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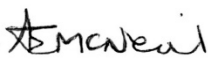





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Report Information

Document title	Palaeo-Yare Catchment Monitoring: Interpretative Report
Document subtitle	Five Year Review of Operational Sampling: January 2015 to December 2019
Document reference	226020.03
Client name	
Address	
On behalf of	Anglian Offshore Dredging Association
Site location	Anglian Dredging Region
WA project codes	226020 77860, 77861, 83743, 88251, 88252, 220700
Dates of fieldwork	2014-2019
Fieldwork directed by	
Project management by	Euan McNeill
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Graphics by	Kitty Foster

Quality Assurance

Version & issue date	Status	Author	Approved by
V1 20/11/2020	Draft	ATH	AEM 
V2 09/02/2021	Final	ATH	AEM 
V3 24/03/2021	Final – addressing comments from Nigel Griffiths and Antony Firth	ATH	AEM 
V4 29/03/2021	Final – edits to Appendix 2	ATH	AEM 
V5 30/06/2021	Final – edits following comments from Historic England	ATH	AEM 
V6 15/07/2021	Final – following further comments from Historic England (typos and update to section 9.1)	ATH	AEM 

DATA LICENCES

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Summary

Wessex Archaeology was commissioned by the Anglian Offshore Dredging Association (Hanson Aggregates Marine; Cemex UK Marine; Volker Dredging and Tarmac Marine), coordinated through the British Marine Aggregate Producers Association (BMAPA) and Hanson Aggregates Marine Limited, to provide an interpretative report on the Operational Sampling events undertaken in the East Coast aggregate extraction block and conducted at aggregate wharves between 2015 and 2019, and to develop an understanding of the results in the wider context of the Palaeo-Yare. The work was initiated by the *Written Scheme of Investigation: Early Prehistoric Material in the Anglian Region* for the licences and Historic England approved licence specific methodologies.

The report summarises the methods and results of 23 Operational Sampling events undertaken between January 2015 and December 2019, as well as five events from mid- to late- 2014 that were omitted from the previous interpretative report.

From the 28 Operational Sampling events undertaken at Frindsbury, Northfleet and Dagenham wharves, 52 lithics and 186 faunal remains have been recovered from approximately 115,000 tonnes of aggregate. The discoveries continue to further our understanding of the region and have allowed us to address certain existing hypotheses.

Of particular interest was the discovery of potentially *in situ* material of Saalian age (300,000 to 130,000 BP, international nomenclature) (referred to previously as Wolstonian in previous reports). The discovery comprised flint artefacts in near pristine condition; evidence for tool production and debitage and megafaunal remains. The discoveries were made in aggregate dredged from Licence Area 240, dredging lane F10, in which an AEZ has since been implemented, through discussions with Historic England. Material of archaeological interest continues to be discovered in aggregate from lanes F8-9, as reported through the *Protocol for Reporting Archaeological Discoveries* and identified through Operational Sampling events undertaken in 2020.

The recent discoveries from Licence Area 240, along with the original discoveries in 2007-2008, highlight the fact this area represents a 'hot spot' for discovery. In addition, discoveries made on the beach following the Bacton Beach Nourishment Project suggest that a location within either Licence Areas 228 or 511 may also be a concentrated source of material, however, the use of multiple licences for the project made it difficult to determine the origin of the finds with any certainty. Although it is possible that other hot-spots exist associated with the now-submerged catchment of the Palaeo-Yare, they have not yet been identified through the Operational Sampling undertaken to date.

Isolated flint artefacts from Licence Area 240 have been dated from the Middle to Upper Palaeolithic. From Licence Area 511, Middle to Lower Palaeolithic flakes have been recovered, and a possible flint blade core has been potentially dated to the Mesolithic. A large blade from Licence Area 512 has been dated to the Upper Palaeolithic. Other flint artefacts that were not possible to date have also been recovered. The ages of the finds suggest hominin use of the area at various times from the Lower Palaeolithic to Mesolithic.

The methodologies for Operational Sampling have continued to be successful, with material successfully recovered at each wharf where sampling has taken place. Fewer Operational Sampling events took place from 2015-2019 than originally planned, however, this was due to operational limitations and commercial concerns that determined the type of aggregate dredged. Operational Sampling in 2020 has increased, largely due to the importance of discoveries in Licence Area 240, and overall, 11 events were undertaken between February and October 2020.



Acknowledgements

Wessex Archaeology was commissioned by the Anglian Offshore Dredging Association (Hanson Aggregates Marine; Cemex UK Marine; Volker Dredging and Tarmac Marine), coordinated through the British Marine Aggregate Producers Association (BMAPA) and Hanson Aggregates Marine Limited, to provide an interpretative report on the Operational Sampling events conducted at aggregate wharves between 2015 and 2019.

Wessex Archaeology would like to thank Mark Russell (BMAPA) and the licensees for their support during the Operational Sampling. Thanks to:

- Nigel Griffiths, Patrick Mallon, Bryn Lockwood, Amy Stewart, Michael Perkins, Aaron Chidgey, Troy Potter, John Valsler, Alice Harley, Steve Chidgey and all the other staff at HAML and at Dagenham and Frindsbury Wharves; and
- Graham Singleton, Joseph Holcroft, Samantha Ringwood, Michael Hinson, Adam Johnson, Andy Lingham and all the other staff at Cemex and at Northfleet Wharf.

Wessex Archaeology would also like to thank Stuart Churchley, from Historic England, for assisting with the Operational Sampling fieldwork at HAML's Dagenham Wharf in November 2019.

Fieldwork was undertaken between 2015 and 2019, by the following staff from Wessex Archaeology: Alistair Byford-Bates, Michal Cepak, Benjamin Cullen, Joaquin Callejo Gomez, Erica Gittins, Tom Harrison, Kerree Kendall, Peta Knott, Steve Legg, Dr Matt Leivers, Jennifer Loader, Lisa McCaig, Michael Murray, Lowri Roberts, Tony Scothern, Graham Scott, Mark Stewart, Phil Trim and Danielle Wilkinson.

The following specialists have also contributed to the archaeological assessments: Dr. Silvia Bello (Natural History Museum), Phil Harding (Wessex Archaeology), Lorrain Higbee (Wessex Archaeology), Dr. Matt Leivers (Wessex Archaeology), Professor Adrian Lister (Natural History Museum), Simon Parfitt (Natural History Museum), and Dr. Andrew Shaw (Wessex Archaeology).

The finds were processed by the Coastal & Marine and Finds teams in Salisbury.

The archaeological assessment of geotechnical survey data was undertaken by Dr. Claire Mellett.

This report has been compiled by Andrea Hamel, with contributions from Alistair Byford-Bates, Joaquin Callejo Gomez, Erica Gittins, Kerree Kendall, Peta Knott, Dr. Matt Leivers, Lowri Roberts, Graham Scott, Phil Trim and Dr Andrew Shaw. Kitty Foster produced the figures. Euan McNeill managed the project, and Quality Assurance was provided by Dan Atkinson.



Paleo-Yare Catchment Monitoring: Interpretative Report

Five Year Review of Operational Sampling: January 2015 to December 2019

1 INTRODUCTION

1.1 Project description

- 1.1.1 Wessex Archaeology was commissioned by the Anglian Offshore Dredging Association (Hanson Aggregates Marine; Cemex UK Marine; Volker Dredging and Tarmac Marine), coordinated through the British Marine Aggregate Producers Association (BMAPA) and Hanson Aggregates Marine Limited), to produce an interpretative report detailing the methods and results of the operational sampling events undertaken in the East Anglia aggregate extraction block (Figure 1), over the last five years. The report covers the period from January 2015 to December 2019 and integrates the results of Operational Sampling with evidence in the wider Palaeo-Yare region.
- 1.1.2 The operational sampling work was undertaken in line with the *Written Scheme of Investigations: Early Prehistoric Material in the Anglian Region* (Fjodr 2015) and Appendix I (Fjodr 2016), and with the individual Monitoring Method Statements (Wessex Archaeology 2016a-c, 2017). This report comprises the First Full-Term Interpretative Report, as per the WSI.
- 1.1.3 This report follows on from, and draws from the results of, the previous summary, the *Palaeo-Yare Operational Sampling conducted under the short-term licensing provisional Written Scheme of Investigation: Interpretive Report* (Wessex Archaeology 2015a), that summarised the results of Operational Sampling visits carried out by the aggregate licence operators between May 2012 and December 2014. However, five reports (from June to November 2014) were previously omitted and these are addressed here.
- 1.1.4 Previous assessments relevant to this report includes work conducted in the Licence Area 240 (Wessex Archaeology 2011a) on behalf of English Heritage (now Historic England), funded by the Aggregate Levy Sustainability Fund (ALSF); work commissioned by HAML which involved a programme of archaeological monitoring within Licence Area 240 (Wessex Archaeology 2011b); and the Palaeo-Yare Catchment Assessment (Wessex Archaeology 2013a, 2013b).

1.2 Background

- 1.2.1 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, the marine aggregate company (HAML) voluntarily implemented an Archaeological Exclusion Zone (AEZ) covering this area.

- 1.2.2 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.
- 1.2.3 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).
- 1.2.4 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 (**Table 1**) (updated assessment in Figure 2). 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.

Table 1 Interpretation of geological units identified within the Palaeo-Yare catchment area (Wessex Archaeology 2011a; 2013a; 2013b; 2015)

Unit	Interpretation	Age	Description	Archaeological interest
8	Marine deposits associated with the last transgression in the Holocene	Holocene	Shelly, gravelly medium to coarse sand.	Potential to comprise reworked archaeology
7	Basal fill of a shallow under-filled channel feature (equivalent to onshore lower Breydon Formation)	Early Holocene	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.	Highly likely to contain environmental archaeology (e.g. peat) and may preserve Mesolithic archaeology (faunal and lithic)
6	Fluvial alluvium	Possibly mid-Weichselian	Sandy gravel. Only identified in Area 240.	Potential to contain Middle Palaeolithic archaeology but no evidence found to date



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. Only identified in Area 240.	Potential to contain Middle Palaeolithic archaeology but no evidence found to date
4	Brown Bank Formation	Early Weichselian (110 – 75 ka)	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. Similar aged sediments also observed in Area 401/402.	Potential to contain Middle Palaeolithic archaeology. There is evidence for occupation during this period in northern France (Locht <i>et al.</i> 2016) and material from Dartford (Wenban-Smith <i>et al.</i> 2010) illustrates potential for Early Weichselian occupation north of Channel.
3b	Reworked glaciofluvial outwash	Saalian glaciation (347 to 130 ka)	Unit 3b is comprised of sands and gravels and forms the principal floodplain deposits of the offshore extents of the Palaeo-Yare.	Highly likely to preserve Middle Palaeolithic archaeology (faunal remains and lithics) Although the deposit is 'outwash' the archaeological material on its surfaces is predominantly <i>in situ</i> (ie: the deposits are derived from reworked material deposited in the Palaeo-Yare where they formed surfaces that were then inhabited)
3a	Reworked glaciofluvial outwash	Saalian glaciation (347 to 130 ka)	A channel (Channel A) infill deposit identified in Area 240 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	May contain reworked Palaeolithic archaeological material



			channel feature in the northeast and comprises gravel and sand. Only identified in Area 240.	
2	Yarmouth Roads Formation	Cromerian period (478 to 787 ka)	Unit 2 generally comprises silty, gravelly, fine to coarse sands. Observed throughout the region overlying Unit 1. To the south of Area 240 and to the east of the region Unit 2 is more complex and comprises silty sand with very frequent thin beds and laminae of firm to stiff clay and peaty organic clay.	Potential to preserve Lower Palaeolithic archaeology
1	Westkapelle Ground Formation	Pliocene/Early Pleistocene	The deepest unit and is observed throughout the region.	None – predates hominin occupation of northern Europe

- 1.2.5 The flint artefacts recovered from Licence Area 240 were interpreted as being principally associated with a specific glaciofluvial sediment, Unit 3b (Wessex Archaeology 2015a). Deposited during the Saalian, Unit 3b forms a floodplain deposit of the middle Pleistocene channel of the Palaeo-Yare.
- 1.2.6 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.
- 1.2.7 A provisional WSI was produced, the rationale for which is discussed in more detail elsewhere (ie: 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.
- 1.2.8 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 2015a) (results included in updated assessment in Figure 2). 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.

1.3 Archaeological Significance

1.3.1 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* (English Heritage 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.

1.3.2 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 (Roberts and Parfitt 1999, Parfitt 2010, Lewis *et al.* 2019).

1.3.3 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).

1.3.4 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/Prehistoric Society 2008);
- *North Sea Prehistory Research and Management Framework* (Peeters, Murphy and Flemming 2009); and
- *Research and Archaeology Revisited: a revised framework for the East of England* (East Anglian Archaeology 2011).
- *People and the Sea: A Maritime Research Agenda for England* (Ransley *et al.* 2013)

1.4 Aims and Objectives

1.4.1 The aim, as set out in the WSI (Fjodr 2015) is to capture evidence of early prehistory in the Anglian Region, contributing to our knowledge and understanding of the past in a manner that is made publicly available, whilst maintaining the effectiveness of the WSI throughout the duration of the marine licenses.

1.4.2 The objectives of the WSI are as follows:

- to capture early prehistoric artefacts and faunal remains recovered in the course of dredging;
- to advance knowledge and understanding of the distribution and significance of early prehistoric material in the Anglian Region, with reference to a series of hypotheses; and



- to refine the implementation of the WSI and the associated management of marine aggregate dredging throughout the duration of the marine licenses; and
- to make the results of implementing the WSI available to the public.

1.4.3 The principal outputs arising from the implementation of the WSI (Fjodr 2015) for the licences has been a series of unpublished Operational Sampling Reports on the results of processing operational samples dredged from each licence area (Wessex Archaeology 2014a-e, 2015b-k, 2016d, 2017b-d, 2018a-c, 2019a-f). The reports are provided to the Licensees and Archaeological Curator for comment, and the results are compiled in this single integrated interpretative report for wider distribution.

1.4.4 This report collates and reviews the finds of all of the Operational Sampling conducted between January 2015 to December 2019 and fulfils the *First Full-Term Interpretative Report* as indicated in the WSI (Fjodr 2015: 13). As per the WSI, this interpretative report:

- provides an overall record of early prehistoric material captured in the course of aggregate dredging;
- sets the results within their palaeogeographic context, to contribute to knowledge and understanding of the early prehistory of the Anglian Region;
- assesses the archaeological discoveries in relation to the hypotheses set out in Appendix 1 of the WSI (Fjodr 2016); and
- reviews the hypotheses and Operational Sampling methodologies to determine whether revisions are required.

2 HYPOTHESES

2.1 Overview

2.1.1 A set of hypotheses were developed, in order to test the key conclusions of the *Palaeo-Yare Catchment Assessment* (Wessex Archaeology 2013a) and address remaining uncertainties. The hypotheses were predominantly focussed on the proven potential for artefacts within the Palaeo-Yare floodplain deposits (Unit 3b) and were divided into five groups relating to specific issues. The early hypotheses (**Table 2**) were addressed in the previous summary report and were tested during Operational Sampling events undertaken up to the end of 2014.

Table 2 Summary of hypotheses (from the provisional WSI)

Hypotheses:	
Inhabitation	<p>H1a: Palaeolithic material is recovered only from Unit 3b, which dates to the Saalian (Wolstonian).</p> <p>H1b: Palaeolithic material recovered from Unit 3b is predominantly <i>in situ</i>.</p>
Choice and use of location	<p>H2a: Palaeolithic material is recovered only from Unit 3b deposits on the margin of Channel A, not within the Channel itself.</p> <p>H2b: Palaeolithic material is recovered only from Unit 3b deposits within the limits of the Palaeo-Yare floodplain, and not within the Unit 3b outliers to the north and south of the floodplain</p> <p>H2c: The recovery of Palaeolithic material is clustered in relatively large quantities in discrete locations; material is not recovered from otherwise similar locations.</p>



Natural processes	<p>H3a: The distribution of recovered Palaeolithic material does not vary according to variations in the sediment structure of Unit 3b.</p> <p>H3b: Palaeolithic material is not recovered where Unit 3b appears to have been reworked by natural processes in the past.</p> <p>H3c: Palaeolithic material is not recovered where Unit 3b appears to be covered by major bank structures.</p>
Dredging History	<p>H4a: Palaeolithic material is not present where the dredging history indicates that a high level of dredging has taken place since the introduction of EMS (Electronic Monitoring System).</p> <p>H4b: Palaeolithic material is not present where geophysical data indicates that a high level of dredging has taken place.</p>
Operation Sampling methods	<p>H5a: Palaeolithic material is found at all wharves where Operational Sampling takes place</p>

2.1.2 In 2015, the hypotheses were in the process of being updated, and the following were used:

Table 3 Summary of hypotheses (from Operational Sampling results in 2015)

Activity	Description
Inhabitation	<p>H1.1: Middle Palaeolithic material is recovered only from Unit 3b</p> <p>H1.2: Middle Palaeolithic material from Unit 3b dates to the Saalian (Wolstonian)</p> <p>H1.3: Middle Palaeolithic material recovered from Unit 3b is predominantly <i>in situ</i></p> <p>H1.4: Late Upper Palaeolithic material is recovered only from the vicinity of Channel B</p> <p>H1.5: Late Upper Palaeolithic material from the vicinity of Channel B is predominantly <i>in situ</i></p> <p>H1.6: <i>In situ</i> Lower Palaeolithic material is recovered only from Unit 3b</p> <p>H1.7: Other than from Unit 3b and Late Upper Palaeolithic material from the vicinity of Channel B, no artefactual material appears to be <i>in situ</i></p> <p>H1.8: No prehistoric material is recovered for periods later than the Late Upper Palaeolithic</p> <p>H1.9: All faunal remains appear to be in secondary contexts</p>
Choice and use of location	<p>H2.1: Middle Palaeolithic material is not recovered from Channel A, only from the margin of Channel A.</p> <p>H2.2: Middle Palaeolithic material is recovered from all Unit 3b deposits (other than Channel A itself), including outliers to the north and south of the floodplain</p> <p>H2.3: Middle Palaeolithic material is clustered in relatively large quantities at discrete locations.</p> <p>H2.4: Middle Palaeolithic material is present in small quantities throughout Unit 3b deposits.</p>
Natural processes	<p>H3.1: Middle Palaeolithic material is recovered in areas where Unit 3b has been reworked by natural processes.</p> <p>H3.2: Middle Palaeolithic material is not recovered where Unit 3b appears to be covered by major bank structures.</p> <p>H3.3: Palaeolithic material is not present where dredging indicates that high level of dredging has taken place since the introduction of EMS.</p>
Dredging History	<p>H4.1: Middle Palaeolithic material is recovered where geophysical data indicates that a high level of dredging has taken place.</p>
Operation Sampling methods	<p>H5.1: Faunal and artefactual material is found at all wharves where Operational Sampling takes place.</p>



2.1.3 The hypotheses were further refined based on the results of the interpretive report produced in 2015 (Wessex Archaeology 2015a), and the revised hypotheses were presented in Appendix 1 of the updated WSI (Fjodr 2016). The present hypotheses are summarised in **Table 4**.

Table 4 Summary of hypotheses (from Appendix 1 of the WSI (Fjodr 2016))

Activity	Description
Inhabitation	<p>H1.1: Middle Palaeolithic material is recovered from units other than 3b</p> <p>H1.2 Some of the Middle Palaeolithic material recovered from Unit 3b is <i>in situ</i></p> <p>H1.3 Late Upper Palaeolithic material is recovered from other places in addition to the vicinity of Channel B</p> <p>H1.4 Some Late Upper Palaeolithic material from the vicinity of Channel B is <i>in situ</i>.</p> <p>H1.5 Some <i>in situ</i> Lower Palaeolithic material is recovered from other units than Unit 3b.</p> <p>H1.6 Artefactual material appears to be <i>in situ</i> in areas other than Unit 3b and the vicinity of Channel B.</p> <p>H1.7 Prehistoric material is recovered for periods later than the Late Upper Palaeolithic.</p> <p>H1.8 Faunal remains appear to be in primary contexts.</p>
Choice and use of location	<p>H2.1: Middle Palaeolithic material is recovered from the floodplain of Channel A, not from Channel A.</p> <p>H2.2: Middle Palaeolithic material is recovered from outlying deposits of Unit 3b north and south of the floodplain.</p> <p>H2.3: Middle Palaeolithic material is clustered in relatively large quantities at discrete locations.</p> <p>H2.4 Middle Palaeolithic material is present in small quantities throughout Unit 3b deposits.</p>
Natural processes	<p>H3.1: Middle Palaeolithic material is recovered in areas where Unit 3b has been reworked by natural processes.</p> <p>H3.2: Middle Palaeolithic material is recovered where Unit 3b appears to be covered by major bank structures.</p>
Dredging History	<p>H4.1: Middle Palaeolithic material is recovered where dredging history indicates that a high level of dredging has taken place since the introduction of EMS.</p> <p>H4.2: Middle Palaeolithic material is recovered where geophysical data indicates that a high level of dredging has taken place.</p>
Operation Sampling methods	<p>H5.1: Faunal and artefactual material is found at all wharves where Operational Sampling takes place.</p>

2.1.4 As was envisioned, these hypotheses are being tested through physical sampling and monitoring of dredge loads from the licence areas as detailed in the WSI. Certain licence areas lend themselves to certain hypotheses. The hypotheses applicable to each licence area are set out in the Monitoring Method Statements (Wessex Archaeology 2016a-c, 2017) and are summarised in **Table 5**.

Table 5 Hypotheses (Fjodr 2016) to be tested by licence area (based on the Monitoring Method Statements (Wessex Archaeology 2016a-c, 2017))

	Licence Area	H1.1	H1.2	H1.3	H1.4	H1.5	H1.6	H1.7	H1.8	H2.1	H2.2	H2.3	H2.4	H3.1	H3.2	H4.1	H4.2	H5.1
CEMEX	511	✓	✓		✓	✓		✓	✓	✓		✓	✓	✓				✓
	512	✓	✓	✓		✓		✓	✓	✓		✓	✓					✓



	513/1	✓	✓	✓		✓	✓	✓	✓	✓		✓	✓		✓	✓		✓
	513/2	✓	✓	✓		✓	✓	✓	✓			✓	✓	✓				✓
HAML	212	✓		✓		✓	✓	✓	✓			✓						✓
	240		✓		✓	✓		✓	✓	✓		✓	✓	✓		✓	✓	✓
	242/361	✓	✓	✓		✓	✓	✓	✓			✓			✓	✓		✓
	401/2	✓		✓		✓	✓	✓	✓	✓		✓	✓					✓
Tarmac	296	✓		✓		✓	✓	✓	✓			✓						✓
	494	✓		✓		✓	✓	✓	✓			✓						✓

3 OPERATIONAL SAMPLING METHODOLOGY

3.1 Method Statements

3.1.1 The development and implementation of Licence-Specific Method Statements are a condition for each of the marine licences for the Anglian Region. The Licence Specific Method Statements apply the WSI (Fjordr 2015) to the specific palaeogeographic circumstances of each licence area to which the marine licence applies.

3.1.2 The WSI sets out all of the requirements for the Licence-Specific Method Statements (Fjordr 2015: 9-10), and these are reflected in the Licence-Specific Monitoring Method Statements that have been produced for each licence area (Wessex Archaeology 2016a-c, 2017).

3.1.3 The following text has been taken directly from the WSI, as it stipulates what each Licence-Specific Method Statement will set out (Fjordr 2015: 9-10):

- document details of the Area Data Sheets(s) upon which the Licence-Specific Method Statement is based. The Area Data Sheet(s) should be appended to the Method Statement;
- arrangements for recording the position from which each Operational Sample is actually dredged;
- arrangements for ensuring, as far as possible, that the dredged aggregate comprises only aggregate dredged from the recorded position of each Operational Sample;
- the name of the wharf to which samples will be taken for processing;
- arrangements for liaising with the wharf and with archaeological contractors to ensure that each Operational Sample is processed promptly and in accordance with the WSI;
- arrangements for recording the conduct of dredging for each Operational Sample, including the provision of position-fixing data and any commentary on the conduct of the dredging that may have affected the effectiveness of the Operational Sample; and
- arrangements for transferring records of the conduct of dredging, including position-fixing data, to the archaeological contractors for incorporation in the Operational Report.

3.1.4 For each area/sub-area:

- the maximum tonnage of aggregate that is permitted to be extracted in the Area/sub-area over the term of the marine licence;

- the hypotheses that are to be tested in the Area/sub-area;
- the overall tonnage that it is proposed to dredge as samples from the Area/sub-area during the licence period, in order to provide a percentage of the maximum tonnage permitted to be extracted;
- a schedule of sampling for each Area/sub-area that sets out the number of Operational Sampling events and size of each sample that is proposed. It is a condition of each marine licence that the Licence-Specific Method Statement be implemented in line with the schedule of sampling that has been approved;
- the general location within the Area/sub-area at which it is proposed to dredge each sample; and
- the proposed timetable for carrying out Operational Sampling events in the Area/sub-area over the licence period, including provision to alert Historic England of the planned dates for each Operational Sampling event when they become known.

3.1.5 Where it is not relevant or reasonably practicable to provide an item of information as listed above, then the reason for omitting the item will be briefly stated in the Licence-Specific Method Statement.

3.2 Review of geoarchaeological data

3.2.1 A marine geoarchaeological assessment of deposits from the Palaeo-Yare was undertaken to build upon the regional-scale Palaeo-Yare Catchment Assessment undertaken by Wessex Archaeology (2013a) and to support this report.

3.2.2 Two assessments were undertaken, with Hanson Aggregates Marine commissioning the assessment of marine aggregate Licence Areas 212, 240, 242/361 and 401/2 (Wessex Archaeology 2020a), and Cemex UK Marine Ltd. commissioning the assessment of Licence Areas 511, 512, 513/1 and 513/2 (Wessex Archaeology 2020b).

3.2.3 For the Hanson Aggregates Marine licence areas, a total of 184 geotechnical vibrocore logs from five surveys undertaken between 2012 and 2017 were reviewed (Wessex Archaeology 2020a). For the Cemex UK Marine Ltd. licence areas, vibrocore logs, photographs and the results from particle size distribution analysis from 71 locations were reviewed.

3.2.4 The geoarchaeological review resulted in updates to the deposit models for Licence Areas 240, 242/361 and Area 401/2. No changes were made to the deposit models for Licence Areas 212, 511, 512, 513/1 or 513/2.

3.2.5 This report should be read in conjunction with the marine geoarchaeological assessments (Wessex Archaeology 2020a, b). However, the main conclusions are summarised in the Operational Sampling Results section below. Figure 2 and the associated data sheets for each licence area (Sheets 1-9) provide an updated illustration of the locations of the sediment units.

3.3 Operational Methodologies and Limitations

Introduction

3.3.1 This section summarises the operational methodologies at the three wharves where Operational Sampling has taken place between 2015 and 2019 and discusses various

limitations that have been identified. In a similar result to the previous period assessment, as noted in the previous interpretative report (Wessex Archaeology 2015a), the proposed number of sampling events were not achieved. However, the quantity of sediment sampled during each visit remains high, with almost 65,000 tons reviewed.

3.3.2 The smaller number of predicted visits was largely due to issues with customer/market demand, where aggregate was not received from the locations identified for sampling. Licence operators change areas and lanes in order to adapt to market demand and the types of material that is required. For example, although for many projects, gravels are required, for other developments, finer grained sediments will be targeted. In addition, between 2014 and 2018, the East Coast dredging region saw a general decline in the extracted tonnage (The Crown Estate 2019: 7), even though the area dredging area gradually increased (The Crown Estate and BMAPA 2020: 7). The 20 year review, covering 1998 to 2017 also notes general decrease in dredged area and tonnages in the East Coast region (The Crown Estate and BMAPA 2018: 13).

3.3.3 Other factors include inclement weather and technical issues at wharves such as breakdown or vessel access problems. For example, in July 2017, two days of Operational Sampling were planned, but due to an electrical failure in the material processing plant, the visit was reduced to one day, and only 25% of the planned cargo could be assessed.

Frindsbury wharf

3.3.4 At Frindsbury Wharf, the recovery of archaeological material was carried out through the observation of aggregate being conveyed into the crushing tower, after the >100 mm and the majority of the <40 mm fractions have been removed. The monitoring archaeologist was positioned above the gantry above the conveyor, where they could look down directly and see the full length of the conveyor. When potential archaeologically significant items were observed, the conveyor was stopped by activating the metal detector using a tin can full of nails. Then the items were retrieved from the stationary conveyor by hand. Due to the physiological effects of height and watching moving conveyors, archaeological observers rotated every 20 minutes to minimise observer fatigue. Despite this, and dependant on observer experience, there was a possibility for archaeologically relevant material to be missed occasionally during this process.

3.3.5 Materials measuring over 100 mm are rejected into an oversize bin, and there were issues with accessing and assessing the material. Due to health and safety issues, and the risks posed by this material falling from height, the material was only examined when the plant was not operational, for example when it has stopped for the day, or occasionally for other operational reasons. Therefore, not all of this material was observed due to the lower material being buried in the pile. There were also occasionally issues with archaeologically assessing oversized and undersized material, where there could be cross-contamination with previous cargoes, for example in August 2019, the oversized and undersized material was only observed on the second day. In addition, all material reaching the oversize pile had fallen from a considerable height, and may therefore have suffered damage, similar to that which may occur during dredging. Robust bones and teeth, such as from mammoth, can however sometimes be found intact. A cargo of fine sand from Licence Area 328 delivered to Frindsbury in 2015 could not be processed and therefore could not be archaeologically assessed.

3.3.6 Each time archaeological material was observed, the conveyor would need to be stopped causing mechanical stress to the working plant meaning there was pressure only to drop the can when the archaeologist was sure the material was archaeologically significant.

Dagenham wharf

- 3.3.7 In 2019 when Frindsbury became no longer available for Operational Sampling due to ongoing works at the plant and dredging of the channel, visits were moved to Dagenham where work is going well. There is a designated driver on hand to spread gravel, adequate space to work, and less requirement to work faster to keep from slowing the process down. During processing, material is transferred from the stockpile into a ground hopper, and when the hopper reaches maximum capacity, the material would ordinarily go through the crusher. Prior to Operational Sampling visits, the hatch on the hopper remains open, to allow oversize to fall to the ground below and to prevent it from going through the crusher. The piled discharged material is then transported via mechanical shovel to a cleared area where it is spread before being visually examined by archaeologists. The thickness of the spread varies between a single stone's depth to upwards of 100 mm and is further thinned as needed. No issues or limitations have been reported on so far. This is a more thorough and efficient approach than was possible at Frindsbury.

Northfleet wharf

- 3.3.8 At Northfleet, aggregate is transferred from stockpiles into a ground hopper, from which it is conveyed up to a series of grading tables. The oversize fraction is then separated out into a holding tank or hopper, from which it can be periodically discharged by the archaeologists onto the ground. The discharged material is spread using mechanical hoes, then thinned by archaeologists using shovels and then visually inspected. Issues can arise when cargoes have higher clay contents than usual, making the inspected fraction dirty and any archaeological artefacts difficult to identify.
- 3.3.9 As part of this interpretative review, the methodologies at the different wharves were reviewed, and the following suggestions were made to further improve Operational Sampling at Northfleet.
- 3.3.10 Although archaeologists have control over the discharge of oversize cargo, there can be pressure to work at an increased pace, because when the hopper gets full, the aggregate is crushed. Due to the need for increased speed, it is possible that some portions of the cargo are not archaeologically assessed as thoroughly as they could be.
- 3.3.11 The introduction of Dagenham as a new wharf for Operational Sampling has suggested improvements for other wharves as well. For example, it has been determined that having a designated driver to assist with work can increase the speed at which the archaeologists can get through the cargo. Additionally, if the mechanical shovel can spread the oversize fraction thinner, the archaeologists can inspect the cargo at a much faster pace before asking for it to be cleared away. At Dagenham, where the cargo can be processed prior to the archaeologists' arrival, rather than when they are on site, it has proved possible to minimise the time archaeologists spend waiting for processing, and therefore the work can be completed quicker, minimising time on site.
- 3.3.12 It has also been identified recently that there are occasionally issues in the cross-contamination of cargoes. On a few occasions, cargoes from other licences/regions such as Area 458 (West Bassurelle (East English Channel region)) have been mixed with the Palaeo-Yare cargo due to the wharf having difficulty isolating the specified cargoes. The inclusion of large flint clasts from this cargo affects the application of the site-specific methodologies and testing of hypotheses as the material cannot be confidently assigned to sediment sequence of the Anglian region. Therefore, there is potential to invalidate any application of the area specific hypotheses under these operational circumstances.



3.4 Awareness

- 3.4.1 Operational Sampling is not undertaken in isolation, but instead is implemented along side other mitigation measures, such as the *Protocol for Reporting Archaeological Discoveries*, which enables wharf and vessel staff to report any discoveries they make.
- 3.4.2 In support of the Protocol, Awareness Visits are undertaken with staff, in order to ensure that wharf and vessel staff are aware of their responsibilities for reporting and understand the types of materials that should be reported. Between 2015 and 2019, all wharves handling cargoes from the Palaeo-Yare catchment area were visited, with Northfleet in 2017, Frindsbury in 2018 and Dagenham in 2016 and 2018. Additionally, the Operational Sampling visits function as a unique opportunity to get wharf staff more involved with the process of discovery and providing detailed feedback about the types of materials discovered.
- 3.4.3 In addition to this, Project Manager Euan McNeill has attended conferences, such as the one in 2019 held by HAML and attended by senior management, wharf managers and staff, and the marine resources team where archaeological rationale and results were presented providing context to the monitoring requirements to all parties and highlighting the success in recovering artefacts together with their importance.

3.5 Development of Gazetteer

- 3.5.1 The results of all of the Operational Sampling events from 2012 to December 2019 have been compiled in a single gazetteer (**Appendix 1**). The gazetteer retains the numbering from the previous interpretative report (Wessex Archaeology 2015a) (**2208-2264**) and finds from 2015 to 2019 (**2265-2462**) have been numbered chronologically based on the date of the Operational Sampling visit, rather than grouped by Licence Area. Locations of the finds are illustrated on Figure 2, with find IDs included on the specific Data Sheets (Sheets 1-8).

4 OPERATIONAL SAMPLING RESULTS

4.1 Overview

- 4.1.1 Between January 2015 and December 2019 23 Operational Sampling events were carried out. This table also includes the five events that were omitted from the previous interpretative report (Wessex Archaeology 2015a), for a total of 28 Operational Sampling events that have been reviewed. Overall, 52 lithics and 186 faunal remains have been recovered (**2254-2257, 2261-2462**). The archaeological discoveries made during the Operational Sampling events are compiled in the gazetteer in **Appendix 1**.



Table 6 Summary of Operational Sampling events and finds by licence area

Licence Area	Sub-area	Date	Operator	Wharf	Palaeolithic Lithics	Other Lithics	Faunal remains
212	South	February 2015	HAML	Frindsbury	-	-	-
240	G6-G8	June 2014	HAML	Frindsbury	-	-	-
240	G8-G9	April 2015	HAML	Frindsbury	-	-	1
240	G7-G9	May 2015	HAML	Frindsbury	-	-	-
240	G8-G9	June 2015	HAML	Frindsbury	-	-	-
240	G9	October 2015	HAML	Frindsbury	-	-	-
240	F6-F7	July 2017	HAML	Frindsbury	-	-	1
240	F6-F7	May 2019	HAML	Frindsbury	-	-	-
240	F6	July 2019	HAML	Frindsbury	1	-	-
240	F6-F7	August 2019	HAML	Frindsbury	1	-	-
240	F10	October 2019	HAML	Frindsbury	2	3	-
240	F10	November 2019	HAML	Dagenham	30	-	111 ¹
242/ 361	South-west	June 2018	HAML	Frindsbury	-	-	-
328	South-east	January 2015	HAML	Frindsbury	-	-	-
401/2	36-37	July/August 2014	HAML	Frindsbury	-	-	-
401/2	36-37	November 2014	HAML	Frindsbury	-	-	-
401/2	36	March 2015	HAML	Frindsbury	-	-	-
401/2	37	November 2015	HAML	Frindsbury	-	-	-
401/2	Eastern side	May 2019	HAML	Frindsbury	-	-	2
511	Dingo & Gazelle	November 2014	CEMEX	Northfleet	-	-	4
511	Gazelle & Jackel	October 2015	CEMEX	Northfleet	-	-	7
511	Hare & Kuala	October 2017	CEMEX	Northfleet	-	1	15
511	Impala & Lynx	June 2018	CEMEX	Northfleet	2	-	23
512	Ilmenite	May 2015	CEMEX	Northfleet	1	-	-
512	Ilmenite	October 2016	CEMEX	Northfleet	-	-	4
512	Kyanite, Ilmenite, Jasper	September 2018	CEMEX	Northfleet	-	-	1
512	Kyanite, Ilmenite, Jasper	November 2019	CEMEX	Northfleet	2	8	-
513/1	Ampere, Beaufort, Celcius	October 2014	CEMEX	Northfleet	-	1	4
513/1	Ampere, Darwin, Beaufort, Celsius, Einstein	July 2017	CEMEX	Northfleet	-	-	13

¹ The high return is discussed in detail in section 4.4 below, but basically is due to the discovery of a significant find, reported through the Protocol which then initiated Operational Sampling visits on cargoes from an area of high potential.

4.1.2 The results of the Operational Sampling events in relation to each licence area are presented in more detail below. Updated datasheets are presented in Sheets 1-8, along with photographs of the finds (Plates 1-78).

