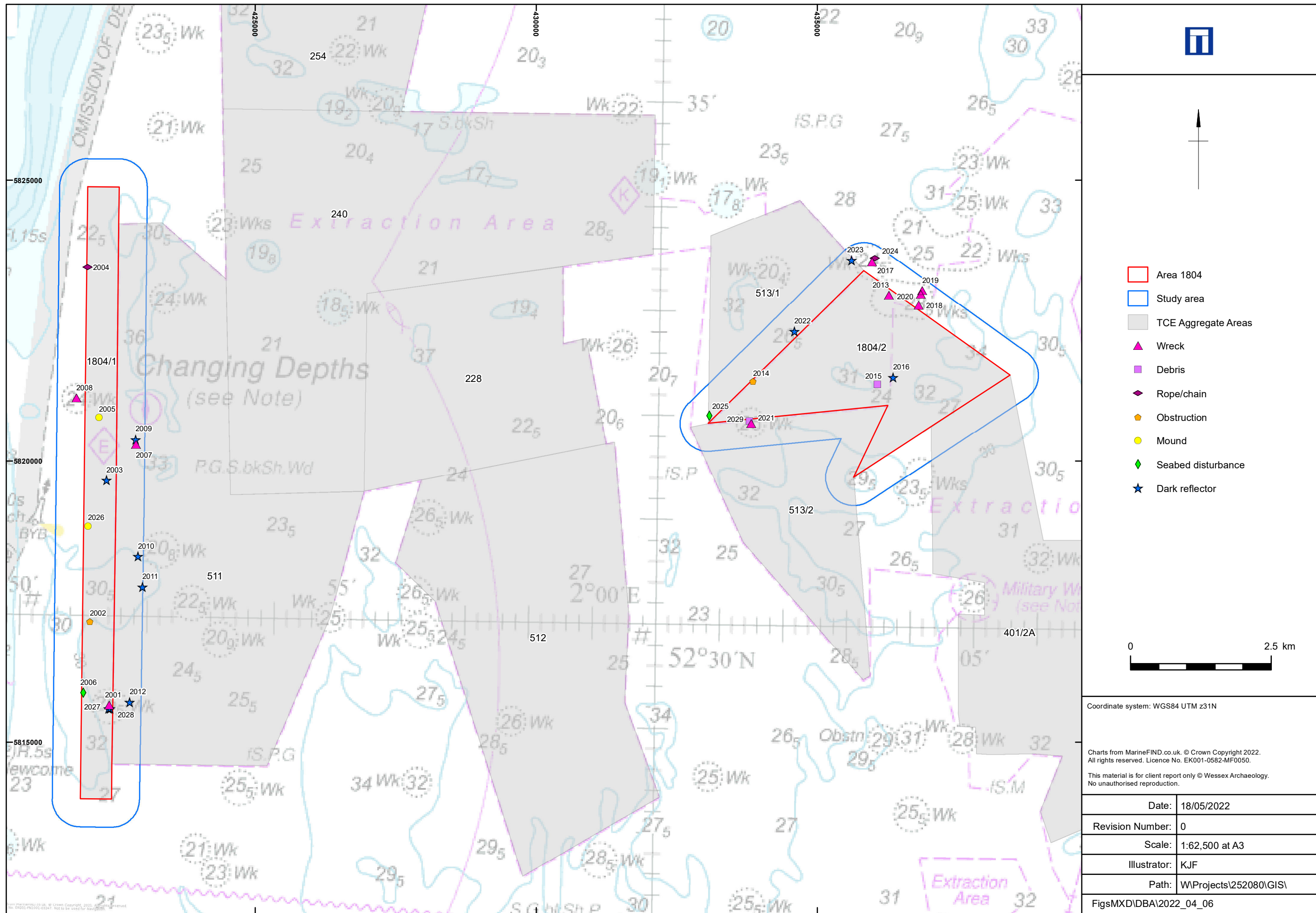
Location of geotechnical vibrocores in Area 1804

Figure 3



Distribution of Lithostratigraphic Units in vibrocores

Figure 4



Seabed features of archaeological potential

Figure 5



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