4.2 Licence Area 212

Operational Sampling results

4.2.1 One Operational Sampling event was undertaken for aggregate dredged from Licence Area 212 (Wessex Archaeology 2015b) (Sheet 1). It took place in February 2015 at Frindsbury Wharf. The vessel trackplots indicate that dredging was undertaken in the southern part of the licence area, which corresponds with the seabed that was previously archaeologically assessed (Wessex Archaeology 2015a).

4.2.2 Approximately two-thirds of the cargo of c. 4000 tonnes was processed. The vast majority of this material (particularly in the 40-100 mm fraction) was believed to be derived from Unit 2. No artefacts or faunal remains were seen. The trackplots indicate that Unit 2 was targeted exclusively, which is likely why no artefacts were recovered.

4.2.3 Previous discoveries from Licence Area 212 have included two flakes (**2249** and **2250**), both of which were considered to result from Levallois reduction, thus likely to date to the Early Middle Palaeolithic (before 180,000 BP), or in the Late Middle Palaeolithic (before 35,000 BP), although the former was favoured (Wessex Archaeology 2015a). A single mammoth tooth has also been recovered (**2251**) (Wessex Archaeology 2015a). The abraded condition of the flakes suggested that they likely derived from a remnant gravelly sand lag deposit, of reworked Unit 3b deposits.

Archaeological assessment of geotechnical survey data

4.2.4 The assessment of vibrocores (Wessex Archaeology 2020a) indicated that Unit 1 was not recorded, likely due to it being present at depths greater than the maximum penetration of the vibrocores (6 m). Unit 2 was recorded in all 20 vibrocores and proven to a depth of 5.68 m below sea floor). Unit 2 comprised slightly silty sand with occasional shell fragments and laminations of clay, and rare inclusions of organic fragments. In one vibrocore (VC-212-02 (2016), a bed of dense peat was recovered. Although the original Palaeo-Yare catchment assessment (Wessex Archaeology 2013a, b) recovered Unit 3b in a single vibrocore, suggesting the possibility for localised, possibly reworked occurrences of 3b, there was no evidence for Unit 3b in any of the vibrocores assessed in 2020, suggesting there is limited evidence for the presence of Unit 3b in Area 212. No changes were made to the deposit model.

4.3 Licence Area 228

4.3.1 No Operational Sampling events were undertaken in Licence Area 228 between 2015 and 2019, however three Operational Sampling events were undertaken in April, October and December 2014 (Sheet 2). Two flakes were recovered (**2258** and **2259**) along with a single piece of mineralised antler, probably from a red deer (**2260**). Licence Area 228 had not been expected to yield any artefacts based on its history of intensive dredging, however the discovery of artefacts suggested that areas of Unit 3b sediment remained. Although they were considered to have some potential for further archaeological discoveries, further Operational Sampling was not recommended (Wessex Archaeology 2015a). A single fossilised tooth (**DEME_0851**) has been reported through the *Protocol for Reporting Archaeological Discoveries*.

4.3.2 However, Licence Area 228 could be the original location for the artefacts that were discovered at Walcott following the Bacton Beach Nourishment project, which is discussed in Section 5 below.

4.4 Licence Area 240

Operational Sampling results

4.4.1 An Operational Sampling event in June 2014 was omitted from the previous summary report (Wessex Archaeology 2015a). Approximately 1000 tonnes of aggregate was processed from a cargo of 4500 tonnes, because observation work was halted due to a breakdown of wharf machinery. The aggregate was dredged from lanes G6-G8 in the southern part of the licence area, and no archaeological material was encountered (Wessex Archaeology 2014a).

4.4.2 Between 2015 and 2019, 10 Operational Sampling events were undertaken for aggregate dredged from Licence Area 240 (Wessex Archaeology 2015c-f, 2017b, 2019a-e) (Sheet 2). The high number of events is due to the high archaeological potential of this area, as evidenced from previous discoveries. Events took place in April, May, June, and October 2015; July 2017; and May, July, August, October and November 2019. In May 2019, the work was undertaken in conjunction with aggregate from Licence Area 401/2, however the aggregate was kept separate for archaeological assessment.

4.4.3 In April 2015, approximately 3000 tonnes of aggregate were processed from a cargo of 4000 tonnes. The aggregate had been dredged from lanes G8-G9 in the south of the licence area, in an area of Unit 3b and Unit 5 sediments. No lithic material was seen, but a single bone of an unidentifiable large mammal was recovered (**2265**), thought to originate from the Unit 3b sediments.

4.4.4 The three Operational Sampling events in May, June and October 2015 yielded no archaeological discoveries. All of the dredging was undertaken in lanes G7-9, in the south of the area, covering mostly Unit 3b sediments, but also some localised Unit 5 deposits. In May 2015, approximately 4000 tonnes of aggregate were processed from a cargo of 4000 tonnes from lanes G7-9. In June 2015, approximately 4000 tonnes of aggregate were processed from a cargo of 4000 tonnes from lanes G8-9. In October 2015, approximately 3500 tonnes of aggregate were processed from a cargo of 4000 tonnes, dredged from lane G9.

4.4.5 In July 2017, work was planned to be carried out over two days, but due to an electrical failure in the material processing plant, the planned schedule was reduced to one day. This meant that only 25% of the 4065 tonne cargo could be examined. The cargo was dredged from Group 4, roughly in the centre of the licence area, dominated by Unit 3b deposits, with localised Unit 5 deposits. The cargo comprised shelly sand with a small amount of gravel, possibly derived from a reworked sandbank that is commonly noted in Unit 3b. It is thought that where Unit 3b sediment is missing, it has been removed, principally due to dredging activity, and could account for the presence of Unit 5 in the central dredging area. One piece of fossilised animal bone (**2278**) (Plate 2) and a piece of wet wood (**2279**) (Plate 3) were observed. Due to the size and mineralised nature of the fragment of bone, it was not possible to identify the species, although the mineralisation could suggest a Lower Palaeolithic date. The wood appeared to be relatively modern.

4.4.6 In May 2019, 100% of an approximate 2500 tonne cargo was archaeologically assessed. The cargo derived from the Eastern dredge lanes, and trackplots covered Unit 2, Unit 3b,

and Unit 5 sediments. The cargo had a high stone content. No archaeological material was recovered during this Operational Sampling event.

- 4.4.7 In July 2019, approximately 80% of a cargo of 3000 tonnes was archaeologically assessed. The cargo was dredged from Group 4, in the centre of the licence area, predominantly made up of Unit 3b, with Unit 2 in the northern end of the dredge lane and Unit 5 at the southern end. The stone fraction of the load appeared to be less than 40% of the total load. A significant amount of the cargo appeared to be mostly sand with small to medium stones and with occasional clay, wood and leather fragments. This points to the cargo being mostly from 3b, however the clumps of clay suggest there was some Unit 5. One Palaeolithic handaxe (**2303**) (Plate 4) was recovered. Specialist examination suggested that this handaxe has typo-technological characteristics that could potentially be indicative of a Late Middle Palaeolithic date. The handaxe is in generally fresh condition, suggesting it may have been found *in situ*, although it is lightly edge damaged. One face is moderately patinated and lightly stained, the other is lightly patinated and unstained, suggesting it could have been sub-aerially exposed on a surface, or sealed between two deposits that differed chemically.
- 4.4.8 In August 2019, approximately 70% of a 3000 tonne cargo was archaeologically assessed. The cargo was from Group 4, as per the previous Operational Sampling event. The cargo had a very low stone content, of approximately 10%, and appeared to be mostly sand with very occasional small to medium stones, with occasional plastic, clay, wood, bone and leather fragments. One Palaeolithic handaxe (**2304**) (Plate 5) was recovered. The handaxe is moderately abraded, indicating some degree of fluvial or marine transport. It is lightly patinated and moderately stained, with two phases of damage apparent. Scars from one phase are moderately patinated, and indicative of ancient light edge damage. A second more extensive phase of damage, including the break which has detached the butt from the remainder of the handaxe, exhibits fresh, unpatinated and unstained surfaces and edges, indicating that this break and edge damage is recent. The handaxe could date to the Lower or Middle Palaeolithic.
- 4.4.9 In October 2019, approximately 80% of a cargo of 3000 tonnes was archaeologically assessed. Dredging had been undertaken in Group 4, as per the previous two events, in the lanes to the west of the AEZ. The cargo had a very low stone content, comprising mostly sand, with very occasional small to medium stones and with occasional plastic, clay, wood, bone and leather fragments. Two Palaeolithic handaxes and three other flint artefacts were recovered. The following provides a summary, however additional details can be found in the Operational Sampling report (Wessex Archaeology 2019d).
- 4.4.10 A well-made cordiform (heart-shaped) handaxe (**2305**) (Plate 6) is in mint/sharp condition, which indicates that it was probably dredged from a primary location, or one that involved minimal movement from its point of discard. It may well have been buried in fine grained silt or clay. Its surface colour also reflects an artefact that was probably sealed in fine grained sediments, the surface retaining the light grey colour of the raw material, with only the slightest traces of a surface stain. The handaxe is plano-convex in profile, a characteristic which has been noted on implements from the Area 240 collection. No trace of the original nodule survives which demonstrates the high level of craftsmanship involved in its manufacture.
- 4.4.11 The second handaxe (**2306**) (Plate 7) is, like many others from Area 240, of plano-convex form, and although unfinished, may well have been conceived with this in mind. The preliminary roughing-out has been completed and the manufacturing process has progressed to thinning and shaping, during which time flaking was terminated. It is possible



that work was undertaken using a soft hammer of antler, or more likely, stone. The implement is of especial interest as it features the process of manufacture and discard taking place, elements that are often lost on finished items. They convey much more about the creation of the handaxe, the processes adopted to accomplish this and the relationships with the knapper.

- 4.4.12 The three other flints comprise two broken flakes (**2307, 2308**) and a fragment of flint (**2309**) (Pates 8-10).
- 4.4.13 All three Operational Sampling events for aggregate from Group 4 have produced handaxes. The material from the latest round of Operational Sampling is of considerable interest and confirms not only the density of material in Area 240, but also its variability. The artefacts suggest an insight into the manufacture, use and discard of handaxes in the locality.
- 4.4.14 In early November 2019, a large mammoth tooth (**Hanson_0935/2321**) (Plate 11) was discovered and reported by staff on board *Arco Avon* from lane F10. This cargo (cargo 1), along with three others from the same lane were delivered to Dagenham where wharf staff discovered a handaxe and two flint flakes (**Hanson_0936/2322-2324**) (Plates 12-14). Subsequently, two days of Operational Sampling followed where several fragments of bone, teeth and tusk (**Hanson_0937, 2325-2350**) (Plates 37-41) and a collection of flints including four handaxes (**Hanson_0938/2351**) (Plate 15) were discovered. Of particular interest was a woolly rhinoceros scapula (**Hanson_0937_001/2325**) (Plates 37-38) that had markings initially thought to be cut or butchery marks. Staff at the wharf recognised that these finds could be particularly significant, and they were immediately reported through the Protocol.
- 4.4.15 Because of the potential significance of the finds, an Operational Sampling event was mobilised quickly, with a team of two archaeologists from Wessex Archaeology, an archaeologist from Historic England, two members of HAML's marine team and one staff member from Dagenham Wharf. The reporting of finds through the Protocol and the Operational Sampling visit were very successful, with 30 flint artefacts and 111 animal bones recovered (**2321** (Plate 11)-**2462**) (Wessex Archaeology 2019e). As the initial finds that motivated the Operational Sampling were reported through the Protocol, the subsequent finds were as well, with **Hanson_0938** covering flints and **Hanson_0939** covering faunal remains.
- 4.4.16 During the Operational Sampling event, the three cargoes from Licence Area 240 were assessed. The three cargoes (cargo 2-4) were delivered by *Arco Beck*. Cargo 2 delivered on 4 November comprised 4537 tonnes on arrival, of which 4364 tonnes was discharged; cargo 3 delivered on 6 November comprised 4537 tonnes on arrival, of which 4364 tonnes were discharged, and cargo 4 delivered on 8 November by comprised 4561 tonnes on arrival, of which 4223 tonnes were discharged. The three cargoes had already been processed by the time archaeologists arrived and the oversize (over 20 mm) had been left for inspection. It is estimated that there were 400 tonnes of oversized material, all of which was processed over the two days the team was on site. The cargoes originated from lane F10 which lies in Group 4 representing the central lanes comprising predominantly Unit 5, with Unit 3b running through the lane and Unit 2 to the northern end.
- 4.4.17 The 30 flints (**2322-2324, 2322-2234**) are discussed in detail in the Operational Sampling report (Wessex Archaeology 2019e), the following provides a brief summary. The flints comprised five handaxes, two Levallois flakes, two possible Levallois flakes, 12 flint flakes, an undiagnostic flake, six possible flakes, a broken flake, and a possible core. The five handaxes date to the Palaeolithic and comprise: a cordiform handaxe that has undergone

considerable damage (**2232**) (Plate 12), a sub-cordate handaxe made from light grey mottled flint, which represents a fine example of the flint knapper's art (**2351**) (Plate 15); a small, unpatinated and unstained cordiform/discoidal handaxe notable by being in a rolled condition, with flake aretes dulled by fine-grained, abrasive fluvial sediment (sand) (**2352**) (Plate 16); a small cordate handaxe in relatively sharp condition that carries extensive traces of impact in the form of incipient points of percussion (**2353**) (Plate 17); and a cordiform handaxe made on a flake, in very sharp condition and unstained and unpatinated apart from a small area around the butt (**2354**) (Plate 18). The two Levallois flakes (**2355**, **2356**) (Plates 19-20) are typical of the style, and flakes of this sort need little modification to serve as ideal knives. The flint flakes were generally in good condition, only slightly dulled by rolling, however they could not necessarily be linked to any specific form of technology or manufacturing process. Overall, the group of material demonstrates the continuing density of Palaeolithic material that remains in Area 240. The collection undoubtedly represents only a small portion of the total that is likely to be present. It is especially valuable in continuing to produce both handaxes and developed Levallois material from the same collection area, and as the condition of the artefacts is variable, they may not all be the same age, potentially suggesting reuse of the area over time.

- 4.4.18 The 26 animal bones reported through the Protocol (**Hanson_0937/2235-2350**) were in poor condition and heavily mineralised. Most of the animal bone fragments were identified as mammoth (*Mammuthus primigenius*). The skeletal elements include fragments of rib and long bones, including three pieces of scapula from the proximal end and caudal border. There are also several fragments of tooth enamel, mostly from the tusk but also from a few molars. Other identified bones included the distal end of an aurochs (*Bos primigenius*) metacarpal, a horse (*Equus ferus*) metatarsal and a small piece of antler from either red deer (*Cervus elaphus*) or reindeer (*Rangifer tarandus*). There are also a few small fragments of skull and other long bones with no distinguishing features that could be either from mammoth or aurochs and a poorly preserved cattle radius of more recent date.
- 4.4.19 In contrast, most of the 85 animal bones recovered during Operational Sampling (**Hanson_0939/2378-2462**) are in good condition and have intact cortical surfaces with well-defined details. However, some were in a poor state showing signs of erosion, and the teeth are fragmented as a result of deterioration of the underlying dentine and cementum, leaving only the enamel surviving. Again most (65%) were identified as remains from mammoth (*Mammuthus primigenius*) including a near complete radius, and thoracic and axis vertebrae. The fragmented bones include pieces of atlas vertebra, scapula, tibia, pelvis and sacrum. There are also seven complete or semi-complete molars and tusks. Clear differences in the preservation condition of the post-cranial bones suggests that the remains originate from different deposits, potentially of separate date. Other identified bones include an aurochs (*Bos primigenius*) metacarpal and astragalus, and a horse (*Equus ferus*) navicular.
- 4.4.20 The bone with potential butchery marks (**Hanson_0937_001/2325**) (Plates 37-38) was taken to the Natural History Museum for further assessment by Dr Simon Parfitt, a Pleistocene faunal specialist, and Dr Silvia Bello, a specialist in identifying human modifications to bone surfaces. The bone was confirmed to be a rhinoceros scapula, thought to belong to a woolly rhinoceros. The markings were determined to be not butchery/modified by humans, but rather had been carnivore damage, possibly hyenas. Hyena remains or evidence of their presence have not previously discovered in Area 240 and it is a significant discovery.
- 4.4.21 The faunal remains and tools were discovered from the same general location (lane F10) and it may be that the mammoth remains derive from the same mammoth, which suggests

that this may have been a site where butchering was taking place, despite no butchery marks being visible on any of the recovered bones. The large mammoth tooth (**Hanson_0935/2321**) (Plate 11) was assessed by Professor Adrian Lister at the Natural History Museum who commented that the roots are so complete that the skull, or parts of it, are likely still on the seabed.

- 4.4.22 The current evidence from Area 240 and Lane F10 adjacent to the existing AEZ may indicate a location where a series of events occurred over time, with worked flint, tool production and debitage and megafauna remains also present. The variable conditions of both the artefacts and the faunal remains suggest that they have multiple taphonomic histories, that may well be multiple ages and potentially from different specific contexts. The fresh condition material appears to be minimally disturbed, but it is not yet possible to attribute it to a single context, horizontal or spatial data or refitting, so although it is not yet possible to say that there is an *in situ* 'site' (as defined as a single time-constrained event or series of events), the location is significant, and further work may enable these to be assessed.
- 4.4.23 Following these discoveries, discussions with Historic England resulted in a temporary AEZ placed around F10 where the artefacts originated and up to F9 as a precautionary measure. F9 has not previously been dredged, and therefore it is unknown whether or not any material of Palaeolithic origin is present. Going forward it was recommended that the AEZ should be reviewed periodically through a series of Operational Sampling visits at Dagenham Wharf, subject to discussions with Historic England. For example, the AEZ could possibly be worked under supervision to help identify other finds or to broaden the project.
- 4.4.24 Operational Sampling events in 2020 continue to produce artefacts and faunal remains, and discoveries made on vessels and at the wharf continue to be reported through the Protocol. Of particular interest, one bone (**Hanson_0958**) may exhibit evidence of butchery marks, which would make it an extremely important find, although it has yet to be assessed by Dr. Silvia Bello from the Natural History Museum in person, due to Covid-19 restrictions.

Archaeological assessment of geotechnical survey data

- 4.4.25 The geoarchaeological assessment in 2020 (Wessex Archaeology 2020a) did not record any Unit 1 sediments, but Unit 2 was identified in 39 of the 48 vibrocores, comprising well-sorted, silty, gravelly, fine sands with rare shell and wood fragments and occasional thin beds or laminae of clay, organic silt and clay, and occasional organic material. It is expected to be present across the entirety of Area 240 and was only absent from the remaining vibrocores due to a greater thickness of overlying deposits at these locations. Unit 3b, which overlies Unit 2, was recorded in 25 of the 48 vibrocores, and comprised a poorly sorted, silty, gravelly, sand or silty, sandy gravel. It often has an orange to dark brown colour which may indicate oxidisation suggesting the deposit was once subaerially exposed.
- 4.4.26 Unit 4 was not recorded, but none of the vibrocores were derived from the area previously mapped as Unit 4 which is confined to Channel A in the north of Area 240. Unit 5 was recorded in five vibrocores and comprises silty gravelly sand with laminations of organic silt or silty clay. Unit 6 was not recovered, and Unit 7 was only recovered from two vibrocores, comprising clayey gravelly sand with laminations of silty clay, and one of the vibrocores exhibited wood fragments.
- 4.4.27 Based on these assessments, the deposit model was reviewed. There were no changes to the extent of Unit 2, although in areas of dredging, Unit 2 is expected to be encountered at shallower depths due to the removal of overlying sediments. Unit 3b was previously mapped as an extensive deposit across Area 240, with the exception of localised patches where it

had been removed by historic dredging activity. Only one update has been made, removing an area of Unit 3b in the vicinity of vibrocores VC28 and VC30 where no Unit 3b was present (Figure 2). In conclusion, the recent work generally confirmed the previously understood extent of the Unit 3b deposits, with the exception of the minor update.

4.5 Licence Area 242/361

Operational Sampling results

- 4.5.1 Minimal dredging activity has been undertaken in Licence Area 242/361 between 2015 and 2019, and therefore there was little need for Operational Sampling. One Operational Sampling event was undertaken for aggregate material dredged from Licence Area 242/361B in June 2018 (Wessex Archaeology 2018a) (Sheet 4). The trackplot indicates that dredging took place in the south-west of the licence area, in a bank feature of unknown age over Unit 3b and Unit 2b sediments.
- 4.5.2 The cargo load comprised 3823 tonnes, of which approximately 75% was processed. The stone fraction of the load appeared to be less than 30% of the total, and a significant amount of this appeared to be shell and small stone with the occasional faunal remain and wood fragments. This suggested the cargo comprised Unit 8 sediments, *ie*: marine deposits associated with the last transgression in the Holocene.
- 4.5.3 No archaeologically relevant material was recovered. Two pieces of recovered flint were determined to have thermal fractures rather than mechanical ones, and therefore were confirmed as natural. A fragment from the outer layers of an animal horn was observed but not recovered. Previous discoveries from Licence Area 242/361 include a single mammoth tooth along with fragments of a large mammal bone (Wessex Archaeology 2015).
- 4.5.4 This licence area covers part of the previous Licence Area 328, which is discussed below.

Archaeological assessment of geotechnical survey data

- 4.5.5 The archaeological assessment of geotechnical data (Wessex Archaeology 2020a) did not record any Unit 1, which was likely present at depths greater than the maximum penetration of the vibrocores (6 m), but Unit 2 was present in 7 of the 15 vibrocores, comprising silty gravelly sand with rare shell recorded locally. Unit 3b was present in nine of the vibrocores, comprising silty, gravelly sand and sandy gravel, with localised inclusions of organic material. Unit 8 was recorded in 10 of the vibrocores, comprising silty gravelly sand with shell fragments, for the five vibrocores where Unit 8 was not present, Unit 3b is exposed at the seabed. Based on the assessment, the deposit model has been updated, and the extent of Unit 3b deposits have been extended slightly to include the locations of VC-28 and VC-30 (Figure 2).

4.6 Licence Area 254

- 4.6.1 No Operational Sampling events have been undertaken in Licence Area 254. Since 2016, the licence area has been reduced in size (Figure 1), and now only covers the north-western corner of the previous licence area extents. The sediments being dredged comprise Unit 2 and sandbanks, with the majority of dredging targeting the sandbanks, which are of low archaeological potential.

4.7 Licence Area 328

Operational Sampling results

- 4.7.1 One Operational Sampling visit was undertaken for aggregate dredged from Licence Area 328, in January 2015 (Wessex Archaeology 2015g). The vessel trackplot indicates that



dredging was undertaken in the eastern part of the licence area, which is now within Licence Area 242/361 (discussed above) (Sheet 4). The dredging trackplots cover Unit 2 and Unit 3b sediments.

- 4.7.2 The cargo comprised fine-grained sand and appeared to be effectively stone free. As such, it could not be processed through the plant at Frindsbury, despite repeated attempts. Consequently, the trial Operational Sampling visit was abandoned without the cargo being monitored.
- 4.7.3 No archaeological material was retrieved, and given the description of the aggregate, it is likely that dredging only took place in Unit 2 sediments. The previous Operational Sampling visit, in September 2013, also revealed no archaeological material, and it was concluded that dredging then had been limited to Unit 2 and Unit 8 sediments (Wessex Archaeology 2015a).

Archaeological assessment of geotechnical survey data

- 4.7.4 For the archaeological assessment of geotechnical survey data – see the discussion in the Licence Area 242/361 section above.

4.8 Licence Area 401/2

Operational Sampling results

- 4.8.1 Only limited dredging activity has been undertaken in Licence Area 401/2 between 2015 and 2019, and therefore limited Operational Sampling was required. Two Operational Sampling visits were undertaken in July/August and November 2014. For both of these visits, the dredging was undertaken in the north-eastern part of the licence area, and no archaeological evidence was encountered (Wessex Archaeology 2014b,c) (Sheet 5). The targeted area was thought to be dominated by Unit 3b deposits, but for both visits the cargo comprised shelly sand with very little gravel, possibly a thickness of recent marine sediment (Unit 8) or derived from a reworked sandbank.
- 4.8.2 Between 2015 and 2019, three Operational Sampling events were undertaken for aggregate dredged from Licence Area 401/2 (Wessex Archaeology 2015h, i, 2019a) (Sheet 4). The first in March 2015, the second in November 2015, and the third was undertaken in May 2019 in conjunction with aggregate from Licence Area 240, however the aggregate was kept separate for assessment.
- 4.8.3 In March 2015, the entire 4000 tonne cargo dredged from lane 36 was processed. The Operational Sampling trial targeted an area in the north-eastern corner of the licence area, thought to be dominated by Unit 3b deposits. However, the cargo proved to be shelly sand with a small amount of gravel, possibly a thickness of recent marine sediment (Unit 8) or derived from a reworked sand bank. Similar bank features are known to exist elsewhere in the northern part of the licence area, masking the surviving Unit 3b deposits, and it could be that their distribution is wider than was previously thought. No archaeological material was seen.
- 4.8.4 In November 2015, the trial again targeted an area in the north-eastern corner of the Licence Area (lane 37), within the Palaeo-Yare floodplain, thought to be dominated by Unit 3b deposits. However, the dredged aggregate again proved to be shelly sand with a small amount of gravel, possibly a thickness of recent marine sediment (Unit 8) or derived from a reworked bank, and again, no archaeological material was seen during the archaeological assessment of three-fifths of the 4500 tonne cargo.

- 4.8.5 In May 2019, an estimated 30% of a 3000 tonne cargo was archaeologically assessed. The cargo derived from the south-eastern part of the licence area, in Unit 4 sediments. The cargo was mostly sand, with a very low stone content (probably less than 30%). A significant amount of the cargo appeared to be shell and small stone, with occasional faunal remains and wood fragments. Two megafauna bone fragments (**2301-2302**) (Plate 47) were recovered from the large reject bin. The exact species is unknown, but it appears to be fragments from the proximal end of a tibia.

Archaeological assessment of geotechnical survey data

- 4.8.6 As with the previous licence areas, the geoarchaeological assessment of the vibrocores did not indicate any Unit 1, as it was likely below their maximum penetration (6 m) (Wessex Archaeology 2020a). Of the 45 vibrocores assessed, 35 included Unit 2, a slightly silty, occasionally gravelly sand with rare shell recorded locally. Where it was absent was due to the presence of overlying Unit 8, 4 and 3b. Unit 3b was recovered from 28 vibrocores, and is characterised by slightly silty gravelly sand and occasionally sandy gravel. At some places, Unit 3b is exposed at the seabed, and the deposit varies in thickness between 0.10 m and 3.15 m, although it could be thicker in places where it is below the maximum penetration depth of the vibrocores. Unit 4 was recovered in four vibrocores, comprising very silty sand, sandy clay or silt and clay with a characteristic dark colour. Units 5, 6 and 7 were not recorded, but Unit 8 was, and it comprises gravelly sand and sandy gravel with shell fragments and occasional whole shells. It is present across most of the licence area, except where Unit 3b is exposed. Based on the assessment, changes have been made to the extents of Unit 3b and Unit 4. In the northwest, the extent of Unit 3b was reduced, but it was extended in the southeast corner. Unit 4 was reduced in the southeast (Figure 2).

4.9 Licence Area 511

Operational Sampling results

- 4.9.1 Licence Area 511 covers previous Licence Areas 251 (in the southern part of the present licence area) and 319 (in the northern part). Although aggregate from Licence Area 251 has previously been assessed through Operational Sampling, the dredging was undertaken in the part of Licence Area 251 that is now part of Licence Area 512 and is discussed in that section below. In Licence Area 319, previous Operational Sampling events (Wessex Archaeology 2015) revealed three lithics (**2232**, **2233** and **2234**), one dated to the Lower Palaeolithic and two to the Holocene. The Lower Palaeolithic material comprised an iron-stained tertiary flake struck with a hard hammer, which may have derived from biface manufacture or trimming, and specialist assessment suggested that it was almost certainly Lower Palaeolithic, was consistent with the post-Anglian development of the Paleo-Yare floodplain, and was recovered from within the limits of Channel B, indicating the flint had been recovered from Unit 3b sediments below the Channel B cut, that some of the fill within the base of Channel B is reworked older sediments (Unit 3b) or that the flint has been reworked into younger Holocene sediments within the Channel. The Holocene lithics were likely from the Early Holocene Unit 7 deposits associated with the infill of Channel B. Faunal remains have also been discovered, including a mammoth tooth, fragments of unidentified mammal and red deer bones, and a fragment of red deer antler (**2235**, **2236**, **2241** and **2242**).
- 4.9.2 An Operational Sampling event undertaken in November 2014 was omitted from the previous summary report. For operational reasons, dredging was undertaken in the Dingo and Gazelle areas, comprising Unit 2 and Unit 3b sediments. Four pieces of faunal remains were recovered: a portion of mammoth tooth (**2261**) (Plate 48), a fragment of probably mammoth rib (**2262**) (Plate 49), part of the proximal shaft of the radius of a large mammal (**2263**) (Plate 50) and a part of a sheep tibia (**2264**) (Plate 51). Because the cargo came



from two sediment units, it was not possible to determine which the finds were recovered from (Wessex Archaeology 2014d).

- 4.9.3 Between 2015 and 2019, three Operational Sampling events were undertaken for aggregate dredged from Licence Area 511; in October 2015, October 2017 and May 2018 (Wessex Archaeology 2015j, 2017c, 2018b) (Sheet 6).
- 4.9.4 In October 2015, approximately half of the combined cargoes of 10,000 tonnes, dredged from the Gazelle area was examined. Gazelle is situated in the north-western part of the licence area and comprises Unit 3b sediments. Seven pieces of faunal remains were recovered: a portion of a tibia from a large Quaternary mammal (**2267**) (Plate 52); a red deer metatarsal (**2268**) (Plate 53); a fragment of pelvis from a large mammal (**2269**) (Plate 54); two unidentified large mammal bone fragments (**2270**, **2271**) (Plates 55-56); two pieces of red deer antler (**2272**) (Plate 57); and a relatively modern cattle tibia (**2273**) (Plate 58).
- 4.9.5 In October 2017, approximately 3245 tonnes of aggregate were processed from a cargo of 5,828 tonnes, dredged from the Hare and Kuala sub areas, in the northern part of the licence area. Both areas comprise Unit 3b sediments. Fifteen fragments of faunal remains were recovered (**2285**) (Plate 59). Several stone finds were recovered (**2287**) (Plate 60). Of the stones, one was a possible flint blade core that had possibly been used to make small flint blades in the Mesolithic period. Other stones recovered were thought to be cannonballs or shot, or naturally rolled.
- 4.9.6 In May 2018, approximately 4115 tonnes of aggregate were processed from a total cargo of 5322 tonnes. The aggregate was dredged from the Impala and Lynx sub-areas, in the north-north-eastern part of the licence area, covering Unit 3b sediments. Material >20 mm was examined. Four stone fragments were recovered, two of which were identified as possible Lower/Middle Palaeolithic flakes (**2289**) (Plate 61). Faunal remains included 17 fragments of mammoth teeth (**2290**) (Plate 62), two unidentified herbivore teeth (**2291**) (Plate 63), one unidentified horn (**2292**) (Plate 63) and 13 unidentified animal bones (**2293**) (Plates 63-64). The high number of mammoth teeth could be due to local taphonomic factors which have created a slightly higher concentration of faunal remains in this location, and that the upper layers of Unit 3b in the sub-areas of Impala and Lynx have more faunal material within them than the deeper layers encountered in areas that have been dredged more intensively. The wooden fragments (**2294**) were thought to be of natural origin.
- 4.9.7 Although not discovered through Operational Sampling, the significant discovery of hundreds of artefacts at Walcott, following the Bacton Beach Nourishment project, could derive from Licence Area 511 (as discussed in more detail in Section 5).

Archaeological assessment of geotechnical survey data

- 4.9.8 The archaeological assessment of geotechnical data (Wessex Archaeology 2020b) did not record Unit 1, as it was likely below the 6 m maximum penetration of the vibrocore. Unit 2 was recorded in all but three vibrocores, comprising silty sand often with laminations of silt and shell fragments. Unit 3b was recovered in 15 vibrocores and comprised silty gravelly sand and silty sandy gravel. It was often exposed at the seabed and could reach thicknesses of up to 5.2 m. Units 3a, 4, 5, 6 and 7 were not present. Unit 8 was present in 10 vibrocores, comprising silty gravelly sand with occasional shell fragments. Based on the assessment, no changes were made to the deposit model.

4.10 Licence Area 512

Operational Sampling results

- 4.10.1 Four Operational Sampling events were undertaken in Licence Area 512: in May 2015, October 2016, September 2018 and November 2019 (Wessex Archaeology 2015k, 2016d, 2018c, 2019f) (Sheet 7).
- 4.10.2 In May 2015, approximately 2200 tonnes of aggregate were processed from a cargo of 4500 tonnes. The cargo was dredged from the Ilmenite area, in the northern part of the licence area, covering Unit 3b sediments. A single piece of struck flint was recovered (**2266**) (Plate 65), comprising a portion of a large blade of apparent Upper Palaeolithic date. The piece is broken and somewhat worn, suggesting it was not *in situ*.
- 4.10.3 In October 2016, approximately 2800 tonnes were processed from a cargo of 5600 tonnes. The aggregate was dredged from the Ilmenite area, in the northern part of the licence area, covering Unit 3b sediments. Four faunal pieces were recovered: a portion of a distal radius shaft possibly from an aurochs (**2274**) (Plate 66), a heavily mineralised bone too small to be identified (**2275**) (Plate 67); a heavily mineralised possible fragment of ilium of a large mammal (**2276**) (Plate 68), and a heavily mineralised and abraded long bone shaft fragment of a large animal (**2277**) (Plate 69).
- 4.10.4 In September 2018, approximately 4448 tonnes of aggregate were processed from a total cargo of 3429 m³. A total of 184.5 tonnes of oversize material was manually processed by two archaeologists. The aggregate derived predominantly from the Kyanite, Jasper and Ilmenite sub-areas, in the northern part of the licence area, in Unit 3b sediments. One fragment of fossilised animal bone was found (**2298**) (Plate 70), but it was too small to identify which species it came from.
- 4.10.5 In November 2019, approximately 4430 tonnes of aggregate were processed from a total cargo of 10,262 tonnes. The aggregate was dredged predominantly from the Kyanite, Jasper and Ilmenite sub-areas, in the northern part of the licence area, in Unit 3b sediments. The dredging was in a slightly different location than previous, and on this occasion, 10 flints were recovered.
- 4.10.6 One broken flint flake is likely to be of Palaeolithic date (**2318**) (Plate 71). It has developed a mottled green/brown surface stain which is identical to much of the Palaeolithic material from Licence Area 240. The flake itself is undiagnostic and cannot be linked with certainty to the production of handaxe or flake production via cores. The proximal end is broken, making it impossible to comment on hammer form. Flake arrêtes are slightly dulled as might be expected from long periods in a fluvial environment.
- 4.10.7 One flake with negative flake scars on the dorsal surface, suggests that it was of human manufacture (**2317**) (Plate 72). The flake has a light patina and glossy, slightly rolled surface condition. It cannot be linked to a clear manufacturing process.
- 4.10.8 The remaining eight flints (**2311-2316, 2319-2320**) (Plates 73-74) are less readily assigned to a Palaeolithic date or to human manufacture. They were retained as they show some characteristics of conchoidal fracture, which result from impact. However other convincing evidence that fracture resulted from intentional percussion are rare or absence. They are unstained and in fresh condition, suggesting that they have not been exposed to prolonged abrasion since their manufacture.
- 4.10.9 The evidence from the Operational Sampling events in 2015, 2016 and 2018 corroborates the finds from three Operational Sampling events undertaken in 2013 and 2014, when it
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was formerly Licence Area 251 (Wessex Archaeology 2015), when a single lithic scraper was recovered (**2237**), and a fragment of pelvic bone from a cow or deer.

Archaeological assessment of geotechnical survey data

- 4.10.10 The archaeological assessment of geotechnical data (Wessex Archaeology 2020b) again recorded no Unit 1. Unit 2 was recorded in all vibrocores except for one. It is characterised by silty sand with shell fragments or gravel recorded occasionally. At two locations, Unit 2 comprised sandy silt. Unit 2 is not exposed at the seabed but can be present at very shallow depths (0.05 m). Unit 2 is overlain by Unit 3b in the north of Licence Area 512, and it was recorded in five vibrocores, and was exposed at seabed. Unit 3b comprises silty gravelly sand and silty sandy gravel locally, with a thickness that range from 0.01 m to 3.40 m. Units 3a, 4, 5 6 and 7 are not present. Unit 8 was present in six vibrocores and comprised silty gravelly sand with shell fragments. Based on the assessment of vibrocores data, no changes were made to the deposit model.

4.11 Licence Area 513/1

Operational Sampling results

- 4.11.1 In October 2014, one Operational Sampling event was undertaken (Wessex Archaeology 2014e). Dredging was undertaken in Unit 3b sediments in the Ampere, Beaufort and Celcius areas in the western part of the licence area. Part of a vertebra of a very large mammal (probably mammoth or possibly whale) (**2254**), and two other unidentified large mammalian bones were recovered (**2255** and **2256**), all of which were highly mineralised (Plate 75). A single piece of undatable struck flint (**2257**) (Plate 76), most probably a fragment of a bipolar blade core, was also recovered.
- 4.11.2 In July 2017, one Operational Sampling event was undertaken for aggregate dredged from Licence Area 513/1 (Wessex Archaeology 2017d) (Sheet 8). Approximately 3,100 tonnes was processed from a cargo of 5,500 tonnes. The intention had been to assess 3,500 tonnes, however due to technical issues that occurred within the processing plant, the target could not be met. However, the amount processed was considered sufficient for the objectives of the study.
- 4.11.3 The trackplot indicates that dredging was undertaken in the Darwin area, roughly in the centre of the licence area, in Unit 3b sediments, with areas of reworked bank at the northern and southern ends of the trackplot area.
- 4.11.4 Although no lithics were encountered, 13 faunal pieces were recovered. All were heavily mineralised. Twelve of the fragments were too small to be identified (**2280**), but there was also a heavily mineralised fragment of the base of an antler (**2281**) (Plates 77-78). There were also heavily mineralised wood fragments and pieces of coal (**2282**) and non-mineralised wood fragments believed to be recent (**2283**).
- 4.11.5 The results corroborated those of previous Operational Sampling events conducted in 2013, in what was then Licence Area 360, and then in 2014, where mineralised faunal remains were also recovered. The trackplots for both of these locations assessed by Operational Sampling events indicate that dredging was undertaken in close proximity to the Operational Sampling in 2017. In 2013, numerous highly abraded and/or mineralised faunal remains were recovered (**2240**), including antler, part of the distal humerus of an unidentified very large animal, and other unidentified mammalian bones (including a rib and skull fragment) (Wessex Archaeology 2015a). The previous interpretive report (Wessex Archaeology 2015a) suggested that the very highly abraded and/or mineralised condition of the artefacts

discovered in 2013 suggested that Unit 3b was absent from the area dredged, and that the samples are instead from the underlying Unit 2.

Archaeological assessment of geotechnical survey data

- 4.11.6 The archaeological assessment of vibrocores (Wessex Archaeology 2020b) did not recover Unit 1, however Unit 2 was recovered in seven of the eight vibrocores, comprising silty sand with occasional shell fragments and thin beds of silt locally. It can be present at seabed or in the shallow sub-surface below Unit 3b. Unit 3b was present in six vibrocores, with a thickness generally greater than 2.5 m, and comprising silty gravelly sand and silty sandy gravel. At all six locations, Unit 3b was exposed at seabed. Units 3a, 4, 5, 7 and 8 were not present. Based on the assessment, no changes were made to the deposit model.

4.12 Licence Area 513/2

- 4.12.1 No Operational Sampling events have been undertaken for Licence Area 513/2 in the last five years, although three Operational Sampling events were undertaken between 2013 and 2014 (Wessex Archaeology 2015a), for aggregate dredged from the previous Licence Area 251 (in the northern part of the current Licence Area 513/2) (Sheet 9). However, the review of EMS data indicates that only minimal dredging has been undertaken in the area over the last five years.

5 AGGREGATE FROM THE PALAEO-YARE USED FOR THE BACTON BEACH NOURISHMENT PROJECT

5.1 Introduction

- 5.1.1 In July and August 2019, to provide aggregate for the Bacton Beach Nourishment Project, a number of licence areas were dredged, including Licence Areas 212, 228, 254, 494, 511, and 512. Overall, approximately 1.5 million cubic metres of sediment was dredged and deposited on the beach in front of the Bacton Gas Terminal and the villages of Bacton and Walcott, with the aim of protecting these sites from erosion and flooding (Royal HaskoningDHV 2018; <https://www.north-norfolk.gov.uk/sandscaping> accessed 24/03/2020).
- 5.1.2 The work was undertaken separately to the Palaeo-Yare Operational Sampling work, and Operational Sampling was not possible as aggregate was deposited directly on the beach. Instead, a bespoke Protocol was established so vessel and shore staff could report any discoveries, and eight archaeological walkover surveys were undertaken following the deposition of aggregate on the beach (Wessex Archaeology 2019g). The project targeted sand instead of gravel, and avoided Licence Area 240, and therefore, the likely impact on sediments of archaeological potential was expected to be low. At the time, only 12 finds were recovered from the walkover survey or reported through the Protocol: three flints which were later confirmed as natural; a piece of peat possibly from a Pleistocene deposit and the remaining eight finds related to maritime activity, Second World War munitions, and possible aircraft material (*ibid*).
- 5.1.3 However, by March 2020, members of the general public walking on the beach had discovered and reported between 750 and 1000 stone artefacts, representing a significant assemblage of Palaeolithic finds, as well as 50 to 100 fossils.

5.2 Review of data

- 5.2.1 Wessex Archaeology was asked to review the locations of the discoveries on the beach along with the dredging trackplots to determine whether it was possible to determine the provenance of the finds (Wessex Archaeology 2020c).

- 5.2.2 The discoveries on the beach were clustered around the south-eastern end of the project area, near Walcott (from approximately chainage area 4500 to beyond 5900). This meant that any licence areas only used to supply the central or north-western parts of the beach were unlikely to be contenders, and therefore ruled out Licence Areas 212, 512 and 513. Additionally, the finds were made in gravels, and therefore were unlikely to derive from licence areas where dredging had been limited to sand deposits. This ruled out Licence Areas 212, 254 and 494 (where dredging targeted Unit 2, sandbanks and sheet deposit, respectively). This left only Licence Areas 228 and 511 as contenders, because although dredging in Licence Areas 512 and 513 also targeted Unit 3b deposits, the aggregate from these areas was deposited further up the beach.
- 5.2.3 However, it is not possible to confirm which of the two licence areas the artefacts derive from, because the situation is complicated by the way the aggregate was deposited on the beach. The chainage reports indicate that aggregate from Licence Area 228 was deposited between chainage numbers 4558-4706 and 4918-5068, with aggregate from Licence Area 511 deposited on the beach between chainage numbers 4438-4558, 5068-5842 and 5696-5900. These areas correspond with the concentration of finds, but the finds locations are not precise enough to pinpoint a particular chainage area, and it is possible that artefacts were transported along the beach as they were exposed by tidal action.
- 5.2.4 The British Museum has been undertaking an assessment of the artefacts, and as of the end of November 2020, 370 finds had been recorded in detail (pers. comm. Stuart Churchley). The flint finds included waste flakes, Levallois flakes, handaxes, retouched flakes/flake tools, and cores. The handaxes could date to either the Lower or Middle Palaeolithic, but the presence of Levallois technology suggests at least some of the finds date to the Middle Palaeolithic. The artefacts appear to derive from different contexts and sediment types and could include both primary and secondary contexts.

5.3 Conclusion

- 5.3.1 Unfortunately, it was not possible to confirm the provenance of the finds, however it is thought by Wessex Archaeology, based on the artefact techno-typology and the distribution of sedimentary units across the region and the locations used for the extraction, that they are most likely to be derived from the Unit 3b sediments located within the utilised portions of Licence Area 511, Licence Area 228 or both (*ibid*). Dredging in Licence Area 511 took place in the south, in Unit 2 and Unit 3b sediments, which are not generally dredged for commercial aggregate, and therefore have not undergone Operational Sampling. Dredging in Licence Area 228 took place on the eastern side of the licence area, in Unit 3b sediments in a part of the licence that is also not routinely dredged. Either of these locations could be the location for the 'hot spot' of material similar to the one previously discovered in Licence Area 240, supported by the considerable quantity of lithic and faunal remains that have been recovered so far.
- 5.3.2 The fact that neither of the locations are routinely worked is key, indicating that the finds were the product of the specific project circumstances.
- 5.3.3 Interestingly, Licence Areas 228 and 511 are immediately adjacent to Licence Area 240, however the centrepieces of the dredging for the Bacton Beach Nourishment project are approximately 3 km and 6 km, respectively, away from the recent concentration of finds from Licence Area 240.



6 DISCUSSION OF THE RESULTS OF THE GEOARCHAEOLOGICAL ASSESSMENT

6.1 Introduction

6.1.1 The geoarchaeological assessment reviewed data from Hanson's Licence Areas 212, 240, 242/361 and 401/2 and Cemex's Licence Areas 511, 512, 513/1 and 513/2 (Wessex Archaeology 2020a, b). The results of the assessment provide background to the geological units across the Palaeo-Yare.

6.2 Early Pleistocene (2.58 MA – 773 ka)

6.2.1 Unit 1 correlates to the Westkappelle Ground Formation and comprises silty clays and sands that were deposited in a deltaic environment during the Early Pleistocene (Cameron *et al.* 1992). Unit 1 does not outcrop, or subcrop in the shallow subsurface in any of the licence areas assessed and has not been sampled by geotechnical surveys or operational sampling events.

6.2.2 Unit 2 is interpreted as Yarmouth Roads Foundation, also deposited in a deltaic environment during the Early Pleistocene (Cameron *et al.* 1992). Unit 2 comprises fine-grained sands with laminations or beds of silt and clay. Organic mud, peat or fragments of organic matter can be preserved in Yarmouth Roads formation and represent shallowing of the deltaic environment. Yarmouth Roads 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 Early Palaeolithic finds at Happisburgh and Pakefield (Parfitt *et al.* 2005).

6.2.3 Unit 2 is present in all of the licence areas that were assessed, and can be found outcropping at seabed, or subgrouping below overlying deposits.

6.2.4 Unit 2 has been targeted through operational sampling in Area 212, and two flakes were recovered both of which show signs of Levallois technique and were assigned a date of Early Middle Palaeolithic (before 180 kpa) or Late Middle Palaeolithic (before 35 kpa). These finds are younger than the age of Unit 2 and were therefore interpreted to have come from reworked Unit 3b deposits (Fjodr 2016). Unit 3b was not recovered in any of the vibrocores recently assessed for Licence Area 212 (Wessex Archaeology 2020a). A single mammoth tooth was recovered from Unit 2 through Operational Sampling (**2251**), it was broken and the condition suggested the breakage had occurred prior to dredging.

6.2.5 In Area 511, a sample of peat (**2164**) was recorded through the *Protocol for Reporting Finds of Archaeological Interest* within an area of Unit 2 deposits. The sample was not radiocarbon dated, but it is possible it represents an organic bed within Unit 2. However, it is noted that this find was located in Channel B which is an Early Holocene extension of the Palaeo-Yare, although no Holocene deposits (Unit 7) have been mapped in the area. Other finds reported from Unit 2 in Area 511 include faunal remains (**2163, 2261-2264**).

6.3 Middle Pleistocene (773 ka – 126 ka)

6.3.1 Between the deposition of Unit 2 and overlying Unit 3b deposits, there is an unconformity. It represents large-scale palaeogeographic changes that occurred during the Anglian glacial (MIS 12, 478-424 ka) when ice sheets extended as far south as Norfolk, remodelling the landscape and diverting major drainage systems.

6.3.2 The Palaeo-Yare initially formed at the end of the Anglian period, during deglaciation, and has continued to develop through to the present day (Wessex Archaeology 2013a). The now submerged Palaeo-Yare was only active during cold periods (glaciations) when sea

levels were lower than the present day. During these times, the Palaeo-Yare extended eastwards, depositing sands and gravels on the valley floor, creating a palimpsest of river terraces that are now submerged.

- 6.3.3 Deposits directly associated with the development of the Palaeo-Yare include Unit 3a, Unit 3b, Unit 5, Unit 6 and Unit 7. These deposits do not correlate directly to the broader North Sea lithostratigraphic framework (Stoker *et al.* 2011), as they are regional in extent, limited to the Palaeo-Yare catchment.
- 6.3.4 Unit 3a appears to be confined to Channel A in Area 240. Interpretations of Unit 3a are based on geophysical data only as it is present at depths >6 m, beyond the reach of vibrocores. Unit 3a is expected to have formed during MIS 12, MIS 10, or MIS 8, when sea levels were lower and climate was cooler. Given the depth of Unit 3a, no archaeological finds have been recorded and as no dredging activity has occurred within Channel A, these deposits remain buried.
- 6.3.5 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 MIS 9 – MIS 7 according to Optical Stimulated Luminescence (OSL) dating (Wessex Archaeology 2011; Limpenney *et al.* 2011). However, Bayesian modelling of the OSL dates suggest Unit 3b was most likely deposited during MIS 7 – 6 (Marshall 2020). Unit 3b broadly corresponds to the Yare Valley Formation onshore (Athurton *et al.* 1994).
- 6.3.6 The geoarchaeological assessment (Wessex Archaeology 2020a and b) confirmed that Unit 3b is present in Licence Areas 240, 242/361, 401/2, 511, 512, 513/1 and 513/2. The thickness of Unit 3b varies and is difficult to establish due to historic dredging activity. The extent of Unit 3b in each licence area is illustrated on the datasheets (Sheet 1 – 8). Additionally, although not covered for the geoarchaeological assessment, Unit 3b also extends into Licence Areas 228 and 254.
- 6.3.7 Unit 3b is associated with the potential ‘hotspots’ in Licence Area 240 (discussed in **section 4.4** above) and the finds from the Bacton Beach Replenishment project (discussed in **section 5** above). The 2019-2020 discoveries in these areas indicate a wide range of artefacts (including from Area 240 handaxes, Levallois flakes, non-Levallois flakes and a possible core), and indicate a concentration of human activity. In addition, faunal remains from a variety of species (such as mammoths, woolly rhinoceros, aurochs, horse, deer and reindeer) have been encountered. The tools and faunal remains may suggest indicating pinchpoints in the landscape, places of good vantage, flint collecting sites, or even tool manufacturing or camp sites (as discussed in more detail in **section 8** below).
- 6.3.8 In addition, there have been a range of lithic and faunal remains in more isolated contexts from various licence areas (discussed in various places in **section 4**), indicating wider, less intensive presence in the landscape, but presence none-the-less. Overall, the archaeological potential of Unit 3b therefore remains high, for not only isolated finds, but also from the known hotspots and potential for the discovery of further hotspots.

6.4 Late Pleistocene

- 6.4.1 After development of the Palaeo-Yare, most likely during MIS 9 –7 (Saalian), sea levels rose during the Eemian interglacial (MIS 5e) and the lower reaches of the Palaeo-Yare would have flooded, becoming submerged. There is no evidence for Eemian deposits in Licence Areas 212, 240, 242/361, 401/2, 511, 512, 513/1 or 513/2.



- 6.4.2 As sea levels started to fall and climate deteriorated in the Weichselian glacial period (MIS 5d – 2; 110 ka – 11.7 ka), the lower reaches of the Palaeo-Yare would have become exposed and it is during the early parts of the Weichselian that Unit 4 was deposited. Unit 4 correlates to the Brown Bank Formation (Cameron *et al.* 1992) and formed in a shallow, brackish North Sea. Unit 4 comprises characteristically dark grey clays, silts and sands.
- 6.4.3 Unit 4 directly overlies Unit 3b, and is present in Licence Areas 240, 242/361, 401/2, 513/1 and 513/2 (Sheets 2, 3, 4, 7, 8). During the most recent geoarchaeological assessment, the only vibrocore recovered within a region of Unit 4 was in Area 513/2, however no Unit 4 sediments were recovered. Only two finds have ever been reported from Unit 4 sediments, two fragments of unidentified mega-fauna, recovered during operational sampling (**2301-2302**). These are likely reworked. Unit 4 does, however, have broad potential to preserve Palaeolithic archaeology.
- 6.4.4 Unit 5 sediments are interpreted as estuarine sediments deposited or exposed during MIS 3 according to a single OSL date of 36 ± 3 ka (GL 100044) (Wessex Archaeology 2013a). A number of faunal remains and lithics have been recovered from within areas comprising Unit 5, however, Unit 3b also occurs in these areas and it is not possible to determine from which unit the archaeology originates.
- 6.4.5 Unit 6 is coarser-grained than Unit 5 and is interpreted to have been deposited in a cold-climate glaciofluvial setting. While there are no dates from this deposit, it most likely occurred during the coldest parts of the Weichselian (MIS 3–2) when sea levels were lower. Unit 6 was not recorded in any vibrocores assessed. No finds have been recovered from Unit 6.
- 6.5 Holocene (11.7 ka – present day)**
- 6.5.1 At the end of the Weichselian glacial period, climate began to warm, but sea levels remained relatively low and the lower reaches of the Palaeo-Yare would have been exposed. It is during this time that Channel B, a meandering channel in the north-west of Licence Area 240 and running through Licence Area 511, formed by cutting into underlying Unit 3b deposits. Unit 7, characterised by a basal peat overlain by silty, clayey, sand is confined to Channel B in Area 240. These deposits reflect the 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).
- 6.5.2 Unit 7 was recorded in two vibrocores from Licence Area 240 that lie within the previously mapped extent of Unit 7. No operational sampling events have targeted Unit 7.
- 6.5.3 However, a number of Holocene finds were recovered from Unit 3b within Channel B. These include a tertiary flake (**2233**) which appeared to have been hard-hammer struck from a flake core, and was interpreted to be probably Holocene, and a thermal flake with a semi-abrupt concave retouch on one end (**2234**), it was in fresher condition than the others and a specialist noted that it was undoubtedly Holocene. A Mesolithic blade core (**2244**) has also been recovered. These finds are later than the age of Unit 3b, suggesting there is potential to preserve Upper Palaeolithic or Mesolithic archaeological material in Channel B, despite Unit 7 deposits not being recorded in vibrocores. There is also the potential to recover palaeoenvironmental material, although it is not known if this originates in Unit 2 or Unit 7. This is supported by the environmental finds, largely peat deposits considered to be of Mesolithic age, that have been reported from Licence Area 240, and reported through the *Protocol for Reporting Finds of Archaeological Interest*.

- 6.5.4 The final inundation of the lower reaches of the Palaeo-Yare is expected to have occurred around 8.5 ka (Wessex Archaeology 2013a) after which marine processes began to rework and redistribute deposits forming Unit 8, seabed sediments. Given historic dredging activity, in some areas the superficial sediments of Unit 8 may be a palimpsest of marine processes and localised remobilisation due to dredging activity. Therefore, it is possible for reworked archaeological material to be present in Unit 8.

7 DISCUSSION OF THE RESULTS

7.1 Introduction

- 7.1.1 Overall, approximately 65,000 tonnes of aggregate have been archaeologically assessed through Operational Sampling, from approximately 115,000 tonnes received at the wharves. The percentage of aggregate assessed by each Operational Sampling event depended on the methodology at the wharf, and ranged from 3-4% of the overall cargo at wharves where 100% of oversize material was manually sifted to up to 100% of a cargo when aggregate was viewed on a conveyor.
- 7.1.2 The most significant results of the Operational Sampling events were those from Area 240 – with the discovery of potential *in situ* archaeology of Saalian age (MIS 8-7), with fresh lithic artefacts from an area wheremegafauna remains were also recovered. This discovery also highlights the importance of wharf and vessel staff reporting discoveries through the Protocol, as it was due to their vigilance that the initial material was spotted and the Operational Sampling event rapidly mobilised for further assessment. This was further emphasised by the reporting through the Protocol in 2020 of a possibly butchered bone (**Hanson_0958**).
- 7.1.3 Licence Area 240 had by far the most evidence for lithic artefacts,. Lithic artefacts were also discovered in aggregate cargoes dredged from Licence Areas 401/2, 511 and 512.
- 7.1.4 From the Operational Sampling events covered by this interpretative report (between mid-2014 and the end of 2019), 52 lithics were recovered from somewhere in the region of 115,000 tonnes of aggregate. This number compares favourably with the original 88 lithics recovered from Licence Area 240 in 2007/2008 from 55,000 tonnes of aggregate, considering that, as with the Operational Sampling undertaken between 2012 and 2014, when a relatively small number of lithics (14 pieces from around 80,000 tonnes of aggregate) were recovered, the Operational Sampling events were often targeting a range of different licence areas and sediments, rather than focussing specifically on the ‘hot spot’ Unit 3b sediments in Licence Area 240. The ongoing discoveries from across the East Coast aggregate extraction block continue to develop our understanding of hominin exploitation and occupation of this area, and have the potential to identify new sites, or refine the extent of previously known sites.
- 7.1.5 The significant quantity of lithic and faunal remains discovered on the beach following the Bacton Beach Nourishment Project suggest the presence of further ‘hot spots’ in the wider area, and although it has not been possible to determine the provenance of the flint artefacts and faunal remains, it is probable that they derive from Licence Area 228 and/or 511.
- 7.1.6 Operational Sampling results revealed faunal remains across most of the region, with the exception of Licence Areas 212, 242/361, and 328. Most of the faunal remains that derived from lane F10 in Licence Area 240 were in good condition suggesting they were *in situ* or relatively undisturbed. However, other faunal remains have been fragmentary and abraded, indicating they derived from a secondary context and cannot be directly associated with particular sediment units or locations within the Palaeo-Yare, and it is possible that some of

the highly abraded and mineralised bones are of a similar age to Unit 2. The finds from secondary contexts are consistent with the majority of faunal remains recovered previously from within the Palaeo-Yare (Wessex Archaeology 2013a, 2015a) and this region in the southern North Sea.

7.2 Hypotheses assessment

Introduction

- 7.2.1 The 28 Operational Sampling events undertaken from mid-2014 to the end of 2019 can be used to test a number of hypotheses in order to advance the understanding of the distribution and significance of Palaeolithic material within the licence areas of the East Coast Block of the Anglian Region.
- 7.2.2 Nine of the Operational Sampling events produced 52 lithics, while 12 events produced 186 faunal remains. The recovery of this material (or its absence, where none was found) has increased our understanding of the exploitation of the area during the Palaeolithic and later periods. However, the aggregate dredged depended on the commercial needs of the aggregate industry, and therefore the locations targeted were not necessarily conducive to testing the hypotheses. Not all hypotheses could be tested through archaeological assessment.
- 7.2.3 It should be noted that comparing hypotheses over this period is complicated by the fact that three different systems of hypotheses were implemented – with Operational Sampling in 2014 testing the hypotheses from the preliminary WSI, Operational Sampling in 2015 testing the initial draft updated hypotheses, and Operational Sampling from 2016 onwards testing the hypotheses set out in Appendix 1 of the WSI (Fjodr 2016). In some cases (such as for H1.1 and H3.2) the 2015 and 2016 hypotheses are in direct opposition, and therefore the results need to be assessed carefully, rather than referring simply to the results for H1.1.
- 7.2.4 **Appendix 2** provides a summary of the hypotheses, whether they were tested, whether they were proven, and the licence areas that illustrate the results.
- 7.2.5 The hypotheses that were tested are discussed in more detail below.

H1 Inhabitation

- 7.2.6 H1a and H1.1 (2015) *Palaeolithic material is recovered only from Unit 3b, which dates to the Wolstonian* (now referred to as the Saalian) vs. H1.1 (2016) *Palaeolithic material is recovered from units other than 3b*. The 2016 hypothesis was expected to be disproved, as to date no Middle Palaeolithic material has been recovered from units other than 3b. This was a difficult hypothesis to test, as the majority of dredging in Licence Areas 240, 401/2, 511, 512 and 513/1 targeted Unit 3b sediments. Even when Palaeolithic material was discovered in cargoes with a mixture of units, it was assessed as deriving from Unit 3b due to its age and/or little evidence of damage (ie: handaxes from Area 240 (Wessex Archaeology 2019b, 2019c, 2019d)). The November 2019 Operational Sampling of aggregate from Licence Area 240 tested the hypothesis, but the Middle Palaeolithic date suggested that the handaxes derived from Unit 3b. Operational Sampling events of aggregate dredged from other units did not reveal any Palaeolithic material (such as Unit 2 in Licence Area 212 (Wessex Archaeology 2015b) and Unit 8 in Licence Area 401/2 (Wessex Archaeology 2014b,c, 2015h, 2019)).
- 7.2.7 H1.2 (2016) *Some of the Middle Palaeolithic material recovered from Unit 3b is in situ*. This hypothesis was expected to be proved (Fjodr 2016). Operational Sampling events in Licence Area 240 have confirmed this hypothesis, with discoveries of *in situ* material in July,

October, and November 2019 (Wessex Archaeology 2019b, d and e). Many of the handaxes from Licence Area 240, even when found as isolated objects, present little damage. Evidence from Licence Area 511 and 512 (Wessex Archaeology 2018b, 2019f) highlights the fact that not all finds are *in situ*, as flakes from Licence Area 511 appeared worn while flakes from Licence Area 512 appeared to have been rolled, indicating they may have moved within high energy Pleistocene fluvial sediments and/or around on the seabed.

- 7.2.8 H1.3 (2016) *Late Upper Palaeolithic material is recovered from other places in addition to the vicinity of Channel B* is the opposite of H1.4 (2015) *Late Upper Palaeolithic material is recovered only from the vicinity of Channel B* and the 2016 hypothesis was expected to be disproved, as Operational Sampling had only ever recovered Late Upper Palaeolithic material from the vicinity of Channel B. However, a Late Upper Palaeolithic blade from Licence Area 512 (Wessex Archaeology 2015k) suggests that the material is not limited to the vicinity of Channel B. The blade was abraded, and therefore unlikely to have been *in situ*.
- 7.2.9 H1.5 (2016) *Some in situ Lower Palaeolithic material is recovered from other units than Unit 3b*. This hypothesis was expected to be disproved, as the Lower Palaeolithic material recovered by Operational Sampling from units other than Unit 3b has not been *in situ* (Fjodr 2016). As the majority of Operational Sampling targeted Unit 3b sediments, it was not possible to test this hypothesis. No *in situ* Palaeolithic material was discovered in other sediments and this hypothesis remains largely untested.
- 7.2.10 H1.6 (2016) *Artefactual material appears to be in situ in areas other than Unit 3b and the vicinity of Channel B*. This hypothesis was expected to be disproved as artefactual material recovered from Operational Sampling from units other than 3b had not been *in situ* (Fjodr 2016). The hypothesis continues to be repeatedly disproved, as Operational Sampling has continued to demonstrate an absence of *in situ* artefactual material in other units and places.
- 7.2.11 H1.7 (2015) *Other than from Unit 3b and Late Upper Palaeolithic material from the vicinity of Channel B, no artefactual material appears to be in situ*. The majority of material was recovered from Unit 3b, and therefore this was difficult to test. However, the recovery of an apparently Late Upper Palaeolithic blade from Licence Area 512 (Wessex Archaeology 2015) appears to support this hypothesis, as it was broken and somewhat worn, suggesting that it was not *in situ*.
- 7.2.12 H1.7 (2016) *Prehistoric material is recovered for periods later than the Later Upper Palaeolithic*. This hypothesis was expected to be disproved (Fjodr 2016), however, the discovery of a possible Mesolithic flint blade core from Licence Area 511 appears to prove the hypothesis.
- 7.2.13 H1.9 (2015) *All faunal remains appear to be in secondary contexts* vs. H1.8 (2016) *Faunal remains appear to be in primary contexts*. The 2016 hypothesis was expected to be disproved, as material recovered from Operational Sampling events prior to 2016 had been found in secondary contexts. Indeed, there was again evidence for faunal remains recovered from secondary contexts, such as from Licence Area 240 (Wessex Archaeology 2015c), Licence Area 511 (Wessex Archaeology 2015j, 2017c, 2018b), Licence Area 512 (Wessex Archaeology 2018c), and Licence Area 513 (Wessex Archaeology 2017d). However, there were also cases where the provenance was unclear, for example the bone fragments from large herbivores in Licence Area 401/2 (Wessex Archaeology 2019a) could not be confirmed as to deriving from a primary or secondary context. In Licence Area 240, there were faunal remains both in poor condition, suggesting a secondary context, and in

such good condition they suggested a primary context. For example, the Operational Sampling event in November 2019 recovered bones that were in such good condition as to retain evidence for hyena tooth marks, as well as mammoth bones that could be interpreted as deriving from the same animal, all of which suggest they were in a primary context. The clear differences in preservation between some of the faunal remains from Licence Area 240 suggested that the remains originated from different deposits.

H2 Choice and use of location

- 7.2.14 H2.1 (2016) *Middle Palaeolithic material is recovered from the floodplain of Channel A, not from Channel A* was tested through Operational Sampling visits for aggregate dredged from Licence Area 240 in 2019 (Wessex Archaeology 2019b, 2019d, and 2019e). The hypothesis was expected to be proved (Fjodr 2016), and these Operational Sampling visits support the hypothesis. The handaxes discovered, believed to be from the Middle Palaeolithic, were recovered from the floodplain deposits of Channel A. It should be noted that dredging has not taken place, nor is it likely to take place, within Channel A due to the presence of fine grained material (Unit 4), and therefore expectations of the absence of Middle Palaeolithic material from Channel A are tempered by operational circumstances (Fjodr 2016).
- 7.2.15 H2.3 (2016) *Middle Palaeolithic material is clustered in relatively large quantities at discrete locations*. This hypothesis was expected to be disproved, as Middle Palaeolithic material recovered by Operational Sampling up to 2016 had comprised only a few examples within any sample (Fjodr 2016). Although the original discovery of Middle Palaeolithic material from Licence Area 240 appeared to be in a large quantity, the circumstances of dredging and reporting were different to the Operational Sampling methodology (*ibid*). The hypothesis was tested by Operational Sampling events in Licence Areas 212, 240, 242/361B, 401/2, 511, 512 and 513/1. For the vast majority of Operational Sampling events, either no Palaeolithic material was encountered (a total of 17 events, in Licence Areas 212, 240, 242/361B, 401/2, 511, 512, and 513/1), or only a small quantity of material was recovered (a total of four events, in Licence Areas 240, 511 and 512). These Operational Sampling events appeared to support the hypothesis, in that dredging had not encountered a discrete location with an identifiable cluster.
- 7.2.16 However, in 2019, discoveries from aggregate in Licence Area 240 began to change the picture. In October 2019, five stone tools were discovered during Operational Sampling, and although five artefacts are not considered to represent a large quantity, the number of artefacts of this nature from one load was considered exceptional (Wessex Archaeology 2019d). Then an Operational Sampling event in November 2019 revealed 30 stone tools, as well as a considerable quantity of faunal material, proved the hypothesis, while indicating that dredging had encountered a potential *in situ* site. This changing picture is perhaps reinforced by the finds at Bacton, which point to high densities of specific areas of Licence Area 228 and/or 511.
- 7.2.17 H2.4 (2015 and 2016) *Middle Palaeolithic material is present in small quantities throughout Unit 3b deposits*. This hypothesis was expected to be proved, as Middle Palaeolithic material continues to be recovered in small quantities from Unit 3b (Fjodr 2016). Many of the Operational Sampling events did indeed recover small quantities of Middle Palaeolithic material, thus supporting this hypothesis, however, the majority of events recovered no material of Palaeolithic date. The threshold for the hypothesis is that it will be disproved if Operational Sampling recovers large quantities of Middle Palaeolithic material (Fjodr 2016) and the two events in Licence Area 240 in 2019 recovered relatively large quantities of material indicates that discrete locations also have high concentrations.

H3 Natural Processes

- 7.2.18 H3a *the distribution of recovered Palaeolithic material does not vary according to variations in the sediment structure of Unit 3b* appeared to be valid, as it was tested during an Operational Sampling event in 2014 on aggregate dredged from Licence Area 513/1, if the sandy material targeted by the sample did indeed represent a sediment structure variation (Wessex Archaeology 2014e). Material that was encountered comprised part of a vertebra and a single piece of struck flint.
- 7.2.19 H3c and H3.2 (2015) *Middle Palaeolithic material is not recovered where Unit 3b appears to be covered by major bank structures* vs. H3.2 (2016) *Middle Palaeolithic material is recovered where Unit 3b appears to be covered by Major bank structures*. The 2016 hypothesis was expected to be disproved (Fjodr 2016). Operational Sampling undertaken in 2014 for aggregate dredged from Licence Area 401/2 (Wessex Archaeology 2014b) appeared to support H3c and H3.2 (2015) and disprove H3.2 (2016), as the cargo comprised shelly sand of recent marine sediment or reworked bank, and no archaeological material was seen. It was further supported by subsequent Operational Sampling events in November 2014, March 2015 and November 2015 (Wessex Archaeology 2014c, 2015h and 2015i). However, in general, this hypothesis was not tested, as the aggregate targeted for Operational Sampling was from areas of Unit 3b. The only licence area with recorded reworked banks that underwent Operational Sampling was Licence Area 513/1, but although some dredging was undertaken in the reworked banks, the majority of dredging targeted Unit 3b sediments.
- 7.2.20 H3.3 (2015) is addressed below, as it relates to dredging history, as opposed to natural processes.

H4 Human Process, including dredging history

- 7.2.21 Over the last several decades, dredging activity has taken place within the East Coast region. The aim of these hypotheses was to test whether evidence for previous dredging, identified through geophysical or EMS data, could be used to indicate whether there would be a presence or absence of Palaeolithic material.
- 7.2.22 The hypotheses from the provisional WSI stated that Palaeolithic material **is not** present: where the dredging history indicated that a high level of dredging had taken place since the introduction of EMS (H4a) or where geophysical data indicated that a high level of dredging had taken place (H4b).
- 7.2.23 The hypotheses tested in 2015 stated that Palaeolithic material **is not** present where a high level of dredging had taken place since the introduction of EMS (H3.3) however Middle Palaeolithic material **is** being recovered where geophysical data indicates that a high level of dredging has taken place (H4.1).
- 7.2.24 The hypotheses from Appendix 1 of the WSI (Fjodr 2016) state that: *Middle Palaeolithic material is recovered where dredging history indicates that a high level of dredging has taken place since the introduction of EMS (H4.1) and Middle Palaeolithic material is recovered where geophysical data indicates that a high level of dredging has taken place (H4.2)*. It was expected that both of these hypotheses would be disproved, as in 2016, no Middle Palaeolithic material had been recovered by Operational Sampling in areas where the dredging history or geophysical survey data indicate that a high level of dredging has taken place (Fjodr 2016).
- 7.2.25 The EMS data from the previous interpretative report (Wessex Archaeology 2015a) comprised dredging results from 1993 to 2012, and this has been utilised for the review

along with the EMS data for dredging undertaken between January 2015 and December 2019, in order to provide a cumulative assessment. While the data from 1993 to 2012 was rated as very low intensity, low intensity, medium intensity and high intensity, the 2015-2019 data was categorised based on the length of time dredged: low refers to 1-15 minutes, medium refers to 15 mins to 1 hour and 15 mins, and high refers to greater than an hour and 15 minutes (Figure 3).

- 7.2.26 The EMS data from 1993 to 2012 revealed few licence areas with high intensity dredging, and only two Operational Sampling events (one in Licence Area 228 the other in Licence Area 296) targeted areas classed as high cumulative intensity, while the remainder targeted areas only dredged to medium intensity (Wessex Archaeology 2015a). In addition, Palaeolithic material was not expected to be discovered in Licence Area 296 based on the Palaeogeographic interpretation, and none was found, therefore the hypothesis had not been adequately assessed at that stage.
- 7.2.27 The majority of aggregate assessed during Operational Sampling from 2015 to 2019 had been dredged from areas described as low or medium intensity by the EMS data. Only Licence Areas 240 and 513/1 exhibit locations with high intensity of dredging corresponding with dredging locations archaeologically assessed through Operational Sampling.
- 7.2.28 Discoveries in Licence Area 240 correspond with high intensity dredging in lanes F6 and F7 including two handaxes discovered in July and August 2019. In addition, lane F10 also corresponds with high intensity dredging, and yet, it is where the significant discoveries were made in November 2019. These discoveries, and in particular the November 2019 discoveries, support H4.1 and H4.2 (2016), even though it was expected that these hypotheses would be disproved. This supports the premise that there is vertical as well as lateral variation in artefact concentration, effectively temporal variation and clustering due to periodic occupation. It also suggests that although dredging has been intensive, in this part of Licence Area 240, it may only just have revealed a layer of sediment of particular archaeological interest.
- 7.2.29 In Licence Area 513/1, dredging corresponds precisely with the EMS data high intensity areas, and there was one undatable lithic and 17 faunal remains discovered, albeit fragmentary and heavily mineralised. As the finds could not be dated to the Middle Palaeolithic, they could not test the hypothesis.

H5 Operational sampling methods

- 7.2.30 Hypothesis 5a, 5.1 (2015) and 5.1 (2016) are all basically the same: *Faunal and artefactual material is found at all wharves where Operational Sampling takes place*. This hypothesis aimed to test whether the methodologies were effective at all wharves where they were deployed. To date, this has proved to be the case: the differing methodologies have not proven to significantly affect the outcomes of the Operational Sampling.
- 7.2.31 This also highlights the difference between different licence areas, and even within different locations of the same licence area. For example, material was found during six of the 11 Operational Sampling events in Licence Area 240, whereas no discoveries have yet been made in aggregate from Licence Area 401/2, in spite of the same methodologies being employed.

Hypotheses not tested

- 7.2.32 The 2016 hypotheses H1.4, H2.2, H3.1, H3.2 were not tested.

- 7.2.33 H1.4 (2016) *Some Late Upper Palaeolithic material from the vicinity of Channel B is in situ.* This hypothesis was expected to be proved (Fjordr 2016). However, no *in situ* Late Upper Palaeolithic material from the vicinity of Channel B was encountered, and the Late Upper Palaeolithic material from Licence Area 512, some distance away from Channel B, was worn and likely not *in situ*.
- 7.2.34 H2.2 (2016) *Middle Palaeolithic material is recovered from outlying deposits of Unit 3b north and south of the floodplain.* This hypothesis was expected to be disproved, as to date no Middle Palaeolithic material had been recovered by Operational Sampling from outlying deposits of Unit 3b (Fjordr 2016). Operational Sampling specifically tested Unit 3b deposits within the floodplain, and no Operational Sampling was undertaken for Unit 3b sediments to the north and south of the floodplain, and therefore this hypothesis could not be tested.
- 7.2.35 H3.1 *Middle Palaeolithic material is recovered in areas where Unit 3b has been reworked by natural processes.* This hypothesis was expected to be disproved (Fjordr 2016). This hypothesis was not tested, as sampling did not determine whether sediments had been reworked by natural processes.

7.3 Research frameworks

- 7.3.1 The results of this assessment can contribute to the research questions set out in the relevant research frameworks.

Research and Conservation Framework for the British Palaeolithic English Heritage/Prehistoric Society 2008)

- 7.3.2 The majority of research questions in this Research Framework are too specific for the collection of material from the East Coast aggregate areas to answer at this time (ie: 'does any British Palaeolithic archaeology suggest the presence of a complete annual settlement system' or 'did a significant population crash occur over Lower Palaeolithic/Middle Pleistocene time?'). However, the material can readily contribute to Theme 4: Sharing Human Origins: Developing New Audiences. These questions refer to:

- public perception of the Pleistocene;
- how Palaeolithic archaeology can contribute towards an understanding of human societies and what it is to be human;
- how archaeologists can engage the public with remote periods without any obvious surviving 'monuments'; and
- how can our understanding of Pleistocene environmental change inform the current climate change debate?

- 7.3.3 The discovery of flint tools and hominin remains from the East Coast licence areas enables the public to interact with the Pleistocene, to touch history. The flint tools in particular contribute towards an understanding of what it is to be human, because the public can handle the tools and imagine what it was like to create and use them; the tool marks from tens of thousands of years ago are still present and can be traced on the artefacts. Even without surviving 'monuments' these tools and faunal remains provide tangible links to the past and can excite the imagination. Many of the wharves where finds have been made, either through Operational Sampling or reported through the Protocol, including Hanson's Frindsbury and Dagenham wharves, have display cases to showcase the material that has been recovered, ensuring that not only staff have ready access to the material, but also

visitors to the site. The fact that all of these artefacts were discovered in past landscapes that are now submerged resonates strongly with themes of climate change, and how our landscapes have changed over time. Although this Research Framework dates to 2008, issues around climate change are, if anything, even more pressing today.

- 7.3.4 The Research Framework identifies strategic research and conservation themes, and a key one of these is 'areas', specifically mentioning how human occupation can be researched in drowned areas, and obviously this project directly addresses this issue, through archaeological assessment of geotechnical data and artefacts that have been recovered. The marine aggregate industry plays a key role in the discovery of Palaeolithic material, and the dissemination of the results.
- 7.3.5 Another strategic research and conservation theme is curation and conservation, calling for Palaeolithic specialists and local authority curators to demonstrate why archaeological investigation should be funded by developers. Again, this project provides a fantastic example of best practice, and how the support of industry can not only facilitate archaeological investigation but can make a significant contribution to our understanding of the past, by reducing and mitigating the effects of marine aggregate dredging on the marine historic environment. This report will be uploaded to OASIS and will be available through the ADS ensuring that the locations of discoveries are readily publicly available.

North Sea Prehistory Research and Management Framework (Peeters, Murphy and Flemming 2009)

- 7.3.6 This Research Framework notes that the submerged prehistoric landscapes of the North Sea, and the finds and archaeological sites from them, present a common European cultural heritage that is of world-wide significance. The Framework sets out a Research Agenda, indicating the potential of the region, and identifying gaps in knowledge. The evidence from the Palaeo-Yare assessment addresses the following:
- Topic A.3 – Survival of deposits of archaeological significance: the topic notes that potential is unevenly spread, and that understanding this, and the extent of erosional processes is key to develop a clear picture of the overall North Sea floor cultural heritage. The Palaeo-Yare project addresses this by examining areas of the seabed across the East Coast region, and in particular in Licence Area 240, where the high potential location on the seabed has been narrowed down to a small number of dredging lanes. The discoveries related to the Bacton Beach Nourishment project, probably deriving from Licence Area 228 or 511 also indicate a concentration of material. The negative results, and even results of small quantities of material highlight the uneven distribution across the submerged landscape.
 - Topic B.1: Middle/Late Pleistocene reshaping of topography and river drainage systems. This is explored through the geoarchaeological assessment of the distribution of units and Channels A and B.
 - Topic G.1: Spatial perspectives on North Sea Palaeolandscapes: this concerns the fact that the North Sea Basin is commonly perceived as a large body of water separating Britain from the Continent. However, the Palaeo-Yare project addresses how hominins were utilising the now submerged landscape, providing evidence not only for tool manufacture, but also, possibly for hunting.
 - Topic H.3: Conservation of submerged prehistoric landscapes in a dynamic environment. The ongoing implementation of the original AEZ in Licence Area 240

continues the conservation of the archaeological resource in this area, ensuring that some areas of the seabed are protected for study in the future.

- Topic I.2 Surveying: the Research Framework notes that the archaeological and palaeoenvironmental significance of data from geological surveys conducted by hydrocarbon and aggregate industries is often ignored. However, the Palaeo-Yare project illustrates that aggregate companies not only recognise the archaeological importance of the data gathered from East Coast licence areas, but also lead the way in ensuring that the data is archaeologically assessed.
- Topic I.3: Data sharing and finds reporting: This project ensures that finds are not only reported, but shared, through OASIS and the ADS, and also through datasets being forwarded to the National Record for the Historic Environment, soon to be the National Marine Historic Record.
- Topic J.1: Changing worlds: This topic is about climate change, and as discussed above, the discoveries from the East Coast provide a unique opportunity to share with the public information about how the climate has changed in the past, and how the area that we now know as the North Sea was once a vibrant landscape, populated with mammoths, woolly rhinoceros and other animals, as well as a hominin population that hunted in and occupied the area.

Research and Archaeology Revisited: a revised framework for the East of England (East Anglian Archaeology 2011)

- 7.3.7 In the future research topics section, the Research Framework recommends the intensive study of a single site, that could help to underpin thinking on the nature of the Lower/Middle Palaeolithic resource contained in sand/gravel aggregates. The central issue to resolve is whether lithic artefacts are present within sand/gravel deposits as tight concentrations at specific horizons or whether they are homogeneously distributed throughout the deposits in which they occur. This was specifically addressed through the hypotheses that were assessed for the Palaeo-Yare project, for example H1 and H2, especially H2.3 (2016) and H2.4 (2016) (see discussion above). Additionally, further Operational Sampling events for aggregate dredged from Licence Area 240 have the potential to further address the intensive study of a single site.
- 7.3.8 The Research Framework also recommends that Lower/Middle Palaeolithic artefactual evidence should be sought in the various channel deposits, and hypotheses in H1 and H2 were specifically designed to test the presence of material within and in the vicinity of Channels A and B (discussed in more detail above).
- 7.3.9 The spatial concentration of finds within terrace bodies should be investigated, as to whether they are evenly scattered or occurring as distinct spatial concentrations. At this stage, the resolution and data are not available to interpret specific terrace bodies, as Unit 3b is made up of multiple phases as the river system developed and migrated across the floodplain, and there are likely multiple terrace bodies within the system. Evidence from Licence Area 240 and from the Bacton Beach Nourishment Project does appear to suggest that Palaeolithic material is concentrated in distinct spatial concentrations. However, additionally, evidence from all of the licence areas suggest that there is also material scattered throughout Unit 3b.
- 7.3.10 This Research Framework also emphasises the importance of disseminating results to the wider community, which will be done through the deposition of this report with OASIS to the ADS and the submission of the datasets to the NRHE/NMHR.
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- 7.3.11 *People and the Sea: A Maritime Research Agenda for England* (Ransley et. al. 2013)
- 7.3.12 The Palaeolithic section of the Research Agenda (Westley and Bailey 2013) sets out four themes: coastal change; marine settlement and marine exploitation; seafaring; and maritime networks, identities and perception of maritime space.
- 7.3.13 Coastal change:
- improved understanding of shelf palaeoecology and patterns of palaeoenvironmental change over time through analysis of faunal and floral remains. The discoveries of faunal material from the East Coast licence areas can contribute to further assessments of change over time.
 - increased use of core/borehole data to reconstruct the geomorphology and topology of the shelf, to identify high potential areas that can be subsequently targeted for further high resolution seismic survey and additional precision mapping.
 - application of the above techniques specifically to address changes in fluvial systems and coastlines through the Palaeolithic.
- 7.3.14 Marine Settlement and Marine Exploitation:
- can environmental productivity reconstructions be produced which concentrate on now-submerged areas at a higher spatial resolution than previously achieved so as to resolve features such as rivers, lakes and coastlines?
 - can evidence from productivity reconstructions be used to contextualise hominin settlement patterns?
- 7.3.15 Maritime networks, identities and perception of maritime space:
- in which environments was hominin occupation in north-west Europe concentrated over the last 800,000 years?
 - were resource distributions the primary controls on hominin occupation? If so, what timescales did these operate at?
 - can provenancing of lithic material recovered from the shelf shed light on patterns of movement and distribution?
- 7.3.16 The data from the Palaeo-Yare project can contribute to assessment of the theme of coastal change, particularly in regards to assessments of geophysical and geotechnical survey data and the discoveries of faunal material from the East Coast licence areas. The reviews of geoarchaeological and geophysical data can continue to identify high potential areas that can subsequently be targeted for further assessment, while the discoveries of faunal remains provide solid evidence for the types of animals that were inhabiting the area. This work contributes to developing a more detailed understanding of fluvial systems and coastlines throughout the Palaeolithic.
- 7.3.17 With regards to settlement and marine exploitation, the data from the project can inform our understanding of the use of the landscape and resources. Although it is not possible to conclusively discuss settlement patterns from the available data, there is definitely a concentration of activity in Area 240, and as revealed by the Bacton Beach Nourishment
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Project (probably in Licence Area 228 or 511), and further assessment could provide more information.

- 7.3.18 For marine networks, identities and perception of maritime space, the concentration of discoveries in Area 240, both the early discoveries and most recent, have the potential to further our understanding about the types of environments where human occupation was concentrated. It is too early to discuss timescales for activity, but access to resources may have been key to riverine occupation and activity.

8 CONCLUSIONS

8.1 Archaeological Material

- 8.1.1 Between January 2015 and December 2019, 23 Operational Sampling events were carried out. This report also includes an additional five events that were omitted from the previous summary report. Overall, 52 lithics and 186 faunal remains have been recovered from approximately 115,000 tonnes of aggregate. The lithics consisted of Palaeolithic material from two licence areas and a Mesolithic find. The finds have furthered our understanding of the region and have allowed us to address some of the hypotheses.
- 8.1.2 The discoveries made in Licence Area 240 are particularly significant, including potentially *in situ* material of late Middle Pleistocene age (337,000-130,000 BP). The archaeology includes finished handaxes many of which are in fresh condition, along with Levallois cores and products which tend to exhibit greater evidence for reworking (Tizzard *et al.* 2015).
- 8.1.3 The techno-typology and condition of these artefacts indicates that there are two broad artefact assemblages – a handaxe dominated one which is generally fresh, and a second Levallois dominated one which is more abraded. The differences can be related to the lithology of Unit 3b, which has a basal sandy unit and grades up becoming increasingly gravelly and coarse grained (Tizzard *et al.* 2015). This suggests that the fresh handaxes are minimally disturbed and may originate from the basal finer sands, with some reworked into the coarser upper units, whilst the Levallois material likely originates from the upper, coarser sands and gravels, and may be younger. This interpretation suggests the handaxes may date to MIS 9 or MIS 8, which would fit with other handaxe assemblages dated to this period in Britain and northern France. The Levallois material would be younger, dating somewhere from late MIS 8 to early MIS 6, which would also fit with the British and northern France records; the Levallois technique is first found in the north and south of the English Channel towards the end of the Lower Palaeolithic during MIS 9 (White and Ashton 2003, Hérison *et al.* 2016), but is generally seen as marker of the Early Middle Palaeolithic (Scott 2011, Loch *et al.* 2016). The new discoveries from the 2019 Operational Sampling visit may suggest a wider spread of concentrations of archaeology associated with Unit 3b, and indicate a level of hominin activity, broadly comparable in date to that attested by some of the original lithic finds from Licence Area 240.
- 8.1.4 The handaxes from Area 240 have low cortex retention and often show evidence of multiple phases of working and edge modification, which is indicative of curation and being carried around the landscape. This may suggest that potentially a proportion of the handaxes were not produced within the area, but rather were carried in as finished artefacts, used and discarded. The debitage and partially complete handaxes do, however, point to some degree of manufacture taking place locally. This would fit with the handaxes being associated with the finer grained unit (the basal sands of Unit 3b). These kinds of modifications and curation practices are more generally associated with the late Middle



Palaeolithic, but in effect, the Area 240 material may show that these kinds of modifications are not chronological indicators, but rather indicative of transport and curation through the landscape.

- 8.1.5 The Levallois material may have been produced on gravel clasts from Unit 3b, but again, they may be transported and curated material, as there seems to be a high ration of Levallois products in relation to non-Levallois debitage, which is a strong sign of curation. Although, the lack of debitage may also be due to the methodology of collection.
- 8.1.6 Other recovered Palaeolithic material has been less diagnostic, such as possible Middle to Lower Palaeolithic flakes from Licence Area 511, and from Licence Area 512 two Palaeolithic flakes and eight less diagnostic flints.
- 8.1.7 During one Operational Sampling visit, a blade was recovered from a cargo from Licence Area 512, and it appeared to date to the Upper Palaeolithic. The piece was broken and worn, suggesting that it was not *in situ*. Lithic artefacts such as this were also recorded in the previous Operational Sampling interpretative report. These finds were associated with the early Holocene channel cutting into the Palaeo-Yare floodplain deposits and indicate the potential for further artefacts to be discovered. Interestingly, the previous report suggested potential for Licence Areas 240, 251 and 319, to this Licence Area 512 should also now be included.
- 8.1.8 A possible flint blade core from Licence Area 511 is of possible Mesolithic date. Mesolithic finds are relatively rare from the East Coast licence areas, and further discoveries could provide more detail about Mesolithic human activity, coastal inundation and transport of sediments following deglaciation after the last ice age.
- 8.1.9 As concluded in the previous Operational Sampling interpretative report, it seems that the original recovery of a large amount of lithic material from within a fairly tightly-defined part of Licence Area 240, as well as the recent discoveries, represent a 'hot-spot' within which evidence of Palaeolithic activity is preserved. The hundreds of lithics recovered from Walcott Beach following the Bacton Beach Nourishment project, suggest such 'hotspots' may be more widespread in the region.
- 8.1.10 Although there is not sufficient information at this stage to indicate whether these could be defined as places within the landscape associated with focussed activity (in the sense of being places where people were present over a definable period, or repeatedly active; cf. Turq 1989, Scott 2001, Shaw *et al.* 2016), they do appear to be areas where sediments have preserved evidence of human activity reflecting repeated significant periods of time. The location could, therefore, represent ecotonal areas in the landscape which provide particular affordances, for example vantage points, topographic traps, lithic raw material sources and/or animal resources. Although it is possible that these were areas that were visited occasionally over tens of thousands of years, the concentration of tools and faunal remains, suggests that activity was more targeted and concentrated in these were parts of the Paleo-Yare Valley.
- 8.1.11 The 2019 material from Licence Area 240, discovered in lanes so close to the AEZ, could represent the continuation of the specific artefact bearing sediments containing previous discoveries, or possibly another occurrence within a different horizon within Unit 3b. The finds discovered following the Bacton Beach Nourishment Project may also highlight the potential for other 'hot-spots' of activity in the region. In addition, it is likely that other such sites exist associated with the now-submerged catchment of the Palaeo-Yare, but no others

have been encountered during Operational Sampling, or reported through the Protocol, to date.

- 8.1.12 Apart from the recent discoveries in Licence Area 240, the majority of East Coast material appears to represent more generalised and widespread hominin presence within the Palaeo-Yare catchment. The finds could represent general use and discard of finds, for example during a hunting trip, or other resource exploitation activities, but not necessarily extended occupation.

8.2 Faunal Remains

- 8.2.1 Of the faunal remains, again the most significant discoveries were from Licence Area 240. Operational Sampling in 2019 revealed examples from mammoth, aurochs, horse and deer or reindeer. The differences in preservation suggested that the remains originated from different deposits. Most significantly, a bone with markings was discovered, that was identified as a woolly rhinoceros' scapula which exhibited hyena chew marks. In addition, the large mammoth tooth (Hanson_0935) was assessed by Professor Adrian Lister at the Natural History Museum commenting that the roots are so complete that the skull, or parts of it, are likely still on the seabed. In addition, it is possible that some of the remains could derive from the same mammoth, and, if associated with the tools could suggest a site where butchery was taking place.
- 8.2.2 The other faunal remains from Licence Area 240 and other licence areas were less diagnostic, which was not unexpected. They are generally comparable in type and condition to those previously recovered from the region. Finds represented mammoth teeth, mammoth rib, part of a sheep tibia, a red deer metatarsal, and unidentifiable faunal remains. The upper layers of Unit 3b in the Impala and Lynx areas of Licence Area 511 appear to have more faunal material within them than the deeper layers encountered in areas that have been dredged more intensively.
- 8.2.3 Faunal remains have also been discovered on Walcott Beach, following the Bacton Beach Nourishment project. These highlight the presence of potential prey in the area where hundreds of tools were also present. Although there is no evidence for whether the faunal remains are contemporary with the lithic artefacts, and it is not known whether there is any evidence for butchery in the form of cutmarks, they certainly suggest a location and environment within which humans and potential prey species were both present.

8.3 Geoarchaeological assessment

- 8.3.1 Based on the review of geotechnical vibrocores and EMS data (2016-2019), updates were made to the deposit model, with regards to the extent of Unit 3b in Licence Areas 240, 242/361 and 401/2. Changes were also made to the extent of Unit 4 in Licence Area 401/2. No changes were made to any of the other Units or to any of the other licence areas (Wessex Archaeology 2020a-b).

8.4 General Overview

- 8.4.1 The Palaeo-Yare appears to have been a relatively low lying sub arctic river system of braided channels, with season flows and migrating channel units (unlike the Thames with its terraces), and the evidence from Licence Area 240 and the discoveries associated with the Bacton Beach Nourishment project have the potential to tell us more about life during the Middle Palaeolithic. There appear to be clear 'hot spots' of activity within contemporary sediments, to the south of the main channel, within a wider environment of general activity. The Area 240 evidence provides a range of material and suggests flint tool production, possibly suggesting a particularly good source of flint, which is backed up by the

considerable quantity of discoveries from Walcott Beach following the Bacton Beach Nourishment project. This evidence, combined with the variety of faunal material, discussed above, which suggests an environment rich for human exploitation, begins to provide clues as to how people used the landscape.

- 8.4.2 The evidence also offers the possibility of asking further questions about how far the data can be taken – for example will it be possible to assess what specific activities humans were involved in different areas of these landscapes; whether human occupation/exploitation was seasonal; and does the data suggest a single or multiple periods of activity? The considerable number of finds made at Walcott Beach suggest repeated activity in the Palaeo-Yare over time. The ‘hot spot’ areas appear to have enhanced activity or archaeological visibility, is this due to particular affordances? The possible provenances for the Walcott Beach material are 3 to 6 km from the Area 240 concentration, but they may share particular features which made these areas attractive to humans. These ‘hot spots’ may be able to reveal more about the areas of heightened activity, and with further assessment may be able to help pinpoint further areas of heightened potential.

8.5 Contribution to Understanding of British and north European Palaeolithic

- 8.5.1 The discoveries that have been made through Operational Sampling, reported through the Protocol and that were recovered from Walcott Beach following the Bacton Beach Nourishment project comprise a dataset that can inform our understanding of the British Palaeolithic, while evidence from terrestrial sites can provide a wider context.
- 8.5.2 Evidence for Lower Palaeolithic occupation in the wider region comes from a relatively small number of minimally disturbed artefact occurrences such as Happisburgh 1 (Lewis *et al.* 2019), Barnham (Ashton *et al.* 1998), Elvden (Ashton *et al.* 2004), Beaches Pit (Preece *et al.* 2006), along with large amounts of material reworked to some extent within coarse river gravels (Wymer 1999).
- 8.5.3 The regional Lower Palaeolithic archaeological record also includes the earliest archaeological sites in northern Europe, found at Pakefield, Suffolk and Happisburgh, Norfolk. These sites have provided internationally significant artefactual and palaeoenvironmental records, reflecting rare evidence for human occupation predating the Anglian Glaciation (Parfitt *et al.* 2005; 2010, Lewis *et al.* 2019). Investigations at Happisburgh have also revealed the oldest known hominin footprint surface outside Africa at between approximately 1 million and 0.78 million years ago (Ashton *et al.* 2014). Lower Palaeolithic lithic repertoires were generally handaxe-dominated, alongside evidence for simple core and flake working. Subsistence strategies may have included direct-hunting (Hosfield 2011), whilst studies of habitat preferences suggest a preference for river corridors through interglacial landscape and more open landscapes during cooler periods (Ashton *et al.* 2006; 2014).
- 8.5.4 Little archaeological evidence from the Lower Palaeolithic has been recovered from the Palaeo-Yare, comprising a few flakes of possible Lower Palaeolithic date and some faunal remains. Therefore the current evidence from the Palaeo-Yare does not contribute substantially to the understanding of this period, although it does suggest hominin presence in the area.
- 8.5.5 The boundary between the Lower Palaeolithic and the Middle Palaeolithic is signalled by changes in cultural and landscape-use practices (White *et al.* 2006, Scott 2011). These changes included a shift in lithic technology, but also other profound changes in human behaviour, in hominin adaptive, social and cognitive structures (White *et al.* 2006). However, in general, evidence for the British Middle Palaeolithic from terrestrial sites is considered to

be relatively impoverished compared with that of the Channel region and Northern France (Ashton and Scott 2016), which makes the discoveries of a concentration of Middle Palaeolithic material from Licence Area 240 particularly exciting.

- 8.5.6 The Middle Palaeolithic archaeology from Area 240 can be related to that from southern Britain and northern France. These combined records can be divided into several phases, with the Early Middle Palaeolithic dating from around late MIS 9 to MIS 6 and characterised by the emergence and diversification of Levallois technology (Ashton and Scott 2016, Moncel *et al.* 2020). This is followed by a general lack of evidence for settlement during peak cold conditions during MIS 6, both in southern Britain and northern France, which is followed by a general lack of evidence for human activity during MIS 5 in Britain (but see Wenban-Smith *et al.* 2010) in contrast to extensive evidence of archaeology dated to this period in northern France (Locht *et al.* 2016). The lithic technology from MIS 5 sites in northern France is varied but generally associated with Levallois flaking, particularly point production, and non-Levallois strategies geared to producing blades.
- 8.5.7 Subsequent to MIS 5, there is a potential period of human absence in both southern Britain and northern France during peak cold condition in MIS 4. This is followed by the reoccupation across the region in MIS 4/3. This reoccupation is associated with the Late Middle Palaeolithic. In southern Britain, the identification of human activity during this period is based on occurrence of tech-typologically distinct handaxes termed *bout coupés* (Roe 1968, White and Jacobi 2002). In Britain, most sites comprise isolated occurrences of *bout coupés*. However, an assemblage of Late Middle Palaeolithic handaxes dated to MIS 4/3 has been excavated at Lynford Quarry, Norfolk (Bosimier *et al.* 2012). Wider lithic reduction strategies during the Late Middle Palaeolithic in Britain are poorly understood, although there is some indication that core working during this period in Britain may be focused of a technique of discoidal core working (Jacobi and Cook 1998).
- 8.5.8 In northern France, most sites show a focus on Levallois flake production. However, as in Britain, there are sites of this date which exhibit technological strategies focussed on handaxes (Locht *et al.* 2016). The handaxes from these sites are typological distinct from *bout coupés*, however. Rather those from the north of France are similar to handaxes which define the Mousterian of Acheulean Tradition (MTA) at sites such as Pech de l'Azé I or Le Moustier in the south of France (Soressi 2002). This difference may reflect the presence of distinct cultural traditions in different areas.
- 8.5.9 In Britain the Early and Late Middle Palaeolithic periods are also associated with different locations and occupational styles. Early Middle Palaeolithic sites were heavily concentrated in the south-east of England, with particularly strong distribution around the River Thames, and additional evidence in Norfolk and in Wales (Scott 2011). The sites appear to be focussed on sources of flint, with suggestions of primary knapping locations or workshops (such as Lion Tramway Cutting, West Thurrock and Crayford), with sites that appear to suggest places for provisioning following forays into the wider territory, and the more logistical use of the landscape than was seen in the Lower Palaeolithic (*ibid*). In contrast, evidence from the Late Middle Palaeolithic suggests a preponderance of hunting bases or camps with logistical use of wider territories and little permanent settlement (Ashton and Scott 2016). The existing sites tend to be biased towards caves, with less evidence for open air sites.
- 8.5.10 As Unit 3b has been dated to the Early Middle Palaeolithic (MIS 9-7), it is this period where evidence from the Palaeo-Yare has the potential to contribute the most to our understanding of the Palaeolithic. The monograph *Seabed Prehistory: Investigating the Palaeogeography and Early Middle Palaeolithic Archaeology in the Southern North Sea* (Tizzard *et al* 2015)
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used the evidence from discoveries in Licence Area 240 and the subsequent investigations of 3b deposits, to develop ideas about the period and to raise a number of key questions regarding: populating our Palaeogeography; environment and resources; and movement and colonisation.

- 8.5.11 In Britain and northern France, whilst sites dated to MIS 9 see the presence of Levallois flaking (e.g Botnay Pit, Purfleet and Etricourt-Manancourt, HUD) assemblages are generally handaxe dominated. In contrast, assemblages dated to late MIS 8 and later are dominated by Levallois reduction strategy; handaxes are generally absent, or present in very small numbers (White *et al* 2006, Scott 2011, Locht *et al.* 2016). A similar focus on Levallois flaking is evident from sites of this date in northern France (Locht *et al.* 2016).). Therefore, the fact that the discoveries from Licence Area 240 include both handaxes and Levallois flakes is significant. It should be noted that the finds from the Bacton Beach Nourishment Project also include both handaxes and Levallois flakes. As with the Licence Area 240 discoveries in 2007/2008 (Tizzard *et al.* 2015), the handaxes recovered in 2019 are in very good condition, indicating that they were recovered from a primary location, while the Levallois flakes were generally in good condition, but slightly dulled by rolling. This difference in broad conditional states suggests that the handaxes and Levallois material they may come from different layers or depositional contexts, which would fit with Unit 3b comprising a complex unit and reflect multiple phase of deposition (Tizzard *et al.* 2015).
- 8.5.12 The suggested redating of Unit 3b from to MIS 7–6 (Marshall 2020) is particularly notable in terms of regional settlement histories. The presence of Levallois material that is contemporary with deposits of this age from Area 240 is in line with current regional patterns, with extensive evidence for Levallois flaking from sites dated to this period. However, the presence of fresh handaxes is more surprising, as sites dated to MIS 7-6 in the wider region tend to lack such handaxes. There is only one site, located in northern France (Riencourt les-Bapaume, Tuffreau 1993), which may date to late in MIS 7/early in MIS 6 and which has produced Levallois and handaxes which may be contemporary.
- 8.5.13 In northern Europe, Levallois technology is considered to be more intensively curated and mobile than Lower Palaeolithic handaxes, and studies indicate the movement of Levallois flakes as both blanks and as retouched tools, as well as the transport of cores as the sources for flakes (White *et al* 2006, Scott 2011). Sites from the European mainland appear to suggest upland-lowland contrasts, with different spatial organisation of technology, where hominids ‘geared up’ on the higher ground (where there was access to both access to raw materials and views over the valley below) then ventured to the valley bottoms for subsistence activities before returning (White *et al* 2006, Scott 2011).
- 8.5.14 In Britain, sites with large assemblages are generally found adjacent to a source of raw material (for example bedrock flint sources or coarse flint gravels), whereas smaller assemblages may be found further away from raw materials in fine-grained contexts, which highlights a correlation between context and assemblage size (White *et al* 2006: 537). The river deposits of exposed gravel bars or terraces in the Palaeo-Yare region could have provided ample raw materials, although it is also possible that the handaxes from Area 240 were produced elsewhere and transported, but the location may also have had other advantages brought by being in a lowland, ecotonal landscape (Tizzard *et al* 2015).
- 8.5.15 Analysis of British Middle Palaeolithic terrestrial assemblages has drawn out some specific patterns in site and landscape use during the Middle Palaeolithic (Scott 2011 after Turq 1989). Within this framework, the collections of tools from Licence Area 240 are sizeable assemblages and may be characterised as ‘mixed strategy’ locations rather than either ‘extraction and production sites’ (often called a ‘workshop’) where raw materials were

sourced, tested and in the initial stages of reduction was carried out or a ('mixed strategy sites' which contain all stages of reduction, but are distinguished from 'extraction and production sites' by high numbers of finished tool forms and products, such as handaxes, heavily reduced cores or Levallois products). These sites were well-known places in the landscape to which humans returned repeatedly, exploiting particular resources, and therefore these sites build up an accumulation of large artefact assemblages, including debitage (White *et al.* 2006, Scott 2011). Although there are clearly potential issues with collection bias, the large 'hot spot' sites from the Palaeo-Yare likely include 'mixed-strategy sites' as they have produced a large number of finished artefacts forms, including handaxes and Levallois products

- 8.5.16 The discoveries of isolated finds, including handaxes, across the Palaeo-Yare landscape may indicate 'episodic sites' (Scott 2011 after Turq 1989), such as short-term events, with the low drop out of artefacts in context of use across the landscape (see Roebroeks *et al.* 1992).
- 8.5.17 Focus on the transport of selected finished forms such as handaxes and Levallois products through landscapes during in early Middle Palaeolithic, with repeated concentrated activity at particular points in the landscape is a reoccurring theme and one which has been highlighted at La Cotte de St Brelade in the western English Channel. Here a fissure system on the edge of the now submerged landscapes of Normano-Breton Gulf has acted focal point (a 'persistent place' for the discard of artefacts and transport through of curated artefacts (handaxes, reduced cores, Levallois products) produced and used in the now submerged regions, repeatedly over a long period (Shaw *et al.* 2018, Scott and Shaw 2018).
- 8.5.18 The resolution of archaeological record of 'hot-spots' in Area 240 makes assessing the extent of repeated activity at particular places difficult to judge. Nevertheless, if the interpretation of the handaxes and Levallois products as reflecting separate phases of activity is correct (Tizzard *et al.* 2015), which it very likely is, it would imply that these are areas which repeatedly attracted Middle Palaeolithic groups over an extended period of time. Therefore, it can be seen that the Early Middle Palaeolithic archaeology from Area 240 adds to and enhances an emergent pattern of varied but logistical use of technology, indicating clear levels of future planning and anticipation of action in the landscape (White *et al.* 2006, Scott 2011). There appears to be intensification of these behaviours, with more complex use of different parts of the landscape during this period (*ibid*).
- 8.5.19 It is currently difficult to definitively establish human landscape and environmental preferences during the Early Middle Palaeolithic in the North Sea region. Consideration of British sites in isolation would suggest a focus on riverside settings (White *et al.* 2006). However, the record from northern France demonstrates a greater focus on more diverse areas of the landscape settings, including valley-side and upland locations (Locht *et al.* 2016).
- 8.5.20 The environmental record from the Early Middle Palaeolithic in the wider region is generally focussed on human activity associated with open landscapes. However, whether this is reflection of genuine preference or simply prevailing environmental conditions is currently unknown; humans have been shown to be present in fully temperate forest environments during MIS 5e in northern France (Antoine *et al.* 2006). There is limited environmental evidence from the Palaeo-Yare, comprising reworked charcoal and wood from Licence Area 254. This indicates a cold estuarine environment, with a sea level around 25-30 m below OD (Tizzard *et al.* 2015). Generalised glacial-interglacial floral development suggests a possible framework for reconstructing the environment, and during a cooling trend leading

into a glacial period, coniferous forests would likely open into grassland, which in turn would develop into a dry open woodland as conditions warmed leading into an interglacial (Tizzard *et al* 2015). The geophysical, geotechnical and archaeological evidence from Licence Area 240 suggests a coastal, estuarine location near the banks of a river on the margins of grassland, probably within a cool steppe landscape with some trees, with Anglian till cliff framing the coastal landscape, in a way similar to the present-day coastline (*ibid*).

- 8.5.21 By examining the climate, it is possible to begin to speculate about possible seasonal usage of the landscape, with potential occupation when conditions allowed, noting that winter temperatures may have proved difficult and caused pressure for clothing and artificial shelter, although the maritime climate may have been less variable than that of sites further inland (Tizzard *et al* 2015).
- 8.5.22 The current lithic assemblages from Licence Area 240 and the Bacton Beach Nourishment Project cannot explain the duration, extent and development of human activity, but rather raises questions, such as: does the material reflect activity during a single or multiple period of the Middle Palaeolithic, does it reflect a single short phase of activity or does it, as the differences in condition between the Levallois products and the handaxes suggest, reflect repeated preference over time for particular parts of the now submerged landscape, and were these areas in fact used seasonally/annually for subsistence and/or raw material gathering and lithic production (Tizzard *et al* 2015: 105).
- 8.5.23 During this period we are heavily reliant on lithic artefacts to assess Middle Palaeolithic subsistence strategies. Wider subsistence strategies are more elusive. This is partly due to a lack of research in certain areas and partly due to issues of preservation, In the first case fossil remains have not been systematically studied for cut marks, in order consider how carcasses were acquired by humans (i.e through hunting, scavenging or a combination of approaches) (White *et al* 2006). Additionally, there is limited evidence for hunting technology (ie: wooden projectiles and hafts would be unlikely to survive in the archaeological record). The discovery of lithics with a large number of faunal remains from Licence Area 240 in 2019 is therefore particularly significant. Although those reported through the Protocol were in poor condition, the ones recovered during Operational Sampling were in good condition, and therefore could potentially come from primary contexts. Faunal remains were also recovered from the Bacton Beach Nourishment Project, however they are still undergoing assessment, and it is not possible to comment on their condition.
- 8.5.24 There have been studies to model changing demographics in the regions during the Middle Palaeolithic. Assessment of the British Early Middle Palaeolithic record suggests that there is a greater emphasis on occupation late in MIS 8 and early in MIS 7, than later MIS 7/early MIS 6 (Scott and Ashton 2011, Ashton and Scott 2016). This may support the suggestion that late MIS 7/early MIS 6 witnessed a decline in regional population levels leading to abandonment during peak cold condition in MIS 6 (Ashton and Lewis 2002). This pattern of declining populations is, however, at odds with the evidence from northern France, where the evidence for sites dated to late in MIS 7 and into the early part of MIS 6 are relatively numerous (Locht *et al.* 2016). This difference may partly reflect research traditions and partly preservation of archaeology in particular sedimentary contexts. As noted previously, the British Early Middle Palaeolithic record is heavily focussed on fluvial contexts, whereas most late MIS /early MIS 6 sites are preserved within loess sequences (Therdonne, Bapaume-les Osiers and Biache Saint-Vaast D and D1). The new Bayesian chronological modelling of the OSL dates from Area 240 are potentially significant in this regard as they have suggested a date of MIS 7 or early MIS 6 for Unit 3b (Marshall 2020). This would suggest the archaeology from Area 240 significantly adds to the evidence of occupation

during this period in Britain, placing it alongside the small lithic assemblage from Unit 4 at Sandy Lane and Purfleet Road, Aveley (White *et al.* 2006) and, possibly, Stoneham's Pit, Crayford (White *et al.* 2006, Scott 2011). Interestingly, the late MIS7/early MIS6 sites in northern France show an emphasis on the production of elongated and laminar Levallois products, including points, similar to Crayford.

- 8.5.25 Current understanding of the early Upper Palaeolithic settlement history of the region is based on a relatively small number of sites spread across England, Wales, northern France and Belgium. However there is a good corpus of radiocarbon dates taken from organic material, including human remains, which indicates a series of episodic colonisation event during warmer, interstadial periods extending from 38.5 to 29 ka cal BP (Jacobi and Higham 2011). These are associated with the Upper Palaeolithic Aurignacian and Gravettian techno-complexes (Jacobi and Higham 2011, Dinnis 2012).
- 8.5.26 There is clear evidence for Late and Final Upper Palaeolithic activity in the region from 15 to 12.5 ka cal BP (Jacobi and Higham 2011). However, the extent of human occupation during the final period of intense cold that marks the end of the Pleistocene (Younger Dryas; 12.5 to 11.5 cal BP) is currently unclear.
- 8.5.27 Only a few of isolated flint artefacts likely dated to the Upper Palaeolithic have been recovered from the Palaeo-Yare catchment, including a large blade from Licence Area 512. A possible Mesolithic flint blade core was recovered from Licence Area 511. Although few in number, these do indicate human use of the area during the Late Pleistocene and early Holocene periods.

8.6 Hypothesis Testing

- 8.6.1 Of the 17 hypotheses from 2016 (Fjodr 2016), six were not tested (H1.3, H1.6, H1.7, H2.1, H3.1, and H3.2). The remaining 11 have been tested (see **Appendix 2** for a summary). Some hypotheses, such as H1.1 were difficult to test, as the majority of dredging in most licence areas targeted the Unit 3b deposits. The majority of hypotheses were supported.
- 8.6.2 Discoveries made through Operational Sampling are addressing some of the key principle thematic hypotheses related to H1 Inhabitation and H2 Choice and Use of Location. The H1 hypotheses can be reviewed broadly by period:
- Lower Palaeolithic: *in situ* material has only been recovered from Unit 3b (H1.5);
 - Middle Palaeolithic: material has only ever been recovered from Unit 3b, and some of the material has been recovered *in situ* (H1.1 and H1.2);
 - Late Upper Palaeolithic material is recovered from other places in addition to the vicinity of Channel B (H1.3), but it has not yet been discovered *in situ* (H 1.4);
 - Prehistoric material later than the Late Upper Palaeolithic: has been recovered, for example from Licence Area 511 (H1.7);
 - No *in situ* material from any period has been discovered except in Unit 3b sediments (H1.6); and
 - Faunal remains have been recovered from both primary and secondary contexts (H1.8).



- 8.6.3 For the first two H2 hypotheses, about occupation of the wider landscape, discoveries of Middle Palaeolithic artefacts appear to be limited to the margins of Channel A, not Channel A itself (H2.1), but the conclusion may be influenced by the fact that the majority of aggregate material supplied for Operational Sampling was from the margins, not the Channel, and similarly, it was not possible to test H2.2 about the outlying deposits, as these were not targeted.
- 8.6.4 Hypothesis H2.3, regarding material clustered in relatively large quantities at discrete locations was expected to be disproved, and most Operational Sampling events provided only small quantities of material, however the discovery of a concentration of material in Licence Area 240 in 2019 appears to support the hypothesis.
- 8.6.5 Similarly, the majority of Operational Sampling assessments supported the hypothesis that Middle Palaeolithic material is present in small quantities throughout unit 3b deposits (H2.4), which was expected to be proved, but the discovery of a concentration of material in Licence Area 240 disproves this hypothesis. Although the hypothesis was disproved, there is a small quantity of Middle Palaeolithic in discrete locations across the wider area, indicating hominin activity.
- 8.6.6 With regards to dredging history, in Licence Area 240, although there has been a high intensity of dredging, finds have been made. However, the most exciting discoveries in Licence Area 240 were from lanes that were relatively new and had not been dredged since 2008. Regarding Operational Sampling methodologies, finds have been made at all wharves where Operational Sampling takes place, thus proving H5.1.
- 8.6.7 The hypotheses have not been revised at this time; however, they could be reviewed in the future based on the results of this assessment.

8.7 Contribution to Research Agendas

- 8.7.1 The results of this assessment contribute to the Research Agendas as set out in a number of applicable Research Frameworks.

8.8 Operational Sampling Methodologies

- 8.8.1 The methodologies for Operational Sampling at each wharf have enabled material to be recovered and reliable results obtained.
- 8.8.2 The data is somewhat skewed by which licences and sub-areas are being targeted during each review cycle. From a research point of view, it would be helpful to get dredging loads reviewed from a wider variety of licences, but this is understandably constrained by logistical and operational issues for the licensees.
- 8.8.3 Overall 23 Operational Sampling events were carried out between January 2015 and December 2019, and approximately 65,000 tonnes of aggregate was archaeologically assessed from over 115,000 tonnes of overall cargo. During this five year period, 21.28 million tonnes of aggregate was extracted from the East Coast region for construction, and an additional 3.2 million tonnes for beach nourishment projects in 2019 (BMAPA 2015, 2016, 2017, 2018 and 2019). With these large numbers, 115,000 tons may seem relatively small, however it must be remembered that much of the 21.28 million tonnes will have been dredged from areas of little to no archaeological interest.
- 8.8.4 Although fewer Operational Sampling visits were undertaken in the five year period from 2015 to 2019 than planned, there have already been seven visits in 2020 (up to the end of

October), to Northfleet and Dagenham wharves, assessing aggregate from Licence Areas 240, 511 and 512. Numerous finds have been recovered from both areas.

- 8.8.5 Seven Operational Sampling events were undertaken for aggregate dredged from Licence Area 240 between March and September 2020. These visits were undertaken to assess aggregate from lanes F8 and F9, in order to better understand the archaeological potential of the lanes adjacent to the recently implemented AEZ in lane F10. Overall, 22 flint artefacts and 121 faunal remains have been recovered. In addition, in 2020 there were five finds reported through the Protocol: a bone (**Hanson_0955**), two bones (**Hanson_0958**), a fragment of tusk (**Hanson_0969**) and a mammoth bone (**Hanson_0970**). One of the bones (**Hanson_0958**) is of particular interest, as it may exhibit evidence of butchery marks, although it has yet to be assessed by Dr. Silvia Bello from the Natural History Museum in person, due to Covid-19 restrictions. One Operational Sampling event in Licence Area 511 in February revealed flint artefacts and faunal remains.
- 8.8.6 The two Operational Sampling events in Licence Area 512, in August and October 2020, revealed faunal remains.
- 8.8.7 The discoveries made during Operational Sampling events highlight the importance of ongoing archaeological assessment in identifying Palaeolithic material from the East Coast licence areas.
- 8.8.8 Ongoing training of aggregate staff through the Protocol Awareness Programme ensures that wharf staff know what to look for with regard to faunal remains and lithics, but equally importantly are confident in the reporting process. Due to the fact that certain faunal remains and lithic shapes are more readily identifiable (ie: mammoth tusks and teeth as well as handaxes catch the eye), there is potential for these more obvious finds to be reported while finds that are more difficult to discern could be omitted from the record. This is addressed through the Operational Sampling visits, where trained Wessex Archaeology staff review the aggregate cargoes, however there could still be some bias towards larger finds, as the archaeological assessment is generally undertaken on the oversize finds, and smaller material could be screened out.
- 8.8.9 By using in-house specialists at Wessex Archaeology to provide an assessment of lithics and faunal remains, staff are familiar with the Palaeo-Yare as well as previous discoveries, which enables a detailed, thorough assessment.
- 8.8.10 In addition, by using a network of external specialists through the Natural History Museum, finds such as the bone with the hyena tooth marks can receive further assessment from leaders in the field.

9 RECOMMENDATIONS

9.1 Further Operational Sampling

- 9.1.1 Based on the results to date and the known archaeology in the region, it is considered that further operational sampling is needed in Licence Areas 240. Operational sampling should also be undertaken in Licence Areas 228 and 511 for aggregate dredged from the locations that provided sediment for the Bacton Beach Nourishment Project. These areas have yielded significant artefacts and are likely to provide further discoveries, and thus lead to a greater understanding of the archaeology of the region. Sampling should also continue in other areas as finds continue to be made.

9.1.2 It is also very important that when dredging is planned in areas that have not been dredged recently and/or have not had the benefit of previous sampling and assessment, that Operational Sampling should be undertaken at the earliest stage. The need for this assessment should be captured in the Licence-Specific Method Statements.

9.1.3 Within each Licence Area, the number of subareas/lanes that require detailed archaeological focus and Operational Sampling will continue to gradually become more focussed, and it is expected that this process will continue throughout the licence's term.

Licence Area 240

9.1.4 Licence Area 240 remains of particular interest, and specifically dredge lane F10. This is immediately adjacent to the AEZ and has revealed a significant concentration of lithic and faunal material. The discoveries in 2019 led to the implementation of an additional AEZ placed around F10 where the artefacts originated and up to F9 as a precautionary measure. It is possible that the location of the original AEZ was not sufficient to encompass all of the material on and under the seabed, but it is also possible that there are localised scatters over a wider area than previously anticipated.

9.1.5 At this stage, it appears that the full extents of the archaeologically productive sediments have not yet been confirmed, and therefore, further work should be undertaken as frequently and far ranging as possible, for example through increased Operational Sampling visits at Dagenham wharf, subject to discussions with Historic England and the agreement of the Regulator.

9.1.6 Dredging lanes F8/9 have also revealed a number of artefacts in 2020, although not comparable to the concentration from lane F10, and therefore aggregate from these areas should continue to be assessed. It is also suggested that cargoes from lane F8 and F9 are not mixed in order to assess the artefacts from each lane to draw a better conclusion of what is on the seabed in each lane.

9.1.7 It would be useful at this point to reassess the nature and extent of the Licence Area 240 AEZ based on dredging history and any geoarchaeological data from within the AEZ and compare that to F10. Then it would potentially be possible formulate a plan to assess the current survival and artefactual distribution within the AEZ, as our understanding of the potential within the AEZ is falling behind that of the adjacent portions of the licence. Historic England (comment from 19/05/2021) has suggested an opening of the temporary exclusion zone in F10, to enable the area to be systematically sampled. This could then lead to further discussions on wider access to lanes within the current Licence Area 240 AEZ, which could be informed alongside the potential for geoarchaeological data.

Licence Area 511

9.1.8 Licence Area 511 is also of interest, largely because the Bacton Beach Data Review (Wessex Archaeology 2020) indicated that it could have been one of two possible locations for the provenance of the between 750 to 1000 stone tools and 100 faunal remains that were discovered at Walcott following the beach replenishment works. For the replenishment works, aggregate was dredged from the southern part of the Licence Area in Unit 3b and Unit 2 sediments. Operational Sampling should be implemented for cargoes dredged in the vicinity of Bacton Beach dredging to assess what potential remains and to potentially confirm if the licence was a likely source for the Bacton finds.

9.1.9 Due to the significance of the finds from Walcott, it is recommended that cargoes dredged from the locations that were used for the Bacton Beach Nourishment Project (Diamond and Emerald) should undergo Operational Sampling when the location is next dredged.



- 9.1.10 Previous Operational Sampling has been undertaken in the Dingo, Gazelle, Jackel, Hare, Kuala, Impala and Lynx sub-areas, with minimal discoveries, and in 2020, an Operational Sampling report (Wessex Archaeology 2020d) recommended that Operational Sampling should come to an end in the previously monitored locations within this licence area. This was due to the large number of Operational Sampling events that have taken place, for example especially in the Gazelle sub-area, and the fact that the majority of finds are of limited archaeological significance, being limited to fragmentary faunal remains and possible flint flakes.
- 9.1.11 The datasheet associated with the Marine Licence Palaeo-Yare Monitoring Method Statements for Licence Area 511 (Wessex Archaeology 2016b) states that the current rate of assessment (1 in 20 loads) be maintained until four consecutive sample operations within a single dredge lane result in no recovered finds, whereby the dredging rate could be reduced to 1 in 40. As the last four Operational Sampling visits have all resulted in archaeological discoveries, the threshold for decreasing the frequency has not been met.
- 9.1.12 However, due to the low archaeological significance of the finds being recovered during Operational Sampling, it is recommended that the frequency of visits be reconsidered, and that when the next Marine Licence Monitoring Method Statement is written, the level of significance of discoveries is taken into consideration, for example decreasing in frequency following four consecutive visits within a single dredge lane/trackplot location resulting in finds of low archaeological importance.
- 9.1.13 It is also recommended that Operational Sampling be undertaken for any cargoes from locations that have not yet undergone Operational Sampling.

Licence Area 228

- 9.1.14 The previous Interpretative Report (Wessex Archaeology 2015a) recommended no further Operational Sampling, due to the history of intensive dredging and the small number of artefacts recovered, however the review of data from the Bacton Beach Nourishment Project (Wessex Archaeology 2020c) undertaken following the discovery of between 750 and 1000 stone tools on the beach at Walcott, indicated that the material could have derived from either Licence Area 511 or Licence Area 228. Dredging for the beach nourishment was undertaken in mostly Unit 3b sediments, to the east of the previous Operational Sampling events, and it is recommended that when further dredging for gravel cargoes occurs in the immediate vicinity of the dredging undertaken for the Bacton Beach Nourishment Project, that it should be archaeologically assessed through Operational Sampling. Therefore, a Licence Area Monitoring Method Statement should be developed for Volker Dredging Ltd.

Licence Area 512

- 9.1.15 Finds continue to be reported from Licence Area 512, including flint artefacts and faunal remains. The flints discovered in November 2019, although undiagnostic and not possible to link with a particular manufacturing process, indicate the potential for further discoveries. Although not providing the same concentration of artefacts as Licence Area 240, the Operational Sampling in Licence Area 512 continues to provide background information for the Palaeo-Yare region.
- 9.1.16 Previous Operational Sampling has been undertaken in the Kyanite, Ilmenite and Jasper areas, with minimal discoveries. Although, it was recommended in an Operational Sampling report (Wessex Archaeology 2020d) that Operational Sampling should come to an end in previously monitored locations of Licence Area 512, other Operational Sampling Reports (Wessex Archaeology 2020e and f) simply recommended that Operational Sampling be reconsidered.



9.1.17 The datasheet associated with the Marine Licence Palaeo-Yare Monitoring Method Statements (Wessex Archaeology 2016b) notes that the current rate of assessment (1 in 20 loads) should be maintained until four consecutive sample operations within a single dredge lane result in no recovered finds, in which case the Operational Sampling rate could be reduced to 1 in 40. It should be noted that all four of the most recent Operational Sampling events in Licence Area 511 have resulted in finds (either faunal or lithic) (Wessex Archaeology 2019h, 2020e, 2020f and forthcoming), and therefore does not meet the threshold for decreasing the frequency of assessment.

9.1.18 However, due to the relatively low archaeological significance of the finds being recovered, it is recommended that when the next Marine Licence Monitoring Method Statement is written, the recommended frequency be reviewed and the text amended to take into consideration the significance of the finds.

9.1.19 In addition, Operational Sampling should be implemented in any new dredge locations.

Licence Area 513/1

9.1.20 Faunal remains continue to be discovered in this area, highlighting the potential for further discoveries, as does the discovery of a flint tool. Although not providing the same concentration of artefacts as Licence Area 240, the Operational Sampling in Licence Area 513/1 continues to provide background information for the Palaeo-Yare region.

9.1.21 Operational Sampling has been undertaken in the Ampere, Beaufort, Celsius, Darwin and Einstein sub-areas.

9.1.22 Although an Operational Sampling report (Wessex Archaeology 2020d) recommended that Operational Sampling should come to an end in the previously monitored locations of Licence Area 513, the fact that finds were made during both of the Operational Sampling visits undertaken between 2015 and 2019 indicates that the threshold has not yet been met to reduce Operational Sampling to 1 in 40 loads, and it should be maintained at its current rate of 1 in 20 loads.

9.1.23 However, due to the relatively low archaeological significance of the finds being recovered, it is recommended that when the next Marine Licence Monitoring Method Statement is written, the recommended frequency be reviewed and the text amended to consider the significance of the discoveries.

9.1.24 In addition, any new dredging locations should undergo Operational Sampling.

Licence Area 212

9.1.25 Although Licence Area 212 did not produce any finds during Operational Sampling during this period, there have been previous discoveries, and the possible pockets of Unit 3b outliers remain and have some potential for further archaeological recovery. Therefore, further sampling is recommended for 3b sediments across the area.

Licence Area 242/361

9.1.26 The Operational Sampling in Licence Area 242/361 was undertaken in a bank feature of unknown age over Unit 3b and Unit 2b sediments. No archaeologically relevant material was discovered, however further Operational Sampling, particularly in the eastern area is recommended, as previous discoveries have included a mammoth tooth and mammal bone. There is still potential for archaeological discoveries in the Unit 3b sediments, and Operational Sampling should continue for dredging undertaken in these locations.



Licence Area 328 (now 242/361)

- 9.1.27 In Licence Area 328 Operation Sampling indicated that although the trackplot covered Unit 2 and Unit 3b sediments, the cargo comprised fine-grained sand that could not be sampled and no archaeological material was encountered. Licence Area 328 is now part of Licence Area 242/361 discussed above. Dredging in the vicinity of the pocket of Unit 3b sediment previously covered by Licence Area 328 should still undergo Operational Sampling when cargoes are dredged from this location.

Licence Area 401/2

- 9.1.28 In Licence Area 401/2 Operational Sampling in the north-eastern part of the licence area, in the Unit 3b deposits, revealed no artefacts over four visits. However, in the south-eastern part of licence area in apparently Unit 4 sediments, two mega faunal bone fragments were recovered. It is recommended that Licence Area 401/2 should continue to undergo Operational Sampling, particularly in the south-eastern part and in locations with Unit 3b sediments that have not previously been sampled.

Overarching Interpretative Assessment

- 9.1.29 A final recommendation is that to facilitate reporting on Operational Sampling, the Data Sheets (Sheet 1-8) should be updated on an annual basis. This will ensure that they are up-to-date references for the discoveries that have been made in each area. This is especially important in cases where the extent of the licence area has changed since publication of the dataset (for example Licence Area 242/361). The updates could coincide with the release of the Area Involved report published by The Crown Estate and BMAPA, or be undertaken at year end.

9.2 All New Dredge Lanes / Regional Potential

- 9.2.1 The dredging industry has worked hard to collectively provide important data for the process of archaeological assessment of the Palaeo-Yare catchment area, through ongoing vigilance and communication, and Operational Sampling events should continue take place across the region (in adherence with the WSI (Fjodr 2016)). However, this work should not just be limited to existing areas or sub-areas, but rather it is recommended that all new dredge lanes, especially those mapped with Unit 3b sediments should undergo Operational Sampling, irrespective of the aggregate final landing.
- 9.2.2 The finds from Bacton have demonstrated the potential for discoveries beyond the locations that have undergone Operational Sampling in the past and have indicated the need for a clearer and more joined up approach when utilising marine aggregates from a regional location containing such rich prehistoric potential. In addition to ensuring new dredge lanes undergo Operational Sampling, the forthcoming *Marine Archaeological Guidance for Beach Replenishment/Nourishment and Contract Fill Projects* (Wessex Archaeology forthcoming) will also provide further recommendations for these types of projects.

9.3 Operational Sampling Methodologies

- 9.3.1 With the introduction of Dagenham as a new wharf for Operational Sampling and the development of new procedures, it is possible to make more general recommendations to minimise operational constraints and facilitate archaeological assessment.
- 9.3.2 Relatively simple changes, such as spreading the oversize fraction thinner with the mechanical shovel means that archaeologists can inspect the cargo at a much faster pace. Having a designated driver minimises down time to request more aggregate for sampling and means that the archaeologists can get through the cargo more quickly.



- 9.3.3 Other improvements could include minimising the cross contamination of cargoes by ensuring cargoes are kept separate, and processing cargoes before archaeologists arrive on site.
- 9.3.4 An Operational Sampling report for Northfleet Wharf (Wessex Archaeology 2020e) recommended that following issues with cross contamination of the cargoes and a near miss, that the methodology of monitoring and the location utilised should be reviewed to ensure consistency of monitoring in a dynamic work environment.

9.4 The Protocol

- 9.4.1 Operational Sampling continues to be supported by discoveries made by wharf and vessel staff and reported through the Protocol. Indeed, the significant discoveries of archaeological finds and faunal remains during Operational Sampling visits in 2019 examining aggregate from Licence Area 240 came about because of aggregate staff recognising the significance of the initial discoveries. Therefore the Protocol should continue to be promoted, through company procedures, awareness visits and liaison between the Protocol Implementation Service and staff.
- 9.4.2 Even when discoveries reported through the Protocol do not lead to intensive Operational Sampling, they are still highly useful for contributing to the overall understanding of the East Coast region, and can be used to examine the WSI and test the hypotheses.

9.5 Post-fieldwork assessment/Publication

- 9.5.1 The results of the Operational Sampling undertaken for aggregate dredged from Licence Area 240 has revealed potential *in situ* Middle Palaeolithic material of high archaeological significance, within a northern European context. These results, and the further discoveries from Licence Area 240 in 2020 warrant further analysis and warrant publication in a peer-reviewed journal. This would also provide an opportunity to situate the discoveries within the wider understanding of the British and Continental Palaeolithic.
- 9.5.2 The potential *in situ* site likely in Licence Area 228 or 511, as revealed by the discoveries following the Bacton Beach Nourishment project, and currently being assessed by the British Museum also warrant further analysis and will likely warrant publication.
- 9.5.3 For the other licence areas, while the results of Operational Sampling have been of significance and warrant further analysis, the quantity of material recovered to date has been relatively slight. In consequence, any conclusions that could be drawn would be tentative, and would not necessarily further our knowledge of the hominin inhabitation of the region significantly. However, all of these discoveries contribute to the wider picture, and there may be a relationship to be explored, in terms of archaeology, geoarchaeology and/or methodologies with other investigations focussing on Palaeolithic material from the North Sea and beyond, including finds from Happisburgh and Clacton, as well as discoveries in terrestrial contexts.
- 9.5.4 Given the high significance of some of the finds recently discovered, and their relations to hotspots in the Palaeolithic landscape, there is a good case for an 'interim' academic publication as soon as possible. This would be a good opportunity to highlight the results to date and underline the proactive role that the aggregate sector has been playing for many years. The publication could summarise the contributions that have been made over many years to better understand the Pale-Yare in archaeological and geoarchaeological terms.



- 9.5.5 To make the work more broadly accessible to the general public, it is also suggested that the results could be made available online, for example in a format like a StoryMap. The StoryMap could highlight important discoveries and provide a general background, as well as providing locations of all of the discoveries.
- 9.5.6 In addition, it is recommended that, as with the previous Interpretation Report (Wessex Archaeology 2015a), this report should be uploaded to OASIS for archiving with the Archaeology Data Service (ADS), to ensure that the results achieved so far, and the significant investment that has been made in the project, are publicly available.



REFERENCES

Books and Reports

- Antoine P, Limondin-Lozouet N, Auguste P, et al. 2006. Le tuf de Caours (Somme, France): mise en évidence d'une séquence eemienne et d'un site paléolithique associé. *Quaternaire* 17: 281–320.
- Ashton, N. and Lewis, S., 2002. Deserted Britain: declining populations in the British Late Middle Pleistocene. *Antiquity* 76, 388–396.
- Ashton, N and Scott, B 2016 'The British Middle Palaeolithic' in *Quaternary International* 411. Pp 62-72.
- Ashton, N.M., Lewis, and S.G., Parfitt, S.A. (Eds.), 1998. Excavations at the Lower Palaeolithic site at East Farm, Barnham, Suffolk 1989–94. *British Museum Occasional Paper* 125, London.
- Ashton, N.M., Lewis, S.G., Parfitt, S., Candy, I., Keen, D.H., Kemp, R., Penkman, K., Thomas, G.N., and Whittaker, J.E., 2005. Excavations at the Lower Palaeolithic site at Elveden, Suffolk, UK. *Proceedings of the Prehistoric Society* 71, 1–61.
- Athurton, R S, Booth, S J, Morigi, A N, Abbott, M A W, Wood, C J, 1994 *Geology of the country around Great Yarmouth*, London: HMSO, pp 138.
- Boismier, W.A., Gamble, C., Coward, F. (eds.), 2012. *Neanderthals Among Mammoths: Excavations at Lynford Quarry, Norfolk*. English Heritage, Swindon, pp 529.
- BMAPA 2016 *The area involved – 18th annual report 2015*. The Crown Estate and Mineral Products Association. London.
https://www.bmapa.org/documents/BMAPA_18th_Annual_Report.pdf Accessed June 2021.
- BMAPA 2017 *The area involved – 19th annual report 2016*. The Crown Estate and Mineral Products Association. London.
https://www.bmapa.org/documents/BMAPA_19th_Annual_Report.pdf accessed June 2021.
- BMAPA 2018 *The area involved – 20th annual report 2017*. The Crown Estate and Mineral Products Association. London.
https://www.bmapa.org/documents/BMAPA_CE_20th_Ann_Rep_Aug18.pdf Accessed June 2021
- BMAPA 2019 *The area involved – 21st annual report 2018*. The Crown Estate and Mineral Products Association. London.
https://www.bmapa.org/documents/BMAPA_CE_21st_Ann_Rep_2019.pdf Accessed June 2021.
- BMAPA 2020 *The area involved – 22nd annual report 2019*. The Crown Estate and Mineral Products Association. London.
https://www.bmapa.org/documents/BMAPA_CE_22nd_Ann_Rep_2019.pdf Accessed June 2021.

- Cameron, T D J, Crosby, A, Balson, P S, Jeffery, D H, Lott, G K, Bulat, J, Harrison, D J 1992 *The geology of the southern North Sea, British Geological Survey, United Kingdom Offshore Report*, London, HMSO.
- Cook, J. and Jacobi, R. (1998a) Discoidal technology in the Palaeolithic at Oldbury, Kent. In: Ashton, N., Healy, F. and Pettitt, P. (eds.) *Stone age archaeology*. 124-36.
- Dinnis, R. (2012). The archaeology of Britain's first modern humans. *Antiquity*, 86(333), 627–641.
- English Heritage 1998 *Identifying and Protecting Palaeolithic Remains*.
- English Heritage and the Prehistoric Society 2008 *Research and Conservation Framework for the British Palaeolithic*.
- Firth, A 2011 'Submerged Prehistory in the North Sea', in Catsambis, A, Ford, B, and Hamilton, D (eds.), *The Oxford Handbook of Maritime Archaeology*. New York, Oxford University Press, pp. 786-808.
- Fjodr 2015 *Written Scheme of Investigations: Early Prehistoric Material in the Anglian Region*. Unpublished Report ver. 181215.
- Fjodr 2016 *Written Scheme of Investigations: Early Prehistoric Material in the Norfolk Block of the Anglian Region (Appendix I)*. Unpublished Report ver. 031016.
- Historic England 2018 *Sites of Early Human Activity: Scheduling Selection Guide*.
- Hosfield R 2011 'The British Lower Palaeolithic of the early Middle Pleistocene' in *Quaternary Science Reviews*. Vol. 30, issues 11-12, pp. 1486-1510.
- Jacobi, R.M. & Higham, T.F.G. 2011. The British Earlier Upper Palaeolithic: Settlement and Chronology. In: N. Ashton, S. Lewis & C. Stringer, eds. *The Ancient Human Occupation of Britain*. Amsterdam: Elsevier, pp. 181–222.
- Lewis, S G, Ashton, N, Field, M.H., Hoare, P.G., Kamermans, H., Knul, M., Mùcher, H.J., Parfitt, S.A., Roebroeks, W., and Sier, M.J. 2019 'Human occupation of northern Europe in MIS 13: Happisburgh Site 1 (Norfolk, UK) and its European Context. *Quaternary Science Reviews*. Volume 211. Pg. 34-58.
- Limpenny, S E, Barrio-Froján, C, Cotterill, C, Foster-Smith, R L, Pearce, B, Tizzard, L, Limpenny, D, L, Long, D, Walmsley, S, Kirby, S, Baker, K, Meadows, W J, Rees, J, Hill, J, Wilson, C, Leivers, M, Churchley, S, Russell, J, Pacitto, S, and Law, R, 2011 *The East Coast Regional Environmental Characterisation*. Cefas Open Report 08/04
- Locht, J.-L., Herisson, D., Goval, E., Cliquet, D., Huet, B., Coutard, S., Antoine, P., and Feray, P.: Timescales, space and culture during the Middle Palaeolithic in northwestern France, *Quatern. Int.*, 411, 129–148, <https://doi.org/10.1016/j.quaint.2015.07.053>, 2016.
- Marshall, P 2020 'Seeing beneath the sea – Palaeolithic finds from Aggregate Area 240' in Marshall *et. al.* eds *Scientific Dating of Pleistocene Sites: Guidelines for Best Practice*. Consultation Draft p. 29.
- Marshall, P., Bayliss, A., Grant, M., Bridgland, D.R., Duller, G., Housley, R., Matthews, I., Outram, Z., Penkman, K.E.H., Pike, A., Schreve, D. and Xuan, C. 2020 *Scientific dating of Pleistocene sites: guidelines for best practice*. Consultation Draft.
-



- Moncel M-H, Ashton N, Arzarello M, Fontana F, Lamotte A, Scott B, Muttillio B, Berruti B, Nenzioni G, Tuffreau A, and Peretto C (2020) An Early Levallois core technology between MIS 12 and 9 in Western Europe? *J Hum Evol* 139
- Moorlock, B S P, Hamblin, R J O, Booth, S J, Morigi A N, 2000 *Geology of the Country around Lowestoft and Saxmundham*, London: HMSO, p 114.
- Parfitt, S A, Barendregt, R W, Breda, M, Candy, I, Collins, M J, Coope, G R, Durbidge, P, Field, M, H, Lee, J R, Lister, A M, Mutch, R, Penkman, K E H, Preece, R, Rose, J, Stringer, C B, Symmons, R, Whittaker, J E, Wymer J J and Stuart, A J, 2005 The earliest record of human activity in northern Europe, *Nature* 438:1008-1012.
- Parfitt, S A, Aston, N M, Lewis, S G, Abel, R L, Cooper, G R, Field, M H, Gale, R, Hoare, P G, Larkin, N R, Lewis, M D, Karloukovski, V, Maher, B A, Peglar, S M, Preece, R C, Whittaker, J E and Stringer, C B 'Early Pleistocene human occupation at the edge of the boreal zone in northwest Europe. *Nature* Volume 466. 2010. Pg. 229-233.
- Peeters, H, Murphy, P and Flemming, N, (eds.) 2009 *North Sea Prehistory Research and Management Framework*.
- Pettitt, P, and White, M 2012 *The British Palaeolithic: Human Societies at the Edge of the Pleistocene World*. Routledge, Oxon.
- Preece, R.C., Gowlett, J.A.J., Parfitt, S.A., Bridgland, D.R., Lewis, S.G., 2006. Humans in the Hoxnian: habitat, context and fire use at Beeches Pit, West Stow, Suffolk, UK. *J. Quaternary Sci.* 21, 485e496
- Ransley, J, Sturt, F, Dix, J, Adams, J, and Blue, L (Eds) 2013 *People and the Sea: A Maritime Archaeological Research Agenda for England*. (Research Reports No 171). York, GB: Council for British Archaeology.
- Roe, D. A. (1968). British Lower and Middle Palaeolithic handaxe groups. *Proceedings of the Prehistoric Society* 34, 1–82.
- Roebroeks W, De Loecker D, Hennekens P, van Ieperen M (1992) "A veil of stones": On the interpretation of an early Middle Palaeolithic low-density scatter at Maastricht-Belvédère (The Netherlands). *Analecta Praehistorica Leidensia* 25:1
- Royal HaskoningDHV 2018 *Bacton to Walcott Coastal Management Scheme: Environmental Statement*. Reference I&BOB5925R001F0.1.
- Scott, B 2011 *Becoming Neanderthals: The Earlier British Middle Palaeolithic*. Oxbow: Oxford.
- Scott B, and Ashton N. 2011. The Early Middle Palaeolithic: The European Context. In *The Ancient Human Occupation of Britain*, Volume 14, Ashton NM, Lewis SG, Stringer CB (eds). Elsevier: Amsterdam; 91– 112.
- Shaw, A., Bates, M., Conneller, C., Gamble, C., Julien, M.-A., McNabb, J., et al. 2016. The archaeology of persistent places: The Palaeolithic case of La Cotte de St Brelade, Jersey. *Antiquity. A Quarterly Review of Archaeology*, 90(354), 1437–1453.
- Soressi, M., 2002. Le Moustérien de tradition acheuléenne du sud-ouest de la France. Discussion sur la signification du faciès à partir de l'étude comparée de quatre sites: Pech-de-l'Azé I,



Le Moustier, La Rochette et la Grotte XVI. Thèse de doctorat, Université Bordeaux 1, Talence.

- Stoker, M S, Balson, P S, Long, D, and Tappin, D R. 2011. *An overview of the lithostratigraphical framework for the Quaternary deposits on the United Kingdom continental shelf*. British Geological Survey Research Report, RR/11/03. 48pp.
- The Crown Estate 2019 *Marine Aggregates: Capability and Portfolio 2019*. London. <https://www.thecrownestate.co.uk/media/3502/2019-capability-and-portfolio-report.pdf>
- The Crown Estate and BMAPA 2018 *Marine Aggregate Dredging 1998-2017 a twenty-year review*. London. <https://www.thecrownestate.co.uk/media/2870/marine-aggregate-dredging-1998-2017-a-twenty-year-review.pdf>
- The Crown Estate and BMAPA 2020 *The area involved – 22nd Annual Report: Marine Extraction 2019*. London. <https://www.thecrownestate.co.uk/media/3530/2019-area-involved-report.pdf>
- The Prehistoric Society and English Heritage 2008 *Research and Conservation Framework for the British Palaeolithic*.
- Tizzard, L, Benjamin, J, De Loecker, D, 2014 'A Middle Palaeolithic site in the southern North Sea: Investigating the archaeology and palaeogeography of Area 240' in *Journal of Quaternary Science* 29 (7): 698-710.
- Tizzard, L, Bicket, A, De Loecker D, 2015 *Seabed Prehistory: Investigating the Palaeogeography and Early Middle Palaeolithic Archaeology in the Southern North Sea, Wessex Archaeology Monograph 35*. Internal reference 70757.
- Tuffreau, A., 1993. Riencourt-de-Calais). Un gisement du Pale'olithique moyen. *Documents d'Arche'ologie Française* 37. Maison des Sciences de l'Homme, Paris.
- Turq, A., 1989. Approche technologique et economique du faci es Mousterien de type Quina: etude pr eliminaire. *Bulletin de la Societe Prehistorique Française*. 86, 244e256.
- Turq, A, Faivre, JP, Gravina, B, Bourguignon, L 2017 'Building models of Neanderthal territories from raw material transports in the Aquitaine Basin (southwestern France). In *Quaternary International*, Elsevier 433. pp 88-101.
- Ward, I, Larcombe, P, Firth A and Manders, M, 2014 'Practical Approaches to Management of the Marine Environment' *Netherlands Journal of Geosciences*, 93, pp 71-82.
- Wenban Smith, F F, Bates, M and Schwenninger J L, 2010 Early Devensian (MIS 5d-5b) occupation at Dartford, southeast England, *Antiquity*.
- Wessex Archaeology 2011a *Seabed Prehistory: Site evaluation techniques (Area 240) – Synthesis*, Unpublished Report, ref: 70754.04.
- Wessex Archaeology 2011b *Licence Area 240 Archaeological Monitoring of Dredging Activity*, Unpublished Report, WA ref: 77860.02.
- Wessex Archaeology 2013a *Palaeo-Yare Catchment Technical Report*. Unpublished report ref. 83740.04.



- Wessex Archaeology 2013b *Palaeo-Yare Catchment Assessment Addendum Report Short-Term Licence Areas*. Unpublished report ref. 83740.05.
- Wessex Archaeology 2014a *Licence Area 240 Archaeological Mitigation: Frindsbury Wharf Operational Sampling*. Unpublished Report. Internal reference: 77860.13. June 2014.
- Wessex Archaeology 2014b *Licence Area 401/2: Archaeological Mitigation: Frindsbury Wharf Operational Sampling*. Unpublished Report. Internal reference: 77860.14.
- Wessex Archaeology 2014c *Licence Area 401/2: Archaeological Mitigation: Frindsbury Wharf Operational Sampling*. Unpublished Report. Internal reference: 77860.15.
- Wessex Archaeology 2014d *Licence Area 511: Archaeological Mitigation: Northfleet Wharf Operational Sampling*. Unpublished Report. Internal reference: 88251.03.
- Wessex Archaeology 2014e *Licence Area 513/1: Archaeological Mitigation: Northfleet Wharf Operational Sampling*. Unpublished Report. Internal reference: 88251.02.
- Wessex Archaeology 2015a *Palaeo-Yare Operational Sampling conducted under the short-term licensing provisional Written Scheme of Investigation: Interpretive Report*. Unpublished report ref. 83742.01.
- Wessex Archaeology 2015b *Licence Area 212: Archaeological Mitigation: Frindsbury Wharf Operational Sampling*. Unpublished Report. Internal reference: 77860.07.
- Wessex Archaeology 2015c *Licence Area 240: Archaeological Mitigation: Frindsbury Wharf Operational Sampling*. Unpublished Report. Internal reference: 77860.19.
- Wessex Archaeology 2015d *Licence Area 240: Archaeological Mitigation: Frindsbury Wharf Operational Sampling*. Unpublished Report. Internal reference: 77860.20.
- Wessex Archaeology 2015e *Licence Area 240: Archaeological Mitigation: Frindsbury Wharf Operational Sampling*. Unpublished Report. Internal reference: 77860.21.
- Wessex Archaeology 2015f *Licence Area 240: Archaeological Mitigation: Frindsbury Wharf Operational Sampling*. Unpublished Report. Internal reference: 77860.22.
- Wessex Archaeology 2015g *Licence Area 328: Archaeological Mitigation: Frindsbury Wharf Operational Sampling*. Unpublished Report. Internal reference: 77860.16.
- Wessex Archaeology 2015h *Licence Area 401/2: Archaeological Mitigation: Frindsbury Wharf Operational Sampling*. Unpublished Report. Internal reference: 77860.18. May 2015.
- Wessex Archaeology 2015h *Licence Area 401/2: Archaeological Mitigation: Frindsbury Wharf Operational Sampling*. Unpublished Report. Internal reference: 77860.23. December 2015.
- Wessex Archaeology 2015j *Licence Area 511: Archaeological Mitigation: Northfleet Wharf Operational Sampling*. Unpublished Report. Internal reference: 88251.05.
- Wessex Archaeology 2015k *Licence Area 512: Archaeological Mitigation: Northfleet Wharf Operational Sampling*. Unpublished Report. Internal reference: 88251.04.



- Wessex Archaeology 2016a *Licence Areas 212, 240, 242, 361 and 401/2: Monitoring Method Statements*. Version 77860.17 30/08/16 for HAML.
- Wessex Archaeology 2016b *Marine Licence L/2014/00028 (Areas 511, 512, 513/1 and 513/2): PalaeoYare Monitoring Method Statements* Version 88251.2 30/08/16 for CEMEX
- Wessex Archaeology 2016c *Licence Area 296 and 494: Monitoring Method Statements*. Version 88270.06 30/08/16 for Tarmac.
- Wessex Archaeology 2016d *Licence Area 512: Archaeological Mitigation: Northfleet Wharf Operational Sampling*. Unpublished Report. Internal reference: 88252.01. December 2016.
- Wessex Archaeology 2017a *Licence Area 494: Monitoring Method Statement*. Version 88270.07 17/01/17 for Tarmac.
- Wessex Archaeology 2017b *Licence Area 240: Archaeological Mitigation: Frindsbury Wharf Operational Sampling*. Unpublished Report. Internal reference: 77861.01. November 2017.
- Wessex Archaeology 2017c *Licence Area 511: Archaeological Mitigation: Northfleet Wharf Operational Sampling*. Unpublished Report. Internal reference: 88252.03. November 2017.
- Wessex Archaeology 2017d *Licence Area 513/1: Archaeological Mitigation: Northfleet Wharf Operational Sampling*. Unpublished Report. Internal reference: 88252.02. August 2017.
- Wessex Archaeology 2018a *Licence Area 242/361: Archaeological Mitigation: Frindsbury Wharf Operational Sampling*. Unpublished Report. Internal reference: 77861.02. July 2018.
- Wessex Archaeology 2018b *Licence Area 511: Archaeological Mitigation: Northfleet Wharf Operational Sampling*. Unpublished Report. Internal reference: 88252.04. June 2018.
- Wessex Archaeology 2018c *Licence Area 512: Archaeological Mitigation: Northfleet Wharf Operational Sampling*. Unpublished Report. Internal reference: 88252.05. September 2018.
- Wessex Archaeology 2019a *Licence Area 240 and 401/2: Archaeological Mitigation: Frindsbury Wharf Operational Sampling*. Unpublished Report. Internal reference: 220700.01. May 2019.
- Wessex Archaeology 2019b *Licence Area 240: Archaeological Mitigation: Frindsbury Wharf Operational Sampling*. Unpublished Report. Internal reference: 220700.02. July 2019.
- Wessex Archaeology 2019c *Licence Area 240: Archaeological Mitigation: Frindsbury Wharf Operational Sampling*. Unpublished Report. Internal reference: 220700.04. August 2019.
- Wessex Archaeology 2019d *Hanson East Coast Licence Wharf Monitoring: Frindsbury Wharf Operational Sampling*. Unpublished Report. Internal reference: 220700.05. November 2019.
- Wessex Archaeology 2019e *Hanson East Coast Licence Wharf Monitoring: Dagenham Wharf Operational Sampling*. Unpublished Report. Internal reference: 220700.06. February 2020.
-



- Wessex Archaeology 2019f *Licence Area 512: Archaeological Mitigation: Northfleet Wharf Operational Sampling*. Unpublished Report. Internal reference: 88252.06. December 2019.
- Wessex Archaeology 2019g *Bacton Beach Nourishment Norfolk: Results of Walkover Survey and Archaeological Protocol Reporting*. Internal reference: 223720.02.
- Wessex Archaeology 2019h *Licence Area 512: Archaeological Mitigation: Northfleet Wharf Operational Sampling*. Unpublished Report. Internal reference: 88252.06. December 2019. Wessex Archaeology 2020a *Palaeo-Yare Catchment: Geoarchaeological Assessment of Marine Aggregates Licence Areas 212,240, 242/361 and 401/2*. Internal reference: 220701.01.
- Wessex Archaeology 2020b *Palaeo-Yare Catchment: Geoarchaeological Assessment of Marine Aggregates Licence Areas 511, 512, 513/1 and 513/2*. Internal reference: 233240.
- Wessex Archaeology 2020c *Review of Data from the Bacton Beach Nourishment Project: Archaeological Assessment*. Unpublished Report. Internal reference: 226020.01. June 2020.
- Wessex Archaeology 2020d *Licence Area 511: Archaeological Mitigation: Northfleet Wharf Operational Sampling*. Unpublished Report. Internal reference: 88252.07. March 2020.
- Wessex Archaeology 2020e *Licence Area 512: Archaeological Mitigation: Northfleet Wharf Operational Sampling*. Unpublished Report. Internal reference: 88252.08. August 2020. Wessex Archaeology 2020f *Licence Area 512: Archaeological Mitigation: Northfleet Wharf Operational Sampling*. Unpublished Report. Internal reference: 88252.10. November 2020.
- Westley, K, and Bailey, G., 2013 'Palaeolithic' in *People and the Sea A Maritime Research Agenda for England* (Ransley et. al. 2013).
- White MJ, Jacobi RM. 2002. Two sides to every story: bout coupe´ handaxes revisited. *Oxford Journal of Archaeology* 21: 109–133.
- White, M, Scott, B, Ashton, N 2006 'The Early Middle Palaeolithic in Britain: archaeology, settlement history and behaviour' in *Journal of Quaternary Science* 2006. 21 (5) 525-541.
- Wymer, J 1999 *The Lower Palaeolithic Occupation of Britain*. Volume 1 and 2. Wessex Archaeology and English Heritage.

Websites

- Bacton to Walcott Coastal Management: <https://www.north-norfolk.gov.uk/sandscaping> accessed 24/03/2020.



APPENDICES

Appendix 1: Gazetteer of discoveries

Note: discoveries **2145** to **2260** were reported on in the previous interpretative report (Wessex Archaeology 2015a), however they have been included here for reference.

Discoveries **2261** to **2462** relate to Operational Sampling events undertaken from January 2015 to December 2019.

Find ID	Licence Area	Description	UTM31N Easting	UTM31N Northing	Location description	Report Number
2207	240	Mixed wharf. Large, mainly cortical flake, unpatinated, unstained, 3 points of impact, hard, slightly rolled, 1 inverse removal; dubious piece primarily thermal and stained but with three negative alternate removals (probably regard as reject)	426312	5821970	Approximate position: mixed load from transect 1A and 1B	77860.02
2208	240	Mixed. Cordiform on flake blank, ventral surface flaked sufficient to thin butt, dorsal covering flaking, lightly stained, sharp, 135x95x39mm	426312	5821970	Approximate position: mixed load from transect 1A and 1B	77860.02
2209	240	Mixed. Large tertiary flake, hard hammer, plain butt, lightly stained, partially radial flake scars, possibly from Levallois flake core. 95x107x19mm	426312	5821970	Approximate position: mixed load from transect 1A and 1B	77860.02
2210	240	Mixed. Large primary flake, unpatinated/unstained, mint/sharp, could be modern on condition but included due to well-placed point of impact 137x106x37mm	426312	5821970	Approximate position: mixed load from transect 1A and 1B	77860.02
2211	240	Trip 1 mixed Large flake, stained, sharp/slightly rolled, some modern edge damage. 102x103x23 mm	426312	5821970	Approximate position: mixed load from transect 1A and 1B	77860.02
2212	240	Mixed. 1 large primary flake, thermal dorsal surface, cortical butt, stained, slightly rolled/rolled	426312	5821970	Approximate position: mixed load from transect 1A and 1B	77860.02
2213	240	Mixed. Stained secondary, hard hammer struck flake, slightly rolled/rolled, cortical butt, clumsy crushed impact 86x82x23mm	426312	5821970	Approximate position: mixed load from transect 1A and 1B	77860.02
2214	240	Mixed (wharf). Handaxe with plano-convex cross section, probably made on flake. Both sides with covering flaking. Lightly stained, slightly rolled, tip absent. 113x80x23mm	426312	5821970	Approximate position: mixed load from transect 1A and 1B	77860.02
2215	240	Mixed wharf. Core fragment with a pot lid fracture, but with relict flake scars (2 deeply invasive and 1 alternate) that are rolled suggesting the recently formed pot lid may have come from a humanly modified block.	426312	5821970	Approximate position: mixed load from transect 1A and 1B	77860.02
2216	240	1 tertiary flake, punctiform butt, possibly natural; rolled secondary flake, butt damaged, rolled, stained, distal part broken; tertiary flake, cortical butt, lightly rolled/rolled, lightly patinated.	426312	5821970	Centrepoint of track 1B	77860.02
2217	240	Mixed wharf. Large tertiary flake, stained, slightly rolled/rolled, plain butt, uncertain mode, from flake core 77x114x55mm	426391	5821942	Approximate position: mixed load from transect 2A and 2B	77860.02
2218	240	Mixed wharf. Large primary hard hammer struck flake, rolled stained, plain butt 97x112x21mm	426391	5821942	Approximate position: mixed load from transect 2A and 2B	77860.02
2219	240	Flake linear butt, mint ventral, unpatinated, unstained, modern; broken thinning/shaping flake, opposed scars, linear butt	424933	5820703	Centrepoint of track 2A	77860.02
2220	240	Both flakes might be anthropogenic	426391	5821942	Centrepoint of track 2B	77860.02
2221	240	Large hard hammer secondary flake. Possibly represents a stage of handaxe roughing out/shaping. 3 unidirectional flake scars. Good flint, unstained, slightly rolled, unpatinated. Plain butt, no preparation	424944	5820639	Centrepoint of track 4A	77860.02
2222	240	Mixed oversize pile. Handaxe. Ovate/cordiform. Tip absent, well executed bifacial covering flaking, lightly stained, sharp, 87x92x23mm	426978	5823332	Approximate position: mixed load from transect 5A and 5B	77860.02
2223	240	Bulk. Tertiary, slightly rolled, lightly stained, no preparation, possible signs of soft percussion	425017	5820908	Centrepoint of track 5A	77860.02
2224	240	Broken hard hammer secondary flake, light differential staining, sharp. Unidirectional flaking, plain butt 68x57x22mm; rolled primary flake, probably collision	426978	5823332	Centrepoint of track 5B	77860.02
2225	240	Broken flake thermal dorsal, unconvincing butt, probable accidental impact; Flake stained sharp, opposing dorsal scar patterns; flake stained sharp clear butt, hinged distal end	424979	5820780	Centrepoint of track 7A	77860.02
2226	240	Broken flake matt, near mint, smashed butt, accident; lightly stained flake, butt unclear, transverse dorsal scars may be anthropogenic; rolled flake with parallel flaking scars lightly patinated. Possibly represents handaxe thinning	426632	5822423	Centrepoint of track 7B	77860.02
2227	240	Faceted butt, sharp, lightly patinated, hard, dist tip absent but almost certainly blade, possibly retouched	425915	5822227	Centrepoint of track 8B	77860.02
2228	296	One piece of animal bone: a fragment of probable red deer antler	430790	5832560	Centrepoint of operational sampling dredge tracks	88270.01
2229	240	Flake, 77.6 mm long. This piece is relatively undiagnostic - it could derive from either a core or core tool manufacture. More recent damage has removed most of the butt. The condition suggests that it is not from an undisturbed context.	424850	5820830	Centrepoint of operational sampling dredge tracks (May 2012)	77860.04
2230	240	Thick secondary flake, 67.3 mm long, with abrupt retouch and crushing (from use rather than subsequent damage). It originates from core preparation or maintenance. The condition indicates that it is not from an undisturbed context, but is unlikely to have undergone much disturbance.	424850	5820830	Centrepoint of operational sampling dredge tracks (May 2012)	77860.04
2231	240	Animal bone: distal end of cattle metacarpal. The size suggests it comes from a relatively recent (as opposed to prehistoric) animal.	424850	5820830	Centrepoint of operational sampling dredge tracks (May 2012)	77860.04
2232	319	Flake. Iron-stained tertiary flake struck with a hard hammer, almost certainly Lower Palaeolithic. Likely from a derived context.	422950	5821540	Centrepoint of operational sampling dredge tracks	88250.02
2233	319	Flake. Hard-hammer struck tertiary flake with considerable surface gloss but no iron staining. It appears to have been struck from a flake core, and is probably Holocene. Likely recovered in situ.	422950	5821540	Centrepoint of operational sampling dredge tracks	88250.02



2234	319	Flake. Thermal flake with direct semi-abrupt concave retouch on one end. The piece appears relatively fresh, and is undoubtedly Holocene. Likely recovered in situ.	422950	5821540	Centrepoin of operational sampling dredge tracks	88250.02
2235	319	Mammoth tooth	422950	5821540	Centrepoin of operational sampling dredge tracks	88250.02
2236	319	Distal end of red deer humerus	422950	5821540	Centrepoin of operational sampling dredge tracks	88250.02
2237	251	Large scraper made on a secondary flake. It could be Lower Palaeolithic. It appears to have not undergone any substantial post-depositional effects, and was probably in situ.	429812	5818604	Centrepoin of operational sampling dredge tracks	88250.03
2238	296	One piece of animal bone: a fragment of an unidentifiable large mammal	430871	5832625	Centrepoin of operational sampling dredge tracks	88270.02
2239	296	A single auroch's tooth	430871	5832625	Centrepoin of operational sampling dredge tracks	88270.02
2240	360	Antler. Nine pieces of antler	433910	5823120	Centrepoin of operational sampling dredge tracks	88250.04
2240	360	Large mammal bone - three pieces.	433910	5823120	Centrepoin of operational sampling dredge tracks	88250.04
2240	360	Mammal bone - four pieces	433910	5823120	Centrepoin of operational sampling dredge tracks	88250.04
2240	360	Bone. Post-medieval cattle distal tibia.	433910	5823120	Centrepoin of operational sampling dredge tracks	88250.04
2241	319	Large mammal bone.	422790	5821620	Centrepoin of operational sampling dredge tracks	88250.05
2242	319	Red deer antler	422790	5821620	Centrepoin of operational sampling dredge tracks	88250.05
2243	240	Large Levallois point, of a type that generally belongs to the Early Middle Palaeolithic	425110	5820840	Centrepoin of operational sampling dredge tracks	77860.05
2244	240	Large bipolar blade core, likely Upper Palaeolithic, perhaps Creswellian	425110	5820840	Centrepoin of operational sampling dredge tracks	77860.05
2245	240	Mammoth tooth	425110	5820840	Centrepoin of operational sampling dredge tracks	77860.05
2245	240	Fragment of rib from an unidentified (but probably mammoth sized) large animal	425110	5820840	Centrepoin of operational sampling dredge tracks	77860.05
2245	240	Fragment of red deer or cattle scapula	425110	5820840	Centrepoin of operational sampling dredge tracks	77860.05
2245	240	Fragment of red deer antler	425110	5820840	Centrepoin of operational sampling dredge tracks	77860.05
2246	240	Lithic - large tertiary flake of Levallois type. The piece is very fresh, with unabraded ridges, indicating that it had no suffered any significant post-depositional effects prior to dredging and was undoubtedly in situ. The type generally belongs in the Early Middle Palaeolithic.	424990	5820800	Centrepoin of operational sampling dredge tracks	77860.06
2247	240	Mammoth tooth	424990	5820800	Centrepoin of operational sampling dredge tracks	77860.06
2248	242-361	Mammoth tooth	437880	5821900	Centrepoin of operational sampling dredge tracks	77860.07
2248	242-361	Five fragments of large mammal bone, most of which were abraded and/or mineralised.	437880	5821900	Centrepoin of operational sampling dredge tracks	77860.07
2249	212	Flake, Levallois flake with a 'chapeaux de gendarme' butt, showing considerable patina and signs of rolling.	432520	5831000	Centrepoin of operational sampling dredge tracks	77860.08
2250	212	Flake, Levallois flake that shows relatively little damage and has signs of convergent flaking technique	432520	5831000	Centrepoin of operational sampling dredge tracks	77860.08
2251	212	Mammoth tooth	432520	5831000	Centrepoin of operational sampling dredge tracks	77860.08
2252	240	Flake, appears to be a flake from a flint axe, its shape indicating a possible Middle Palaeolithic date. The flake is relatively fresh with only some signs of rolling.	425193	5821222	Centrepoin of operational sampling dredge tracks	77860.11
2253	251	Fragment of cattle or red deer pelvis.	428831	5818622	Centrepoin of operational sampling dredge tracks	88250.07
2254	513/1	One vertebra of very large mammal (probably mammoth or possibly whale). These were very highly mineralised.	433455	5822740	Centrepoin of operational sampling dredge tracks	88251.02
2255	513/1	Unidentified large mammalian bone. These were very highly mineralised.	433455	5822740	Centrepoin of operational sampling dredge tracks	88251.02
2256	513/1	Unidentified large mammalian bone. These were very highly mineralised.	433455	5822740	Centrepoin of operational sampling dredge tracks	88251.02
2257	513/1	Flint. Single piece of struck flint, probably a fragment of a bi-polar blade core. No platforms survive, and there is some gloss and patina. It was not possible to date the object.	433455	5822740	Centrepoin of operational sampling dredge tracks	88251.02
2258	228	Flake: a large secondary flake from a relatively early stage in the construction sequence. The piece is very rolled, patinated and worn, and there is some more recent damage. The ventral surface retains its original surface only in patches, but these bear regular ripple marks, suggesting a deliberate rather than accidental removal.	428753	5822243	Centrepoin of operational sampling dredge tracks	88330.07
2259	228	Flake: a tertiary flake with three flake scars on the dorsal surface, all struck from the same direction. The flake is very rolled and patinated. It appears to have been struck with a hard hammer.	428753	5822243	Centrepoin of operational sampling dredge tracks	88330.07
2260	228	Single piece of mineralised antler, probably from a red deer	428753	5822243	Centrepoin of operational sampling dredge tracks	88330.07
2261	511	Portion of mammoth tooth	422896	5822459	Centrepoin of dredging trackplot	88251.03
2262	511	Fragment of probably mammoth rib	422896	5822459	Centrepoin of dredging trackplot	88251.03
2263	511	Part of proximal shaft of the radius of a large mammal	422896	5822459	Centrepoin of dredging trackplot	88251.03
2264	511	One part of a sheep tibia	422896	5822459	Centrepoin of dredging trackplot	88251.03
2265	240	Bone of an unidentifiable large mammal.	426274	5823332	Approximate position	77860.19
2266	512	Portion of a large blade of apparent Upper Palaeolithic date. The piece is broken and somewhat worn, suggesting that it was not in situ.	429495	5818389	Centrepoin of dredging trackplot	88251.04
2267	511	Portion of a tibia from a large Quaternary mammal	422970.5	5821370.506	Centrepoin of operational sampling dredge tracks	88251.05
2268	511	Red deer metatarsal	422970.5	5821370.506	Centrepoin of operational sampling dredge tracks	88251.05
2269	511	fragment of pelvis from a large mammal	422970.5	5821370.506	Centrepoin of operational sampling dredge tracks	88251.05
2270	511	Unidentified large mammal bone fragment	422970.5	5821370.506	Centrepoin of operational sampling dredge tracks	88251.05
2271	511	Unidentified large mammal bone fragment	422970.5	5821370.506	Centrepoin of operational sampling dredge tracks	88251.05
2272	511	Two pieces of red deer antler	422970.5	5821370.506	Centrepoin of operational sampling dredge tracks	88251.05
2273	511	Relatively modern cattle tibia	422970.5	5821370.506	Centrepoin of operational sampling dredge tracks	88251.05
2274	512	Portion of a distal radius shaft, possibly from an auroch	429111.59	5819564.013	Centrepoin of dredging trackplot	88252.01
2275	512	Heavily mineralised bone of too small a sample to be identified	429111.59	5819564.013	Centrepoin of dredging trackplot	88252.01
2276	512	Heavily mineralised bone, possibly part of the ilium of a large mammal	429111.59	5819564.013	Centrepoin of dredging trackplot	88252.01
2277	512	Heavily mineralised and abraded long bone shaft fragment of a large animal	429111.59	5819564.013	Centrepoin of dredging trackplot	88252.01
2278	240	Fragment of unidentified animal bone, possibly of Lower Palaeolithic date.	425839	5822486	Approximate centrepoin of dredging trackplot.	77861
2279	240	Fragment of wood of relatively modern date.	425839	5822486	Approximate centrepoin of dredging trackplot.	77861
2280	513/1	Heavily mineralised faunal remains. Fragments were too small for identification. (The antler is recorded as Plate 2).	433822.76	5823231.441	Centrepoin of dredging trackplot	88252.02



2281	513/1	Heavily mineralised fragment of the base of an antler	433822.76	5823231.441	Centrepoin of dredging trackplot	88252.02
2282	513/1	Wood fragments. Heavily mineralised, some pieces of coal were present.	433822.76	5823231.441	Centrepoin of dredging trackplot	88252.02
2283	513/1	Wood fragments. Not mineralised, and believed to be recent.	433822.76	5823231.441	Centrepoin of dredging trackplot	88252.02
2284	511	Two pieces of ships coal	423448.56	5821174.272	Centrepoin of dredging trackplot	88252.03
2285	511	Fifteen fragments of faunal remains. The remains recovered were of varying levels of mineralisation, with some so heavily mineralised, they took on the appearance of stone. All fragments were too small to be identified to species level. Two fragments were identified as mineralised antler: one appeared to be the laminated outer layer of an antler while the other is a fragment of a base.	423448.56	5821174.272	Centrepoin of dredging trackplot	88252.03
2286	511	Three pieces of wood were recovered.	423448.56	5821174.272	Centrepoin of dredging trackplot	88252.03
2287	511	Seven pieces of stone were recovered. One comprised a possible flint core that may have been used to make small flint blades. Two rounded stones may have been stone shots or cannonballs, or alternatively could have been rolled on the seabed into a naturally rounded shape. Other stones were recovered due to having holes, and may have comprised fishing weights, but may also have been natural.	423448.56	5821174.272	Centrepoin of dredging trackplot	88252.03
2288	511	Two small pieces of smelting waste or slag were recovered. The slag remains undated.	423448.56	5821174.272	Centrepoin of dredging trackplot	88252.03
2289	511	4 flints including 2 flakes	424064.45	5821836.896	Centrepoin of dredging trackplot	88252.04
2290	511	17 fragments of mammoth teeth.	424064.45	5821836.896	Centrepoin of dredging trackplot	88252.04
2291	511	2 unidentified herbivore teeth	424064.45	5821836.896	Centrepoin of dredging trackplot	88252.04
2292	511	1 unidentified horn	424064.45	5821836.896	Centrepoin of dredging trackplot	88252.04
2293	511	13 unidentified animal bone	424064.45	5821836.896	Centrepoin of dredging trackplot	88252.04
2294	511	10 wood fragments	424064.45	5821836.896	Centrepoin of dredging trackplot	88252.04
2295	512	Circular fragment, flange off the end of a hot air plug from an aircraft.	430166.86	5819142.92	Centrepoin of dredging trackplot	88252.05
2296	512	Fragment of wooden plank in an advanced state of deterioration which prevented identification of its original shape.	430166.86	5819142.92	Centrepoin of dredging trackplot	88252.05
2297	512	Fragment of thin wooden plank. Probably deck planking.	430166.86	5819142.92	Centrepoin of dredging trackplot	88252.05
2298	512	Fragment of fossilised bone. The fragment was too small to identify which species it came from.	430166.86	5819142.92	Centrepoin of dredging trackplot	88252.05
2299	512	Piece of coal	430166.86	5819142.92	Centrepoin of dredging trackplot	88252.05
2300	512	Fragment of slag	430166.86	5819142.92	Centrepoin of dredging trackplot	88252.05
2301	401/2	Fragment of megafauna bone. This one is a fragment of proximal end of tibia	442861	5817311	Approximate centrepoin of dredging trackplot.	220700.01
2302	401/2	Fragments of bone. Proximal end of a tibia from megafauna, the exact species is unknown	442861	5817311	Centrepoin of dredging trackplot	220700.01
2303	240	The handaxe is small (maximum length = 109.7 mm; maximum width = 76.5 mm; maximum thickness is 18.0 mm). Late Middle Palaeolithic in date	425796.90	5822619.22	Approximate centrepoin of dredging trackplot.	220700.02
2304	240	Butt fragment of a Palaeolithic handaxe, 91.6 mm, maximum width 79.5 mm, maximum thickness 30.3 mm. Due to the extensive damage to this worked flint, only the butt end of the possible handaxe is visible.	425944.15	5822625.62	Approximate centrepoin of dredging trackplot.	220700.04
2305	240	Cordiform 'heart shaped' handaxe	426205	5822501	Approximate centrepoin of dredging trackplot.	220700.05
2306	240	Large handaxe roughout	426205	5822501	Approximate centrepoin of dredging trackplot.	220700.05
2307	240	Large broken flake	426205	5822501	Approximate centrepoin of dredging trackplot.	220700.05
2308	240	Broken flake	426205	5822501	Approximate centrepoin of dredging trackplot.	220700.05
2309	240	Broken flint	426205	5822501	Approximate centrepoin of dredging trackplot.	220700.05
2310	240	Mammoth vertebra	426205	5822501	Approximate centrepoin of dredging trackplot.	220700.05
2311	512	Flint flake of possible human manufacture	430621	5818431	Approximate centrepoin of dredging trackplot.	88252.06
2312	512	Flint flake of possible human manufacture	430621	5818431	Approximate centrepoin of dredging trackplot.	88252.06
2313	512	Flint flake of possible human manufacture	430621	5818431	Approximate centrepoin of dredging trackplot.	88252.06
2314	512	Flint flake of possible human manufacture	430621	5818431	Approximate centrepoin of dredging trackplot.	88252.06
2315	512	Flint flake of possible human manufacture	430621	5818431	Approximate centrepoin of dredging trackplot.	88252.06
2316	512	Flint flake of possible human manufacture	430621	5818431	Approximate centrepoin of dredging trackplot.	88252.06
2317	512	Flint flake of probable human manufacture	430621	5818431	Approximate centrepoin of dredging trackplot.	88252.06
2318	512	Broken flint flake of likely Palaeolithic date	430621	5818431	Approximate centrepoin of dredging trackplot.	88252.06
2319	512	Flint flake of possible human manufacture	430621	5818431	Approximate centrepoin of dredging trackplot.	88252.06
2320	512	Flint flake of possible human manufacture	430621	5818431	Approximate centrepoin of dredging trackplot.	88252.06
2321	240	Complete mammoth tooth with roots	426172.56	5822498.675	Position given as the centrepoin of the vessel's dredge track in lane F10 in Licence Area 240. Reported through the Protocol for Reporting Archaeological Discoveries.	220700.06
2322	240	Handaxe	426218.58	5822465.383	Position given as the centrepoin of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2323	240	Flint flake	426218.58	5822465.383	Position given as the centrepoin of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2324	240	Flint flake	426218.58	5822465.383	Position given as the centrepoin of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2325	240	Rhinoceros scapula with teeth marks present	426218.58	5822465.383	Position given as the centrepoin of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2326	240	Bone	426218.58	5822465.383	Position given as the centrepoin of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2327	240	Tusk fragment	426218.58	5822465.383	Position given as the centrepoin of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06



2328	240	Tusk fragment	426218.58	5822465.383	Position given as the centrepoint of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2329	240	Tusk fragment	426218.58	5822465.383	Position given as the centrepoint of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2330	240	Tusk fragment	426218.58	5822465.383	Position given as the centrepoint of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2331	240	Bone	426218.58	5822465.383	Position given as the centrepoint of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2332	240	Bone	426218.58	5822465.383	Position given as the centrepoint of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2333	240	Small mammoth tooth	426218.58	5822465.383	Position given as the centrepoint of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2334	240	Bone - Rib?	426218.58	5822465.383	Position given as the centrepoint of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2335	240	Bone	426218.58	5822465.383	Position given as the centrepoint of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2336	240	Bone	426218.58	5822465.383	Position given as the centrepoint of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2337	240	Tusk fragment	426218.58	5822465.383	Position given as the centrepoint of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2338	240	Bone - Metacarpal?	426218.58	5822465.383	Position given as the centrepoint of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2339	240	Mammoth tooth fragment	426218.58	5822465.383	Position given as the centrepoint of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2340	240	Bone - Rib?	426218.58	5822465.383	Position given as the centrepoint of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2341	240	Bone	426218.58	5822465.383	Position given as the centrepoint of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2342	240	Bone	426218.58	5822465.383	Position given as the centrepoint of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2343	240	Bone	426218.58	5822465.383	Position given as the centrepoint of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2344	240	Bone	426218.58	5822465.383	Position given as the centrepoint of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2345	240	Bone	426218.58	5822465.383	Position given as the centrepoint of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2346	240	Bone	426218.58	5822465.383	Position given as the centrepoint of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2347	240	Bone	426218.58	5822465.383	Position given as the centrepoint of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2348	240	Bone	426218.58	5822465.383	Position given as the centrepoint of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2349	240	Mammoth tooth fragment	426218.58	5822465.383	Position given as the centrepoint of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2350	240	Mammoth tooth fragment	426218.58	5822465.383	Position given as the centrepoint of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2351	240	Handaxe	426218.58	5822465.383	Position given as the centrepoint of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2352	240	Handaxe	426218.58	5822465.383	Position given as the centrepoint of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2353	240	Handaxe	426218.58	5822465.383	Position given as the centrepoint of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2354	240	Handaxe on a flake	426218.58	5822465.383	Position given as the centrepoint of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2355	240	Levallois flake	426218.58	5822465.383	Position given as the centrepoint of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2356	240	Levallois flake	426218.58	5822465.383	Position given as the centrepoint of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2357	240	Undiagnostic flake	426218.58	5822465.383	Position given as the centrepoint of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2358	240	Flake	426218.58	5822465.383	Position given as the centrepoint of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06



2359	240	Flake	426218.58	5822465.383	Position given as the centrepoint of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2360	240	Levallois? flake	426218.58	5822465.383	Position given as the centrepoint of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2361	240	Flake	426218.58	5822465.383	Position given as the centrepoint of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2362	240	Flake	426218.58	5822465.383	Position given as the centrepoint of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2363	240	Flake	426218.58	5822465.383	Position given as the centrepoint of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2364	240	Flake	426218.58	5822465.383	Position given as the centrepoint of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2365	240	Possible flake?	426218.58	5822465.383	Position given as the centrepoint of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2366	240	Broken flake	426218.58	5822465.383	Position given as the centrepoint of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2367	240	Flake	426218.58	5822465.383	Position given as the centrepoint of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2368	240	Possible flake?	426218.58	5822465.383	Position given as the centrepoint of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2369	240	Levallois? flake	426218.58	5822465.383	Position given as the centrepoint of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2370	240	Flake?	426218.58	5822465.383	Position given as the centrepoint of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2371	240	Flake	426218.58	5822465.383	Position given as the centrepoint of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2372	240	Possible core?	426218.58	5822465.383	Position given as the centrepoint of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2373	240	Flake	426218.58	5822465.383	Position given as the centrepoint of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2374	240	Flake	426218.58	5822465.383	Position given as the centrepoint of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2375	240	Possible flake	426218.58	5822465.383	Position given as the centrepoint of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2376	240	Possible flake	426218.58	5822465.383	Position given as the centrepoint of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2377	240	Possible flake	426218.58	5822465.383	Position given as the centrepoint of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2378	240	Mammoth skull fragment	426218.58	5822465.383	Position given as the centrepoint of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2379	240	Mammoth longbone	426218.58	5822465.383	Position given as the centrepoint of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2380	240	Large bone fragment	426218.58	5822465.383	Position given as the centrepoint of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2381	240	Large bone fragment	426218.58	5822465.383	Position given as the centrepoint of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2382	240	Vertebra	426218.58	5822465.383	Position given as the centrepoint of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2383	240	Broken vertebra	426218.58	5822465.383	Position given as the centrepoint of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2384	240	Bone	426218.58	5822465.383	Position given as the centrepoint of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2385	240	Bone	426218.58	5822465.383	Position given as the centrepoint of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2386	240	Bone	426218.58	5822465.383	Position given as the centrepoint of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2387	240	Bone	426218.58	5822465.383	Position given as the centrepoint of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2388	240	Bone	426218.58	5822465.383	Position given as the centrepoint of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2389	240	Bone	426218.58	5822465.383	Position given as the centrepoint of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06



2452	240	Tooth fragment	426218.58	5822465.383	Position given as the centrepoint of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2453	240	Tooth fragment	426218.58	5822465.383	Position given as the centrepoint of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2454	240	Tooth fragment	426218.58	5822465.383	Position given as the centrepoint of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2455	240	Tusk fragment	426218.58	5822465.383	Position given as the centrepoint of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2456	240	Tusk fragment	426218.58	5822465.383	Position given as the centrepoint of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2457	240	Tusk fragment	426218.58	5822465.383	Position given as the centrepoint of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2458	240	Tusk fragment	426218.58	5822465.383	Position given as the centrepoint of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2459	240	Tusk fragment	426218.58	5822465.383	Position given as the centrepoint of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2460	240	Tusk fragment	426218.58	5822465.383	Position given as the centrepoint of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2461	240	Tusk fragment	426218.58	5822465.383	Position given as the centrepoint of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06
2462	240	Tooth fragment	426218.58	5822465.383	Position given as the centrepoint of the vessel's dredge track in lane F10 in Licence Area 240.	220700.06

Appendix 2: Summary of hypotheses

Colour coding:

White box = not tested	Green box = tested and proven	Orange box = tested and disproven	Purple box = tested and both proven and disproven
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Theme	Description 2014	Description 2015	Description 2016	Licence Areas with results	Current understanding in 2021
Inhabitation	H1a Palaeolithic material is recovered only from Unit 3b , which dates to the Saalian (Wolstonian).	H1.1 Middle Palaeolithic material is recovered only from Unit 3b	H1.1 Middle Palaeolithic material is recovered from units other than 3b	212, 240, 401/2	To date, Middle Palaeolithic material has only been recovered from Unit 3b
		H1.2 Middle Palaeolithic material from Unit 3b dates to the Saalian (Wolstonian)			This was not tested until 2019, but the 'hot spot' in Licence Area 240 has been attributed to the Saalian.
	H1b Palaeolithic material recovered from Unit 3b is predominantly <i>in situ</i> .	H1.3 Middle Palaeolithic material recovered from Unit 3b is predominantly <i>in situ</i>	H1.2 Some of the Middle Palaeolithic material recovered from Unit 3b is <i>in situ</i>	240, 511, 512	Some of the Middle Palaeolithic material recovered from Unit 3b is <i>in situ</i>
		H1.4 Late Upper Palaeolithic material is recovered only from the vicinity of Channel B	H1.3 Late Upper Palaeolithic material is recovered from other places in addition to the vicinity of Channel B	512	Late Upper Palaeolithic material is recovered from other places in addition to the vicinity of Channel B
		H1.5 Late Upper Palaeolithic material from the vicinity of Channel B is predominantly <i>in situ</i>	H1.4 Some Late Upper Palaeolithic material from the vicinity of Channel B is <i>in situ</i> .		-
		H1.6 <i>In situ</i> Lower Palaeolithic material is recovered only from Unit 3b	H1.5 Some <i>in situ</i> Lower Palaeolithic material is recovered from other units than Unit 3b.	240, ongoing	So far, <i>in situ</i> Lower Palaeolithic material has only been recovered Unit 3b.
		H1.7 Other than from Unit 3b and Late Upper Palaeolithic material from the vicinity of Channel B, no artefactual material appears to be <i>in situ</i>	H1.6 Artefactual material appears to be <i>in situ</i> in areas other than Unit 3b and the vicinity of Channel B.	512, ongoing	Other than from Unit 3b and Late Upper Palaeolithic material from the vicinity of Channel B, no artefactual material appears to be <i>in situ</i> .
		H1.8 No prehistoric material is recovered for periods later than the Late Upper Palaeolithic	H1.7 Prehistoric material is recovered for periods later than the Late Upper Palaeolithic.	511	Prehistoric material is recovered for periods later than the Late Upper Palaeolithic.
		H1.9 All faunal remains appear to be in secondary contexts	H1.8 Faunal remains appear to be in primary contexts.	240, 401/2, 511, 512	Most faunal remains appear to be from secondary contexts, however, faunal remains from Licence Areas 240 and 511 have been in conditions suggesting primary contexts.
Choice and use of location	H2a Palaeolithic material is recovered only from Unit 3b deposits on the margin of Channel A, not within the Channel itself.	H2.1 Middle Palaeolithic material is not recovered from Channel A, only from the margin of Channel A.	H2.1 Middle Palaeolithic material is not recovered from Channel A, only from the margin of Channel A.	240	Middle Palaeolithic material is not recovered from Channel A, only from the margin of Channel A.
	H2b Palaeolithic material is recovered only from Unit 3b deposits within the limits of the Palaeo-Yare floodplain, and not within the Unit 3b outliers to the north and south of the floodplain	H2.2 Middle Palaeolithic material is recovered from all Unit 3b deposits (other than Channel A itself), including outliers to the north and south of the floodplain	H2.2 Middle Palaeolithic material is recovered from outlying deposits of Unit 3b north and south of the floodplain.		-
	H2c The recovery of Palaeolithic material is clustered in relatively large quantities in discrete locations; material is not recovered from otherwise similar locations	H2.3 Middle Palaeolithic material is clustered in relatively large quantities at discrete locations.	H 2.3 Middle Palaeolithic material is clustered in relatively large quantities at discrete locations.	All licence areas	Middle Palaeolithic material is clustered in relatively large quantities at discrete locations - for example the hotspots in Licence Area 240 and likely the Bacton Beach Nourishment project finds.
		H2.4 Middle Palaeolithic material is present in small quantities throughout Unit 3b deposits.	H2.4 Middle Palaeolithic material is present in small quantities throughout Unit 3b deposits.	240, 511, 512	Middle Palaeolithic material is not present throughout Unit 3b deposits. Some Operational Sampling events for Unit 3b sediments have had no discoveries.
Natural processes	H3a The distribution of recovered Palaeolithic material does not vary according to variations in the sediment structure of Unit 3b.			513/1	The distribution of recovered Palaeolithic material does not vary according to variations in the sediment structure of Unit 3b.



	H3b Palaeolithic material is not recovered where Unit 3b appears to have been reworked by natural processes in the past.	H3.1 Middle Palaeolithic material is recovered in areas where Unit 3b has been reworked by natural processes.	H3.1 Middle Palaeolithic material is recovered in areas where Unit 3b has been reworked by natural processes.		-
	H3c Palaeolithic material is not recovered where Unit 3b appears to be covered by major bank structures.	H3.2 Middle Palaeolithic material is not recovered where Unit 3b appears to be covered by major bank structures.	H3.2 Middle Palaeolithic material is recovered where Unit 3b appears to be covered by major bank structures.	401/2	Palaeolithic material is not recovered where Unit 3b appears to be covered by major bank structures.
-Dredging History	H4a Palaeolithic material is not present where the dredging history indicates that a high level of dredging has taken place since the introduction of EMS (Electronic Monitoring System).	H3.3 Palaeolithic material is not present where dredging indicates that high level of dredging has taken place since the introduction of EMS.	H4.1 Middle Palaeolithic material is recovered where dredging history indicates that a high level of dredging has taken place since the introduction of EMS.	240	Palaeolithic material is recovered where dredging history indicates that a high level of dredging has taken place since the introduction of EMS.
	H4b Palaeolithic material is not present where geophysical data indicates that a high level of dredging has taken place.	H4.1 Middle Palaeolithic material is recovered where geophysical data indicates that a high level of dredging has taken place.	H4.2 Middle Palaeolithic material is recovered where geophysical data indicates that a high level of dredging has taken place.		-
Operation Sampling methods	H5a Palaeolithic material is found at all wharves where Operational Sampling takes place	H5.1 Faunal and artefactual material is found at all wharves where Operational Sampling takes place.	H5.1 Faunal and artefactual material is found at all wharves where Operational Sampling takes place.	All licence areas	Faunal and artefactual material is found at all wharves where Operational Sampling takes place.



Appendix 3: OASIS record form

Project Details:

Project name	Palaeo-Yare Catchment Monitoring: Interpretative Report, Five Year Review of Operational Sampling: January 2015 to December 2019		
Project code	226020		
OASIS ID			
Type of project	Desk-based assessment		
Project description	<p>Wessex Archaeology was commissioned by the Anglian Offshore Dredging Association (Hanson Aggregates Marine ; Cemex UK Marine; Volker Dredging and Tarmac Marine), coordinated through the British Marine Aggregate Producers Association (BMAPA) and Hanson Aggregates Marine Limited, to provide an interpretative report on the 23 Operational Sampling events undertaken in the East Coast aggregate extraction block and conducted at aggregate wharves between 2015 and 2019, and five events undertaken in 2014 that were not included in the previous report.</p> <p>From the 28 Operational Sampling events undertaken at Frindsbury, Northfleet and Dagenham wharves, 52 lithics and 186 faunal remains have been recovered from approximately 115,000 tonnes of aggregate.</p> <p>Of particular interest was the discovery from Licence Area 240, dredging lane F10 of potentially <i>in situ</i> material of Saalian age with: flint artefacts in near pristine condition; evidence for tool production and debitage; and megafaunal remains. Licence Area 240 remains a 'hot spot' for discovery. With a further 'hot spot' suggested in Licence Area 511 or 228 based on the discovery of finds following the Bacton Beach Nourishment Project.</p> <p>Isolated flint artefacts have been recovered from Licence Area 240, Licence Area 511, and Licence Area 512. Faunal remains have been recovered from Licence Area 240, Licence Area 401/2, Licence Area 511, Licence Area 512, and Licence Area 513.</p>		
Project dates	Start: 01 January 2014	End: 31 July 2021	
Previous work	Yes		
Future work	Yes		
Site status	N/A		
Land use	Marine		
Monument type	Findspot Site	Period	Early Middle Palaeolithic to Mesolithic; Palaeolithic

Project Location:

County	Norfolk	District	Marine	Parish	Marine	
Site name	Palaeo-Yare Catchment Monitoring: Interpretative Report, Five Year Review of Operational Sampling: January 2015 to December 2019					
Study area (m²)	N/A (all of East Coast licence areas)					
Site co-ordinates	52.647609	1.849226	52.662952	2.163036	52.463964	1.841778



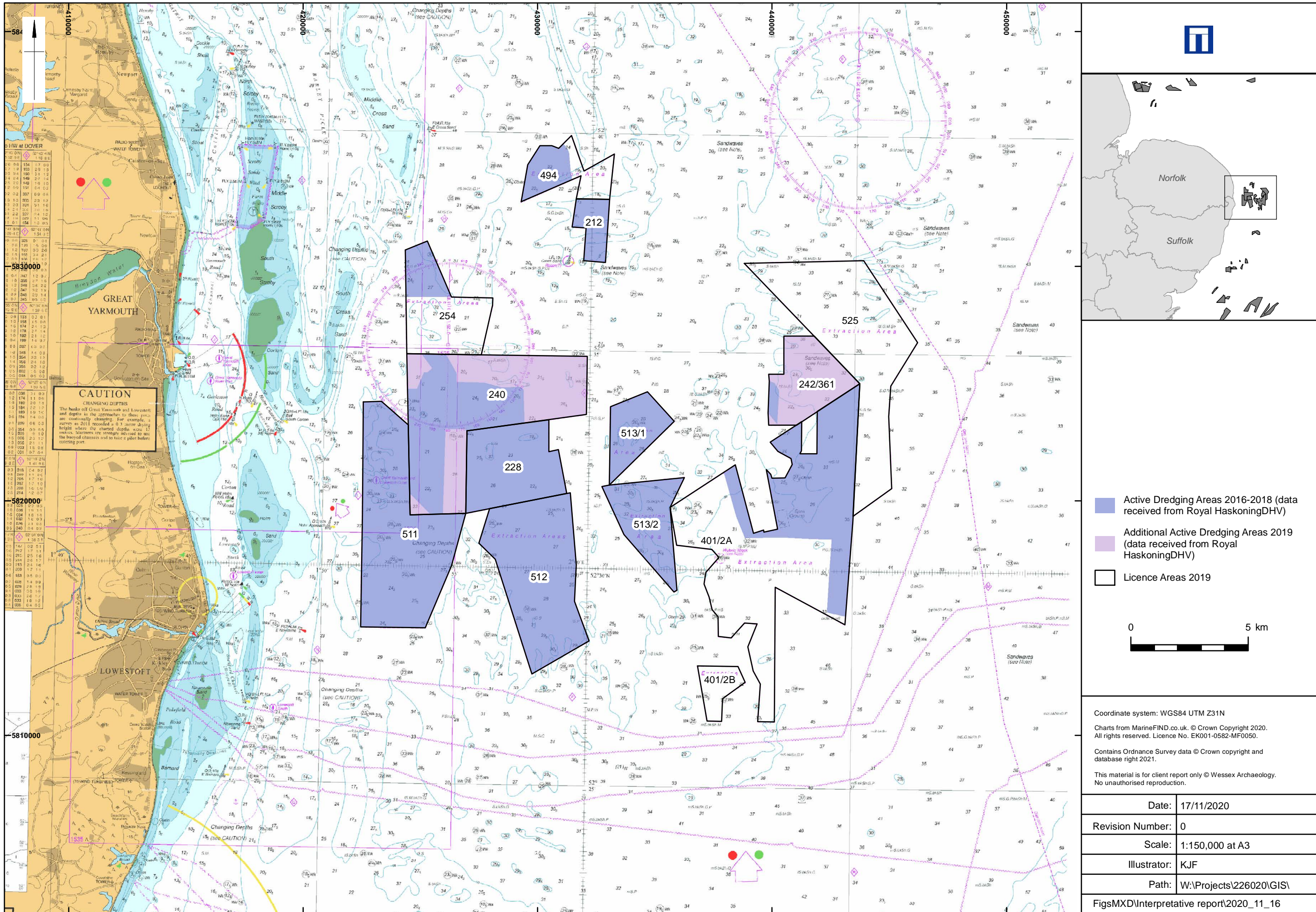
	52.436909 2.183843
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Project Creators:

Name of organisation	Wessex Archaeology		
Project brief originator	Wessex Archaeology	Project design originator	Wessex Archaeology
Project manager	Euan McNeill	Project supervisor	Andrea Hamel

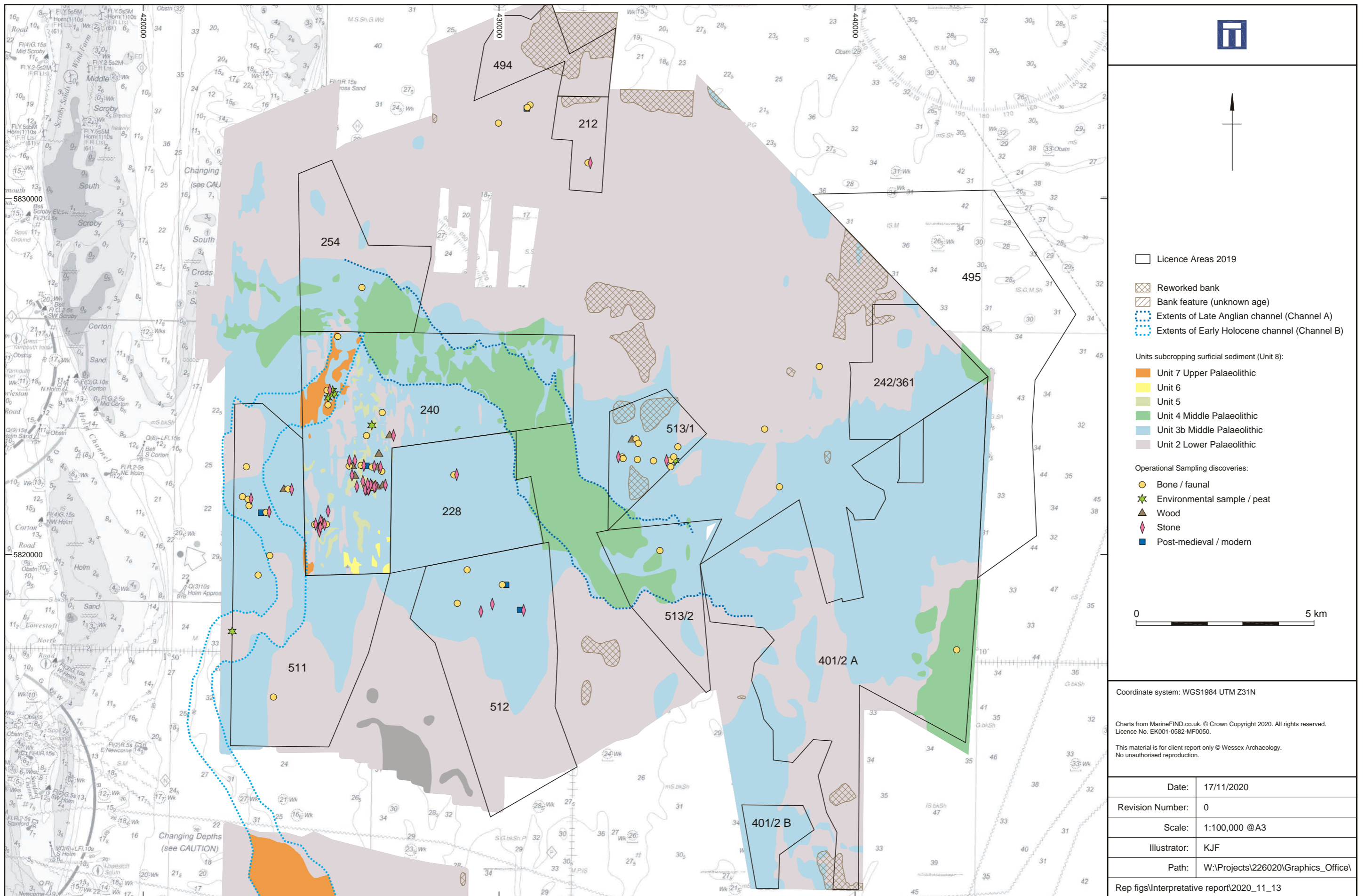
Project Archive and Bibliography:

Physical archive	N/A	Digital archive	Spreadsheets GIS Images	Paper archive	N/A
Report title	Palaeo-Yare Catchment Monitoring: Interpretative Report Five Year Review of Operational Sampling: January 2015 to December 2019			Year	2020
Author	Wessex Archaeology	Place of issue	Salisbury	Report ref.	226020.03



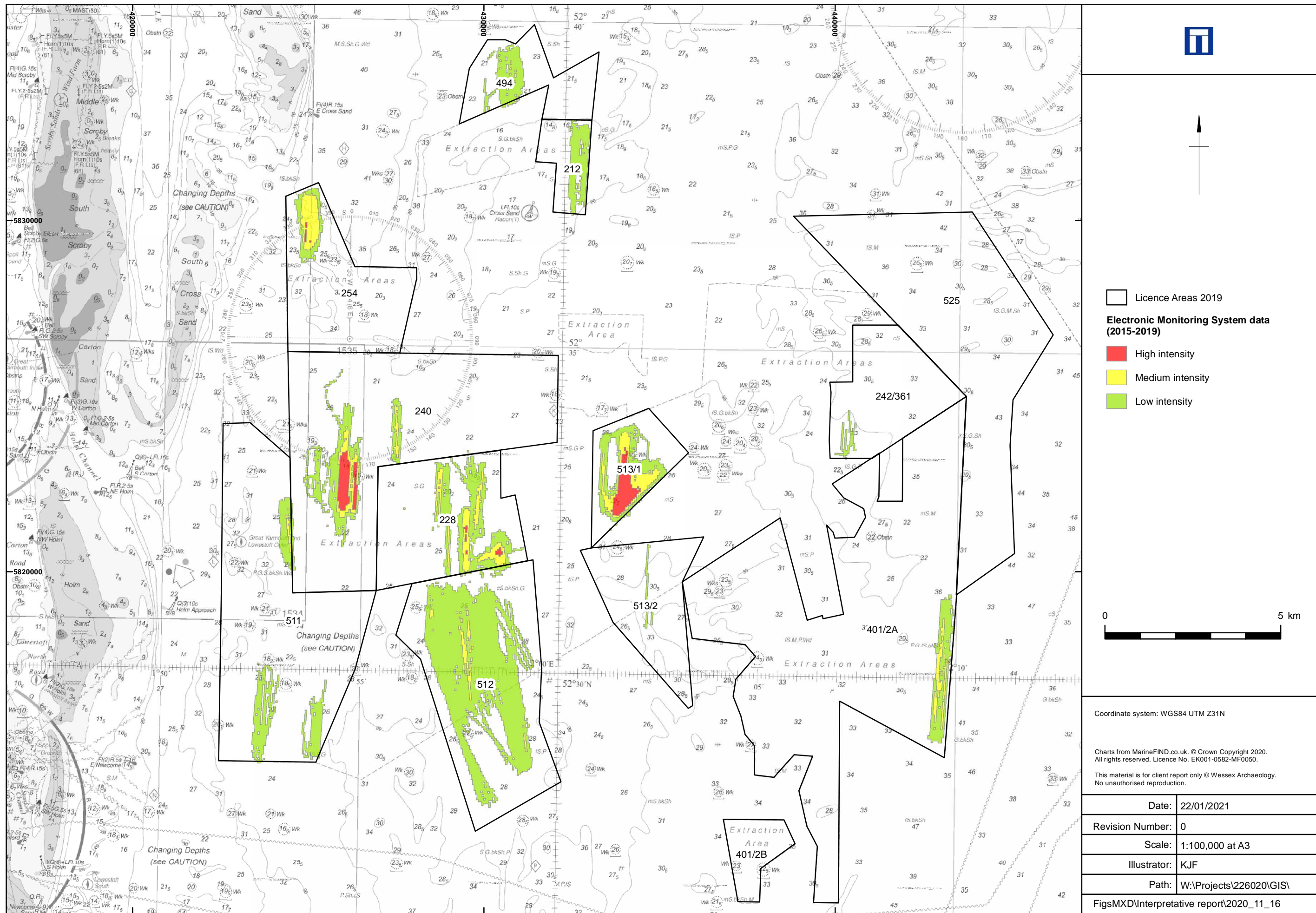
East Anglia Dredging Block

Figure 1



Overview of Palaeo-Yare catchment assessment interpretation and known archaeology

Figure 2



Dredging intensity

Figure 3

Area 212

Geology overview:

- Yarmouth Roads Formation (Unit 2) overlain by veneer of reworked marine sediments (Unit 8).
- Occasional sediment unit up to 1 m thick comprising possible reworked lag deposit of Unit 3b.
- Bank feature situated in the north up to 4 m high possibly comprising reworked sands and gravels.
- Sandwaves comprising reworked, post-transgression sediments up to 5 m high are observed within the area.

Known Archaeology:

- No finds have been reported through the Marine Aggregate Industry *Protocol for Reporting Finds of Archaeological Interest*.
- Two Early Middle Palaeolithic flakes (one showing signs of Levallois technique) were recovered during operational sampling in September 2013 (2249, 2250). Additionally, a mammoth tooth was recovered (2251).
- No artefacts or faunal remains were recovered from the two operational sampling events in November 2013 or February 2015.

Operational sampling undertaken to date:

- Three operational sampling events have been undertaken in Area 212. All targeted areas of Unit 2, with localised areas of possible Unit 3b overlain by a variable thickness of modern seabed sediment.

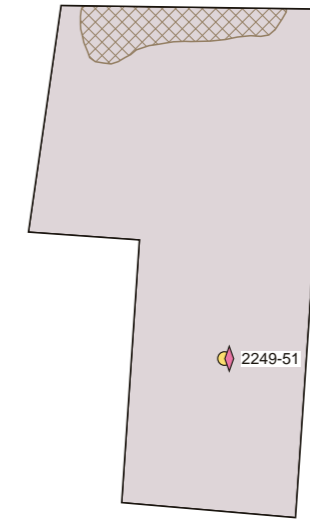
Sampling Operation Groups:

- Group 1:** Previously sampled dredge lanes targeting Unit 2.
- Group 2:** Unsourced dredge lanes targeting Unit 2.
- Group 3:** Dredge lanes targeting the northern reworked bank.

A. Interpretation and Operational Sampling tracks



B. Interpretation and known archaeology



	Hypothesis	Target Group 1		Target Group 2		Target Group 3	
		Hypothesis tested	Threshold	Hypothesis tested	Threshold	Hypothesis tested	Threshold
Inhabitation	H1.1: Middle Palaeolithic material is recovered from units other than Unit 3b	Tested	No further samples required in dredge lanes previously sampled.	Testable	Maintain current rate of assessment (1 in 14 loads).	Testable	Maintain current rate of assessment (1 in 14 loads).
	H1.2: Some of the Middle Palaeolithic material recovered from Unit 3b is <i>in situ</i>	Not testable		Not testable			
	H1.3: Late Upper Palaeolithic material is recovered from other places in addition to the vicinity of Channel B	Tested		Testable			
	H1.4: Some Late Upper Palaeolithic material from the vicinity of Channel B is <i>in situ</i>	Not testable		Not testable			
	H1.5: Some <i>in situ</i> Lower Palaeolithic material is recovered from units other than Unit 3b	Tested		Testable			
	H1.6: Artefactual material appears to be <i>in situ</i> in areas other than Unit 3b and the vicinity of Channel B	Tested		Testable			
	H1.7: Prehistoric material is recovered for periods later than the Later Upper Palaeolithic	Tested		Testable			
	H1.8: Faunal remains appear to be in primary contexts	Tested		Testable			
Choice and use of location	H2.1: Middle Palaeolithic material is recovered from the floodplain of Channel A, not from Channel A	Not testable	On two consecutive sample operations within a single dredge lane with no recovered finds, no further sampling will be required.	Not testable	On two consecutive sample operations within a single dredge lane with no recovered finds, no further sampling will be required.		
	H2.2: Middle Palaeolithic material is recovered from outlying deposits of Unit 3b north and south of the floodplain	Not testable		Not testable			
	H2.3: Middle Palaeolithic material is clustered in relatively large quantities at discrete locations	Tested		Testable			
	H2.4: Middle Palaeolithic material is present in small quantities throughout Unit 3b deposits	Not testable		Not testable			
Natural Processes	H3.1: Middle Palaeolithic material is recovered in areas where Unit 3b has been reworked by natural processes	Not testable	Not testable	Not testable			
	H3.2: Middle Palaeolithic material is recovered where Unit 3b appears to be covered by major bank structures	Not testable		Not testable			
Human Processes, including Dredging History	H4.1: Middle Palaeolithic material is recovered where dredging history indicates that a high level of dredging has taken place since the introduction of EMS	Not testable	Not testable	Not testable			
	H4.2: Middle Palaeolithic material is recovered where geophysical data indicates that a high level of dredging has taken place	Not testable		Not testable			
Operational Sampling Methods	H5.1: Faunal and artefactual material is found at all wharves where Operational Sampling takes place	Tested	Testable	Testable			

Licence Area (311 hectares)
 Reworked bank
 Dredging Sub Areas
 Operational Sampling tracks

● Bone / faunal
 ◆ Stone
 Units subcropping surficial sediment (Unit 8):
 Unit 2 Lower Palaeolithic

Known archaeology:

0 1 2 km

Drawing projection: UTM WGS84 231N.
 Contains Ordnance Survey data © Crown Copyright and database right 2020.
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Date:	19/10/2020	Revision Number:	0
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Path:	W:\Projects\226020\Graphics_Office\Rep figs\Interpretative report\2020_11_13		

Area 228

Geology overview:

- Area 228 short-term licence area is interpreted as predominantly comprising Unit 3b floodplain deposits. The geophysics data is heavily affected, partly due to dredging activity, and the thickness of the remnant Unit 3b deposits is unknown. Although, vibrocore data indicates the presence of sands and gravels in the area.
- In the central and west areas small isolated cuts and fills are observed and are interpreted as possible remnant overbank deposits or reworked sediments of Unit 4, or remnants of older, infilled sediments within Unit 3b.
- Throughout the area Unit 3b overlies Unit 2 sediments.
- To the extreme east of the area the edge of Channel A is observed and the channel is infilled with Unit 4 deposits comprising clays, silts and sands.
- Throughout the area the uppermost unit generally comprises a veneer to possibly 6 m thick where a large east-west trending sandwave is observed.

Known Archaeology:

- Operational Sampling visits in 2014 revealed two flint flakes and a piece of mineralised antler.
- A fossilised tooth (DEME_0851) was recovered and reported through the *Protocol for Reporting Finds of Archaeological Interest*, along with an undated cattle femur (Britannia_0328) and some 19th and 20th century finds.

Dredging activity:

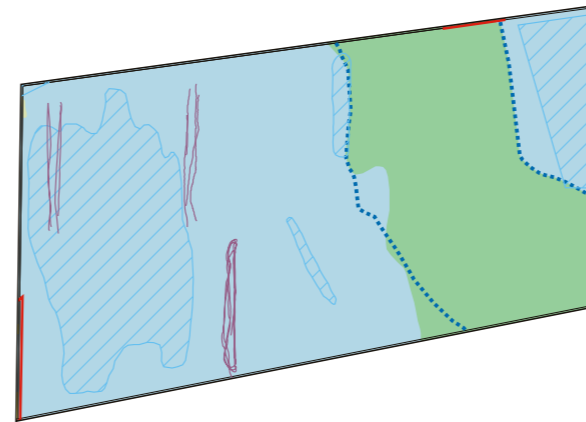
- Dredging has occurred throughout much of the area
- Localised areas have been dredged in all 20 years (1993 - 2012).
- Predominantly classified as low and medium cumulative intensity.
- Areas of medium cumulative intensity in the west and the east coincide with areas of heavy dredging observed in the geophysical data.
- Evidence of heavy dredging observed in the south in 1989 dataset.
- Target aggregate is interpreted to be Unit 3b. In the west it is difficult to estimate how much of coarse-grained target remains, due to dredging activity.

Principal hypotheses to be tested by operational sampling:

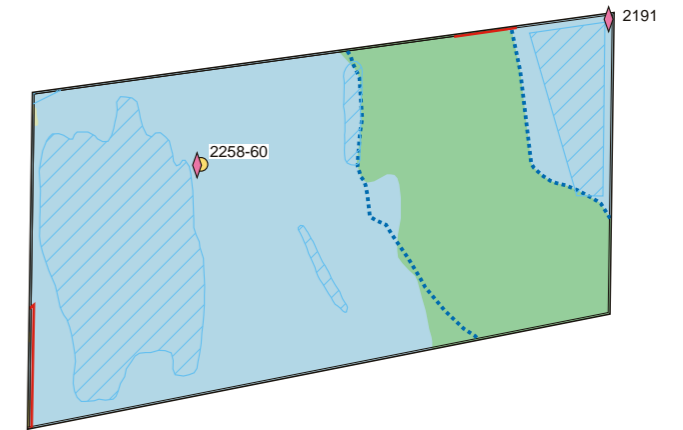
- H1a:** Palaeolithic material is recovered only from Unit 3b, which dates to the Wolstonian.
H1b: Palaeolithic material recovered from Unit 3b is predominantly *in situ*.
H2a: Palaeolithic material is recovered only from Unit 3b deposits on the margin of Channel A, not within the Channel itself.
H2c: The recovery of Palaeolithic material is clustered in relatively large quantities in discrete locations; material is not recovered from otherwise similar locations.
H3a: The distribution of recovered Palaeolithic material does not vary according to variations in the sediment structure of Unit 3b.
H3b: Palaeolithic material is not recovered where Unit 3b appears to have been reworked by natural processes in the past.
H4b: Palaeolithic material is not present where geophysical data indicates that a high level of dredging has taken place.
H5a: Palaeolithic material is found at all wharves where Operational Sampling takes place.

These have not been updated in a recent Monitoring Method Statement, so the hypotheses from the provisional WSI still stand.

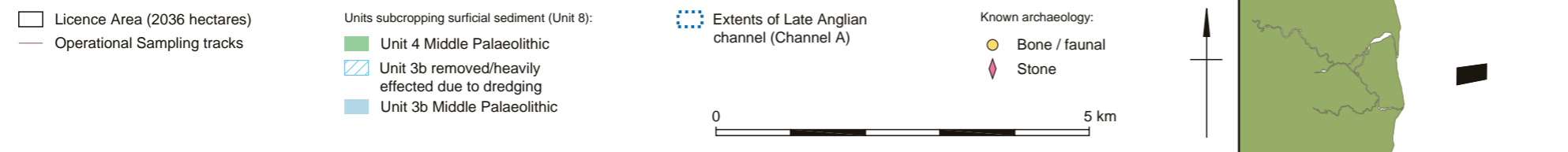
A. Interpretation and Operational Sampling tracks



B. Interpretation and known archaeology



Hypothesis	Target Group 1		Target Group 2		Target Group 3		
	Hypothesis tested	Threshold	Hypothesis tested	Threshold	Hypothesis tested	Threshold	
Inhabitation	H1.1: Middle Palaeolithic material is recovered from units other than Unit 3b	Tested	No further samples required in dredge lanes previously sampled.	Testable	Maintain current rate of assessment (1 in 14 loads).	Testable	Maintain current rate of assessment (1 in 14 loads).
	H1.2: Some of the Middle Palaeolithic material recovered from Unit 3b is <i>in situ</i>	Not testable		Not testable			
	H1.3: Late Upper Palaeolithic material is recovered from other places in addition to the vicinity of Channel B	Tested		Testable			
	H1.4: Some Late Upper Palaeolithic material from the vicinity of Channel B is <i>in situ</i>	Not testable		Not testable			
	H1.5: Some <i>in situ</i> Lower Palaeolithic material is recovered from units other than Unit 3b	Tested		Testable			
	H1.6: Artefactual material appears to be <i>in situ</i> in areas other than Unit 3b and the vicinity of Channel B	Tested		Testable			
	H1.7: Prehistoric material is recovered for periods later than the Later Upper Palaeolithic	Tested		Testable			
	H1.8: Faunal remains appear to be in primary contexts	Tested		Testable			
Choice and use of location	H2.1: Middle Palaeolithic material is recovered from the floodplain of Channel A, not from Channel A	Not testable	On two consecutive sample operations within a single dredge lane with no recovered finds, no further sampling will be required.	Not testable	On two consecutive sample operations within a single dredge lane with no recovered finds, no further sampling will be required.		
	H2.2: Middle Palaeolithic material is recovered from outlying deposits of Unit 3b north and south of the floodplain	Not testable		Not testable			
	H2.3: Middle Palaeolithic material is clustered in relatively large quantities at discrete locations	Tested		Testable			
	H2.4: Middle Palaeolithic material is present in small quantities throughout Unit 3b deposits	Not testable		Not testable			
Natural Processes	H3.1: Middle Palaeolithic material is recovered in areas where Unit 3b has been reworked by natural processes	Not testable	Not testable	Not testable			
	H3.2: Middle Palaeolithic material is recovered where Unit 3b appears to be covered by major bank structures	Not testable	Not testable	Not testable			
Human Processes, including Dredging History	H4.1: Middle Palaeolithic material is recovered where dredging history indicates that a high level of dredging has taken place since the introduction of EMS	Not testable	Not testable	Not testable			
	H4.2: Middle Palaeolithic material is recovered where geophysical data indicates that a high level of dredging has taken place	Not testable	Not testable	Not testable			
Operational Sampling Methods	H5.1: Faunal and artefactual material is found at all wharves where Operational Sampling takes place	Tested	Testable	Testable			

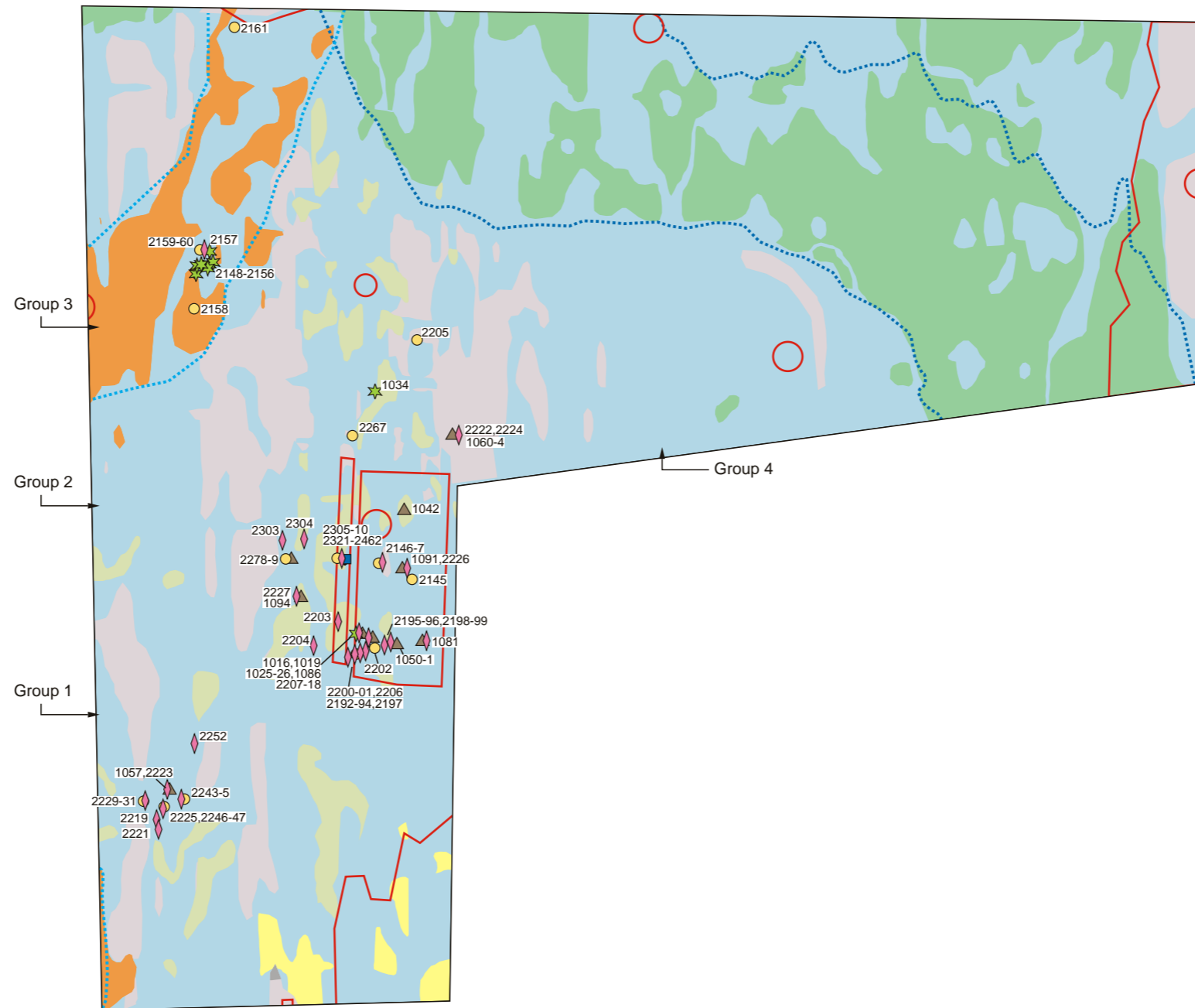


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Area 240

Interpretation and known archaeology



- Licence Area (3154 hectares)
- Dredging Sub Areas
- Operational Sampling tracks

- Units subcropping surficial sediment (Unit 8):
- Unit 7 Upper Palaeolithic
 - Unit 6
 - Unit 5
 - Unit 4 Middle Palaeolithic

- Unit 3b Middle Palaeolithic
 - Unit 2 Lower Palaeolithic
 - Extents of Late Anglian channel (Channel A)
 - Extents of Early Holocene channel (Channel B)
- 0 1 2 km

- Known archaeology:
- Bone / faunal
 - Environmental sample / peat
 - Wood
 - Stone
 - Post-medieval / modern



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Area 240

Geology overview:

- Unit 3b is observed throughout the majority of the Area with exception of where Unit 3b has been removed, principally due to dredging activity
- Unit 2 is observed throughout the area and subcrops Unit 8 (modern marine sediments) where Unit 3b is absent.
- Unit 4 is confined to the northeast associated with Late Anglian channel (Channel A) and comprises bank features and channel infill deposits. No ground truth data located in this feature.
- Isolated pockets of Unit 5 and 6 are observed infilling shallow seabed depressions.
- Unit 7, an early Holocene peat and transgressive sequence, is observed in the northwest associated with early Holocene channel (Channel B).

Known Archaeology:

- Flint artefacts comprising the Middle Palaeolithic Assemblage (2147, 2206, 2192 - 2200, 2203, 2204, 2207 - 2227).
- Several additional reports through Marine Aggregate Industry Protocol for Reporting Finds of Archaeological Interest:
- Flint (2160)
- Faunal remains (2145, 2146, 2158, 2159, 2161, 2266, 2267)
- Peat (2148 - 2157)
- Over 70 non-related operational sampling finds have been reported through the Marine Aggregate Industry Archaeological. Hanson_0286, Hanson_0410, Hanson_0533 and Hanson_0935 are all mammoth teeth thought to belong to a woolly mammoth, *Mammuthus primigenius* or a steppe mammoth, *Mammuthus trogontherri*. Additionally, fragments of mammoth tusk (Hanson_0931) and a vertebra (Hanson_0929) have also been recovered and reported.
- Five faunal remains recovered during Seabed Prehistory project grab sampling (2195, 2196, 2201, 2202, 2205).
- Two worked flints (2229 and 2230) in secondary context and faunal remains fragment (2231) recovered during operational sampling in May 2012.
- Early Middle Palaeolithic large Levallois point (2243), Upper Palaeolithic large bipolar blade core (2244), and faunal remains (2245) recovered during operational sampling in April 2013.
- Early Middle Palaeolithic Levallois flake (2246) and mammoth tooth (2247) recovered during operational sampling in April 2013.
- A relatively fresh flint flake from a flint axe, possible Middle Palaeolithic date (2252) recovered during operational sampling in January 2014.
- A single bone of an unidentifiable large mammal (2264) was recovered during operational sampling in April 2015.
- During 2019, new dredge lanes were added to the current dredging area which were in close proximity to the exclusion zone. As a result, the sampling in July and August of 2019 both produced a Middle Palaeolithic handaxe (need numbers).
- Sampling in October 2019 also produced 2 handaxes and 3 flakes (need numbers).
- The sampling of a Lane F10 cargo in November 2019 produced 30 flint artefacts including five handaxes dated to the Middle Palaeolithic and 111 animal bones. One of the bones recovered was identified as a woolly rhinoceros' scapula that had been chewed by animals, possibly hyenas.

Operational sampling undertaken to date:

- Sixteen operational sampling events have been undertaken in Area 240 up to December 2019. All targeted the southwest dredge lanes, targeting predominantly Unit 3b sediments with localised areas of Unit 2 (due to dredging out of Unit 3b) and localised pockets of Unit 5/6.

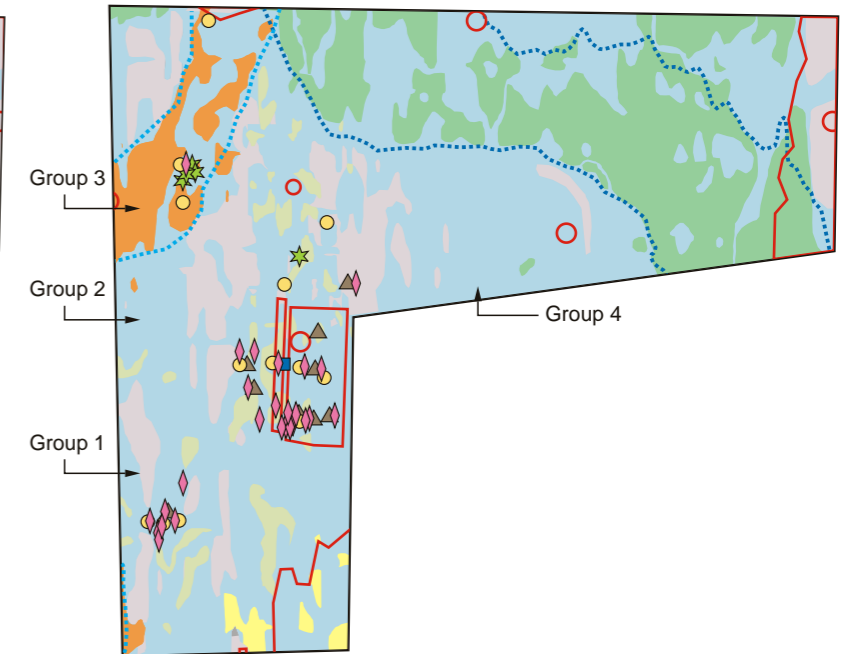
Sampling Operation Groups:

- Group 1:** Southwest dredge lanes: Previously sampled dredge lanes targeting predominantly Unit 3b.
- Group 2:** Central dredge lanes: Unsourced dredge lanes targeting Unit 3b.
- Group 3:** Northwest dredge lanes: targeting Unit 3b and Unit 7 associated with Channel B.
- Group 4:** Eastern dredge lanes: predominantly Unit 3b sediments on southern limits of Channel A.

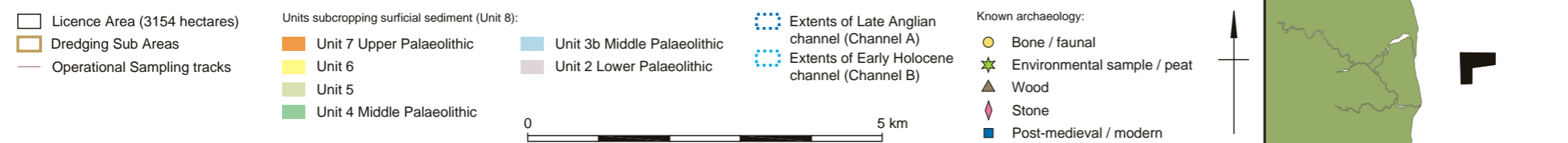
A. Interpretation and Operational Sampling tracks



B. Interpretation and known archaeology



	Hypothesis	Target Group 1		Target Group 2		Target Group 3		Target Group 4	
		Hypothesis tested	Threshold	Hypothesis tested	Threshold	Hypothesis tested	Threshold	Hypothesis tested	Threshold
Inhabitation	H1.1: Middle Palaeolithic material is recovered from units other than Unit 3b	Not testable	Reduce sample events to half current rate (1 in 50 cargos).	Not testable	Instigate rate of assessment (1 in 20 loads).	Not testable	Instigate rate of assessment (1 in 20 loads).	Not testable	Instigate rate of assessment (1 in 20 loads).
	H1.2: Some of the Middle Palaeolithic material recovered from Unit 3b is <i>in situ</i>	Tested		Testable		Testable			
	H1.3: Late Upper Palaeolithic material is recovered from other places in addition to the vicinity of Channel B	Not testable		Not testable		Not testable			
	H1.4: Some Late Upper Palaeolithic material from the vicinity of Channel B is <i>in situ</i>	Tested		Testable		Testable			
	H1.5: Some <i>in situ</i> Lower Palaeolithic material is recovered from units other than Unit 3b	Not testable		Not testable		Not testable			
	H1.6: Artefactual material appears to be <i>in situ</i> in areas other than Unit 3b and the vicinity of Channel B	Not testable		Not testable		Not testable			
	H1.7: Prehistoric material is recovered for periods later than the Later Upper Palaeolithic	Tested		Testable		Testable			
	H1.8: Faunal remains appear to be in primary contexts	Tested		Testable		Testable			
Choice and use of location	H2.1: Middle Palaeolithic material is recovered from the floodplain of Channel A, not from Channel A	Tested	Reduce sample events to half current rate (1 in 50 cargos).	Testable	Instigate rate of assessment (1 in 20 loads).	Testable	Instigate rate of assessment (1 in 20 loads).	Testable	Instigate rate of assessment (1 in 20 loads).
	H2.2: Middle Palaeolithic material is recovered from outlying deposits of Unit 3b north and south of the floodplain	Not testable		Not testable		Not testable			
	H2.3: Middle Palaeolithic material is clustered in relatively large quantities at discrete locations	Tested		Testable		Testable			
	H2.4: Middle Palaeolithic material is present in small quantities throughout Unit 3b deposits	Tested		Testable		Testable			
Natural Processes	H3.1: Middle Palaeolithic material is recovered in areas where Unit 3b has been reworked by natural processes	Not testable	Reduce sample events to half current rate (1 in 50 cargos).	Not testable	Instigate rate of assessment (1 in 20 loads).	Not testable	Instigate rate of assessment (1 in 20 loads).	Not testable	Instigate rate of assessment (1 in 20 loads).
	H3.2: Middle Palaeolithic material is recovered where Unit 3b appears to be covered by major bank structures	Not testable		Not testable		Not testable			
Human Processes, including Dredging History	H4.1: Middle Palaeolithic material is recovered where dredging history indicates that a high level of dredging has taken place since the introduction of EMS	Not testable	Reduce sample events to half current rate (1 in 50 cargos).	Not testable	Instigate rate of assessment (1 in 20 loads).	Not testable	Instigate rate of assessment (1 in 20 loads).	Not testable	Instigate rate of assessment (1 in 20 loads).
	H4.2: Middle Palaeolithic material is recovered where geophysical data indicates that a high level of dredging has taken place	Tested		Not testable		Not testable			
Operational Sampling Methods	H5.1: Faunal and artefactual material is found at all wharves where Operational Sampling takes place	Tested	Reduce sample events to half current rate (1 in 50 cargos).	Testable	Instigate rate of assessment (1 in 20 loads).	Testable	Instigate rate of assessment (1 in 20 loads).	Testable	Instigate rate of assessment (1 in 20 loads).

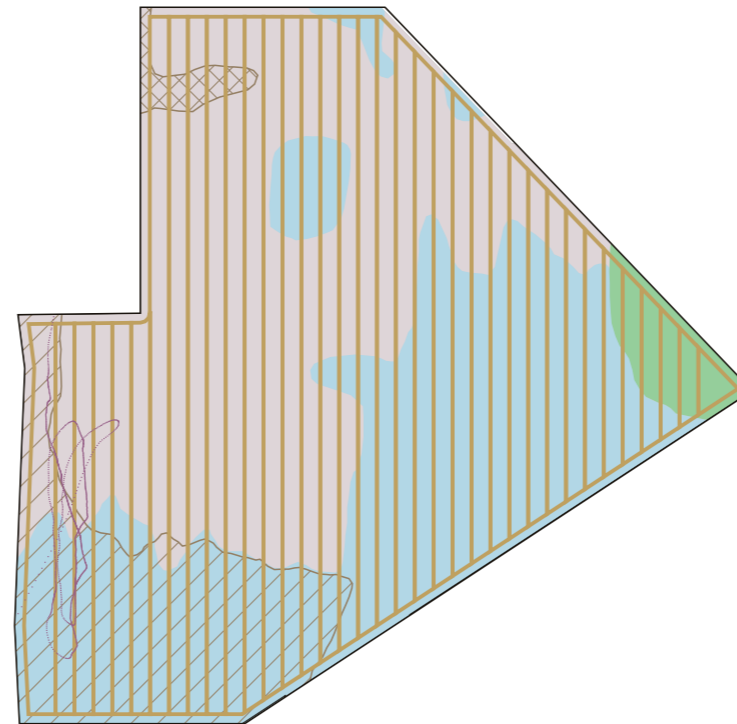


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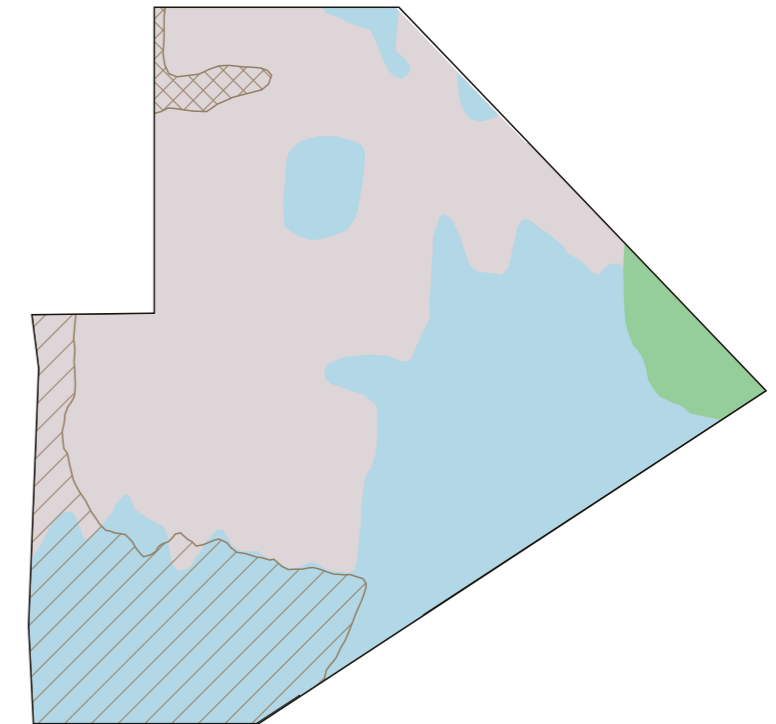
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Area 242/361

A. Interpretation and Operational Sampling tracks



B. Interpretation and known archaeology



Geology overview:

- Unit 3b floodplain deposits are extensive in the south where they underlie Unit 8 sediments. Unit 3b is also present in isolated patches in the north.
- Unit 4 may be present in the eastern corner of the Area within an isolated cut and fill feature observed from geophysical data, no ground truth data available.
- Unit 2 underlies Unit 3b.

Known Archaeology:

- Three finds (2188 - 2190) comprising mammoth teeth, mammoth bone and possible deer bone reported through the Marine Aggregate Industry Protocol for Reporting Finds of Archaeological Interest. The findspot is 10 m north of the area but is most likely to be dredged from within the area.
- To the north of the area a single faunal fragment (2162) was reported through the Protocol for Reporting Finds of Archaeological Interest.
- Operational sampling in July 2013 recovered a single mammoth tooth and five fragments of large mammal bone (2248)

Operational sampling undertaken to date:

- Two operational sampling event have been undertaken in Area 242 (western dredge lanes), once in 2013 and once in 2018.
- The sample targeted Unit 3b adjacent to an area of heavy dredging. Operational sampling indicated recovery of Unit 2 sediments.

Sampling Operation Groups:

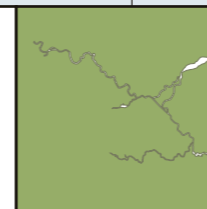
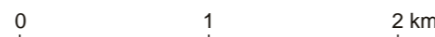
- Group 1:** Sampled western dredge lanes, predominantly Unit 2 sediments with Unit 3b present below large reworked bank feature in south.
Group 2: Eastern dredge lanes: unsampled, targeting predominantly Unit 3b sediments.

	Hypothesis	Target Group 1		Target Group 2	
		Hypothesis tested	Threshold	Hypothesis tested	Threshold
Inhabitation	H1.1: Middle Palaeolithic material is recovered from units other than Unit 3b	Tested	Sample at a rate of assessment (1 in 30 loads). If Unit 3b is encountered below reworked bank feature, sample at a rate of assessment (1 in 20 loads). On two consecutive sample operations within a single dredge lane with no recovered finds, assessment for further sampling will be required based on the results. Similarly if finds are recovered from Unit 3b, the threshold may be reviewed and potentially increased.	Testable	Sample at rate of assessment (1 in 20 loads). On two consecutive sample operations within a single dredge lane with no recovered finds, assessment for further sampling will be required based on the results.
	H1.2: Some of the Middle Palaeolithic material recovered from Unit 3b is <i>in situ</i>	Tested		Not testable	
	H1.3: Late Upper Palaeolithic material is recovered from other places in addition to the vicinity of Channel B	Tested		Testable	
	H1.4: Some Late Upper Palaeolithic material from the vicinity of Channel B is <i>in situ</i>	Not testable		Not testable	
	H1.5: Some <i>in situ</i> Lower Palaeolithic material is recovered from units other than Unit 3b	Tested		Testable	
	H1.6: Artefactual material appears to be <i>in situ</i> in areas other than Unit 3b and the vicinity of Channel B	Tested		Testable	
	H1.7: Prehistoric material is recovered for periods later than the Later Upper Palaeolithic	Tested		Testable	
	H1.8: Faunal remains appear to be in primary contexts	Tested		Testable	
Choice and use of location	H2.1: Middle Palaeolithic material is recovered from the floodplain of Channel A, not from Channel A	Not testable	On two consecutive sample operations within a single dredge lane with no recovered finds, assessment for further sampling will be required based on the results. Similarly if finds are recovered from Unit 3b, the threshold may be reviewed and potentially increased.	Not testable	On two consecutive sample operations within a single dredge lane with no recovered finds, assessment for further sampling will be required based on the results.
	H2.2: Middle Palaeolithic material is recovered from outlying deposits of Unit 3b north and south of the floodplain	Not testable		Not testable	
	H2.3: Middle Palaeolithic material is clustered in relatively large quantities at discrete locations	Tested		Testable	
	H2.4: Middle Palaeolithic material is present in small quantities throughout Unit 3b deposits	Testable		Not testable	
Natural Processes	H3.1: Middle Palaeolithic material is recovered in areas where Unit 3b has been reworked by natural processes	Testable	On two consecutive sample operations within a single dredge lane with no recovered finds, assessment for further sampling will be required based on the results. Similarly if finds are recovered from Unit 3b, the threshold may be reviewed and potentially increased.	Not testable	On two consecutive sample operations within a single dredge lane with no recovered finds, assessment for further sampling will be required based on the results.
	H3.2: Middle Palaeolithic material is recovered where Unit 3b appears to be covered by major bank structures	Tested		Testable	
Human Processes, including Dredging History	H4.1: Middle Palaeolithic material is recovered where dredging history indicates that a high level of dredging has taken place since the introduction of EMS	Not testable	On two consecutive sample operations within a single dredge lane with no recovered finds, assessment for further sampling will be required based on the results. Similarly if finds are recovered from Unit 3b, the threshold may be reviewed and potentially increased.	Not testable	On two consecutive sample operations within a single dredge lane with no recovered finds, assessment for further sampling will be required based on the results.
	H4.2: Middle Palaeolithic material is recovered where geophysical data indicates that a high level of dredging has taken place	Tested		Not testable	
Operational Sampling Methods	H5.1: Faunal and artefactual material is found at all wharves where Operational Sampling takes place	Tested		Testable	

- Licence Area (932 hectares)
- ▭ Dredging Sub Areas
- Operational Sampling tracks

- ▨ Reworked bank
- ▨ Bank feature (unknown age)

- Units subcropping surficial sediment (Unit 8):
- Unit 4 Middle Palaeolithic
 - Unit 3b Middle Palaeolithic (floodplain)
 - Unit 2 Lower Palaeolithic



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Area 401/2

Geology overview:

- Unit 3b floodplain sediments are extensive in the north-east and become more sporadic in the south and east forming isolated patches.
- Unit 3b underlies Unit 8 which can reach thicknesses up to 4.5 m in places.
- Unit 4 is present in the south-east, likely representing the edge of Brown Bank channels which are extensive to the east of the Area.
- Unit 4 sediments overlie Unit 2.

Known Archaeology:

- Twelve finds have been reported through the Marine Aggregate Industry Protocol for Reporting Finds of Archaeological Interest although all were determined to be of a modern origin (Hanson_0546, Hanson_0953, Hanson_0959, Hanson_0960, Hanson_0965, Hanson_0966, Hanson_0967, Hanson_0898).
- Two fragments of unidentified mega-fauna were recovered during operational sampling in May 2019 (2301, 2302).

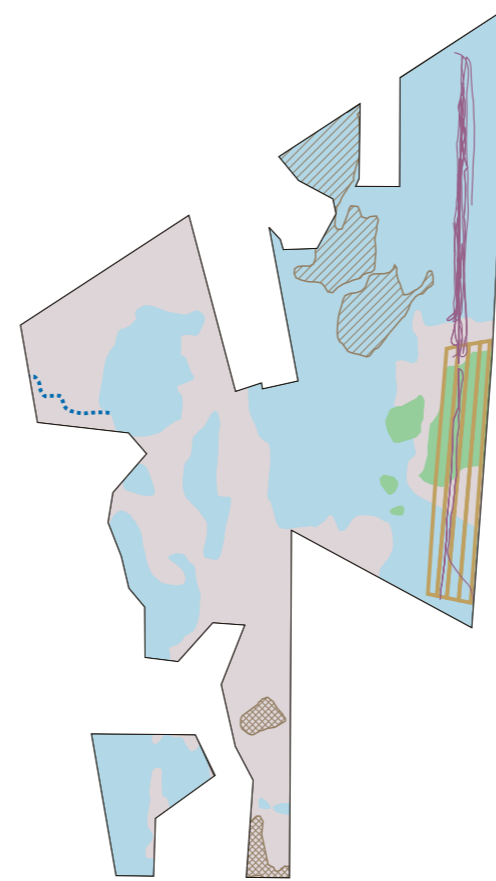
Operational sampling undertaken to date:

- Five operational sampling events have been undertaken in the north to the west of the active dredge area.
- The sampling targeted Unit 3b floodplain deposits and Unit 4. Operational sampling indicated recovery of predominantly seabed sediments (Unit 8) or reworked bank sediments.

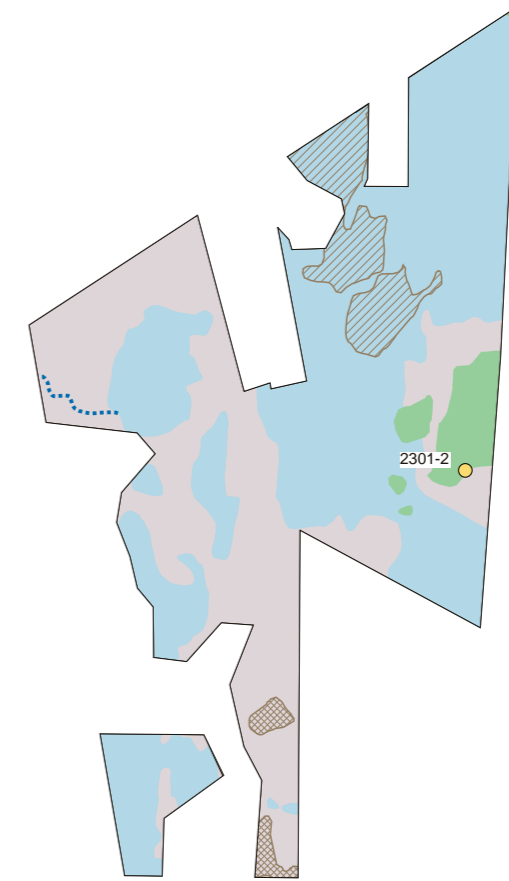
Sampling Operation Groups:

- Group 1:** sampled northern dredge lanes targeting Unit 3b.
- Group 2:** Unsampld northern dredge lanes targeting Unit 3b.
- Group 3:** southern area: unsampled areas targeting possible Unit 4 sediments.

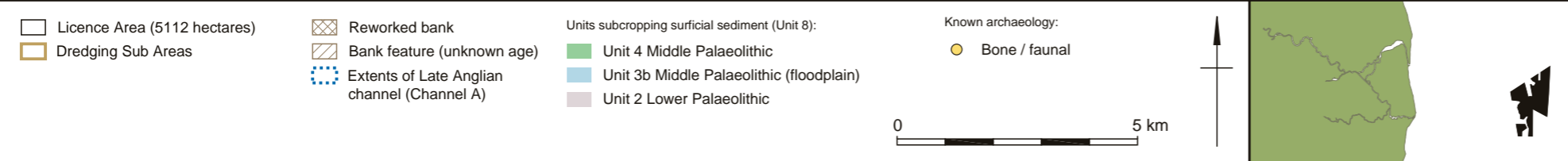
A. Interpretation and Operational Sampling tracks




B. Interpretation and known archaeology



	Hypothesis	Target Group 1		Target Group 2		Target Group 3	
		Hypothesis tested	Threshold	Hypothesis tested	Threshold	Hypothesis tested	Threshold
Inhabitation	H1.1: Middle Palaeolithic material is recovered from units other than Unit 3b	Not testable	No further samples required in western dredge lanes.	Not testable	Sample at rate of assessment (1 in 20 loads). On two consecutive sample operations within a single dredge lane with no recovered finds, assessment for further sampling will be required based on the results.	Testable	Sample at rate of assessment (1 in 20 loads). On two consecutive sample operations within a single dredge lane with no recovered finds, assessment for further sampling will be required based on the results.
	H1.2: Some of the Middle Palaeolithic material recovered from Unit 3b is <i>in situ</i>	Tested		Testable		Not testable	
	H1.3: Late Upper Palaeolithic material is recovered from other places in addition to the vicinity of Channel B	Tested		Testable		Not testable	
	H1.4: Some Late Upper Palaeolithic material from the vicinity of Channel B is <i>in situ</i>	Not testable		Not testable		Testable	
	H1.5: Some <i>in situ</i> Lower Palaeolithic material is recovered from units other than Unit 3b	Not testable		Not testable		Testable	
	H1.6: Artefactual material appears to be <i>in situ</i> in areas other than Unit 3b and the vicinity of Channel B	Not testable		Not testable		Testable	
	H1.7: Prehistoric material is recovered for periods later than the Later Upper Palaeolithic	Tested		Testable		Testable	
	H1.8: Faunal remains appear to be in primary contexts	Tested		Testable		Testable	
Choice and use of location	H2.1: Middle Palaeolithic material is recovered from the floodplain of Channel A, not from Channel A	Tested		Testable		Not testable	
	H2.2: Middle Palaeolithic material is recovered from outlying deposits of Unit 3b north and south of the floodplain	Not testable		Not testable		Not testable	
	H2.3: Middle Palaeolithic material is clustered in relatively large quantities at discrete locations	Tested		Testable		Testable	
	H2.4: Middle Palaeolithic material is present in small quantities throughout Unit 3b deposits	Tested		Testable		Not testable	
Natural Processes	H3.1: Middle Palaeolithic material is recovered in areas where Unit 3b has been reworked by natural processes	Not testable		Not testable		Not testable	
	H3.2: Middle Palaeolithic material is recovered where Unit 3b appears to be covered by major bank structures	Not testable		Not testable		Not testable	
Human Processes, including Dredging History	H4.1: Middle Palaeolithic material is recovered where dredging history indicates that a high level of dredging has taken place since the introduction of EMS	Not testable		Not testable		Not testable	
	H4.2: Middle Palaeolithic material is recovered where geophysical data indicates that a high level of dredging has taken place	Not testable		Not testable		Not testable	
Operational Sampling Methods	H5.1: Faunal and artefactual material is found at all wharves where Operational Sampling takes place	Tested		Testable		Testable	



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Area 511

Geology overview:

- Throughout the majority of Area 511, Unit 2 (Yarmouth Roads Formation) sediments are overlain by a complex unit of sands and gravels interpreted as the Wolstonian floodplain deposits (Unit 3b).
- Area 511 is dominated by the meandering north-south channel (Channel B) which developed during the early Holocene. The channel cuts into underlying Unit 3b sediments which would have been re-worked during the development of the channel.
- Within the channel there are two areas where Unit 2 sediments are interpreted and are not overlain by the floodplain deposits (Unit 3b). In these areas Unit 2 sediments appear to be overlain by up to 4 m of reworked modern sediments (probable Unit 8). However, it is possible that the reworked sediments comprise reworked Unit 3b floodplain sediments.
- There is a small localised area of fine-grained infill sediments observed within the channel, interpreted as Unit 7 deposited during the early Holocene.
- In the southeast of Area 511 Unit 2 is observed overlain by a veneer of reworked recent marine sediments (Unit 8).

Known Archaeology:

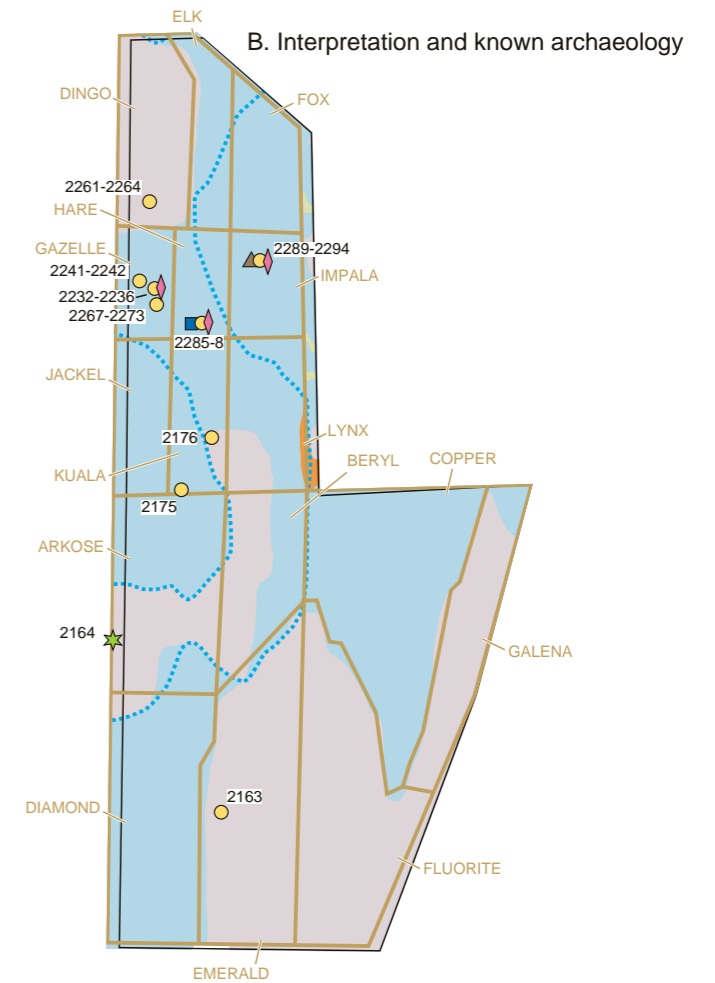
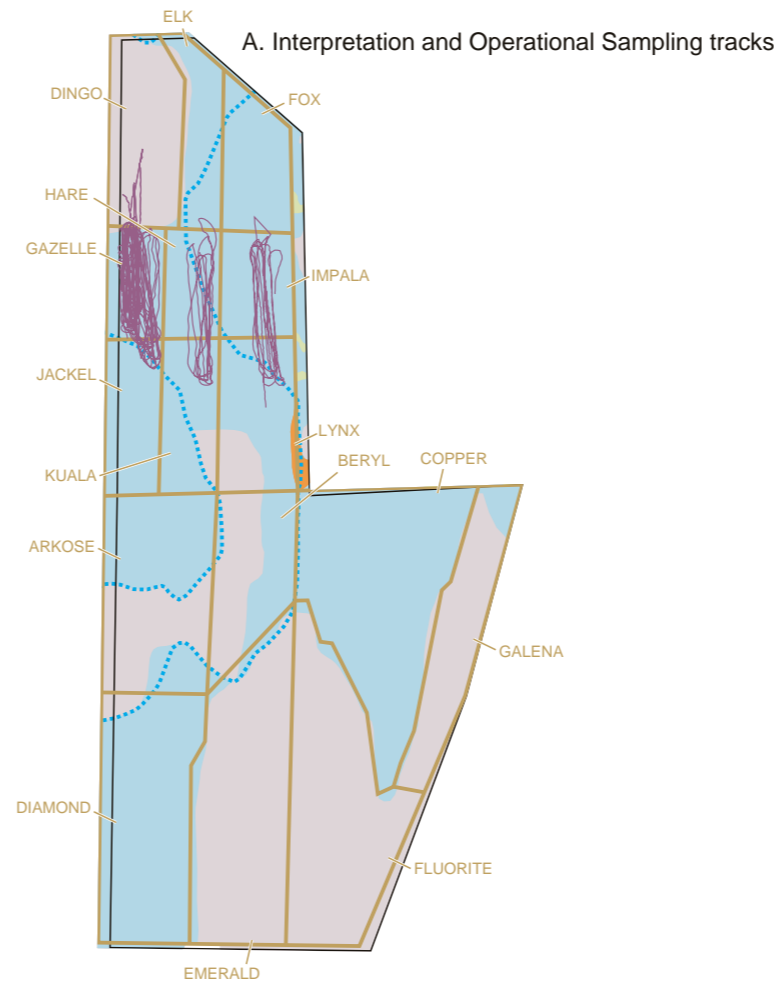
- Three reports of faunal remains (2176, 2175 and 2163), a wooden sleeper (CEMEX_0600), container twist lock (CEMEX_0866), aircraft fragment (CEMEX_0867), shaft housing (CEMEX_0871), aircraft components (CEMEX_0914), aircraft components, bollard, munition, shoes (CEMEX_0915), aircraft components (CEMEX_0918), collection of munitions (CEMEX_0920) have been reported through the Marine Aggregate Industry Protocol for Reporting Finds of Archaeological Interest.
- A further collection of bones and aircraft pieces (CEMEX_0948) were also reported however, whether these were recovered from Licence Area 511 or 512 is unknown.
- A sample of peat (2164) was also recorded through the protocol.
- Nine recoveries were made during operational sampling between 2013-2015;
 - Six faunal recoveries (2235, 2236, 2241, 2242, 2261 and 2262) were reported amounting to fifteen individual bones, including red deer humerus and antler, bones from mammoth and sheep and a mammoth tooth.
 - Three lithics were recovered including a Lower Palaeolithic flake (2232), a tertiary flake possibly Holocene age (2233), and a thermal flake in fresh condition and of Holocene age (2234).
- A possible flint blade core, two flint flakes and five potential flint flakes have been discovered during recent operational sampling (2017) as well as unidentified mineralised bone fragments, mammoth teeth fragments (2018).

Operational sampling undertaken to date:

- Six operational sampling events have been undertaken between February 2013 and 2019.

Sampling Operation Groups:

- Group 1:** Gazelle, Hare, Impala, Jackel, Diamond, Copper, Elk, Fox: All areas and possible dredge lanes target Unit 3b deposits
- Group 2:** Dingo, Emerald, Galena, Flourite: All areas and possible dredge lanes target Unit 2 deposits
- Group 3:** Kuala, Lynx, Arkose, Beryl: target either Unit 3b or Unit 2 depending on dredging lane



	Hypothesis	Target Group 1		Target Group 2		Target Group 3	
		Hypothesis tested	Threshold	Hypothesis tested	Threshold	Hypothesis tested	Threshold
Inhabitation	H1.1: Middle Palaeolithic material is recovered from units other than Unit 3b	Not testable	Maintain current rate of assessment (1 in 20 loads). On four consecutive sample operations within a single dredge lane with no recovered finds reduce rate to 1 in 40.	Testable	Within individual dredge lane if Unit 2 sediment is proved during sampling operation and no lithics recovered, no further operational assessment required.	Testable	Unit 3b target: use Group 1 threshold Unit 2 target: use Group 2 threshold
	H1.2: Some of the Middle Palaeolithic material recovered from Unit 3b is <i>in situ</i>	Tested		Not testable		Testable	
	H1.3: Late Upper Palaeolithic material is recovered from other places in addition to the vicinity of Channel B	Not testable		Not testable		Not testable	
	H1.4: Some Late Upper Palaeolithic material from the vicinity of Channel B is <i>in situ</i>	Tested		Testable		Testable	
	H1.5: Some <i>in situ</i> Lower Palaeolithic material is recovered from units other than Unit 3b	Not testable		Testable		Testable	
	H1.6: Artefactual material appears to be <i>in situ</i> in areas other than Unit 3b and the vicinity of Channel B	Not testable		Not testable		Not testable	
	H1.7: Prehistoric material is recovered for periods later than the Later Upper Palaeolithic	Tested		Testable		Testable	
	H1.8: Faunal remains appear to be in primary contexts	Tested		Testable		Testable	
Choice and use of location	H2.1: Middle Palaeolithic material is recovered from the floodplain of Channel A, not from Channel A	Tested		Testable		Testable	
	H2.2: Middle Palaeolithic material is recovered from outlying deposits of Unit 3b north and south of the floodplain	Not testable		Not testable		Not testable	
	H2.3: Middle Palaeolithic material is clustered in relatively large quantities at discrete locations	Tested		Testable		Testable	
	H2.4: Middle Palaeolithic material is present in small quantities throughout Unit 3b deposits	Tested		Not testable		Testable	
Natural Processes	H3.1: Middle Palaeolithic material is recovered in areas where Unit 3b has been reworked by natural processes	Tested		Not testable		Testable	
	H3.2: Middle Palaeolithic material is recovered where Unit 3b appears to be covered by major bank structures	Not testable		Not testable		Not testable	
Human Processes, including Dredging History	H4.1: Middle Palaeolithic material is recovered where dredging history indicates that a high level of dredging has taken place since the introduction of EMS	Not testable		Not testable		Not testable	
	H4.2: Middle Palaeolithic material is recovered where geophysical data indicates that a high level of dredging has taken place	Not testable		Not testable		Not testable	
Operational Sampling Methods	H5.1: Faunal and artefactual material is found at all wharves where Operational Sampling takes place	Tested		Testable		Testable	

Licence Area (2622 hectares)
 Dredging Sub Areas
 Operational Sampling tracks
 Extents of Early Holocene channel (Channel B)
 Units subcropping surficial sediment (Unit 8):
 Unit 7 Upper Palaeolithic
 Unit 3b Middle Palaeolithic (floodplain)
 Unit 2 Lower Palaeolithic
● Bone / faunal
★ Environmental sample / peat
▲ Wood
◆ Stone
 Post-medieval / modern

0 5 km

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Area 512

Geology overview:

- The north of Area 512 is dominated by sand and gravel deposits interpreted as Wolstonian floodplain deposits (Unit 3b) and are primarily observed as a bank feature up to 5 m high and thinning to the south and northwest.
- In the south of the area fine-grained silts, sands and clays (in excess of 5 m thick) interpreted as Unit 2 Yarmouth Roads Formation are observed overlain by a veneer of sand and gravel interpreted as probable recent reworked marine sediments (Unit 8).
- Unit 3b is also present along the southern margin of Area 512, where it comprises silty gravelly sand, suggesting the Wolstonian floodplain is preserved in isolated patches in this region.

Known Archaeology:

- An alloy object with rivet holes and fabric (CEMEX_0609), aluminium fragment (CEMEX_0743), drogue parachute (CEMEX_0770), knife blade (CEMEX_0789), part of anchor (CEMEX_0904) and hook (CEMEX_0905) have been reported through the Marine Aggregate Industry Protocol for Reporting Finds of Archaeological Interest.
- A further collection of bones and aircraft pieces (CEMEX_0948) and (CEMEX_0951 & CEMEX_0952) were reported however, whether these were recovered from Licence 511 or 512 and 460 or 512 respectively is unknown.
- Operational Sampling was undertaken on the 13th and 14th March 2013 in sub-licence area Ilmenite (and partially in Kyanite). A single lithic was recovered and is a large scraper made on a secondary flake and is possible Lower Palaeolithic (2237).
- Further operational sampling was undertaken in December 2013 in sub-licence area Ilmenite with no recoveries.
- In April 2014 a pelvis fragment of a cow or deer (2253) was recovered from sub-licence area Ilmenite.
- In May 2015 a single piece of struck flint, a portion of a large blade was recovered (2266) from sub-licence area Ilmenite. The lithic was broken and somewhat worn, not *in situ*.
- Recent visits have produced possible auroch bone fragments (2016), unidentifiable bone fragments (2018), a section of sheep rib, two worked flint flakes and several possible worked flint flakes (2019).

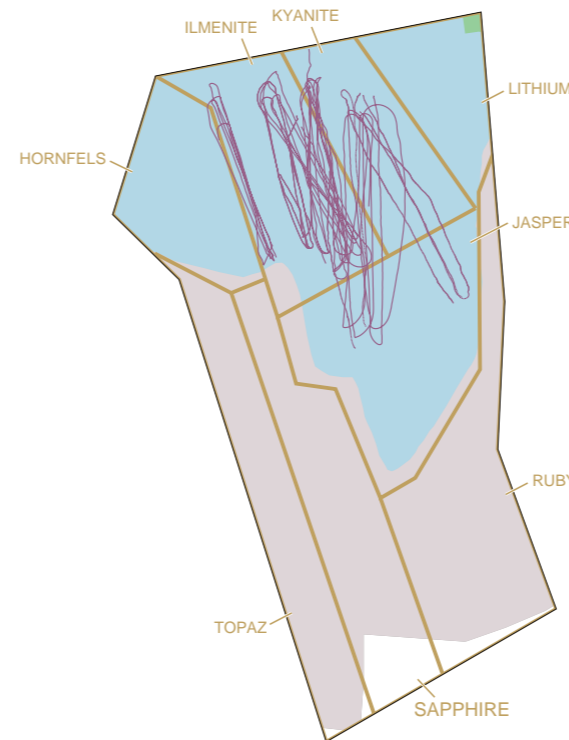
Operational sampling undertaken to date:

- Seven operational sampling events have been undertaken, targeting Unit 3b up until November 2019.

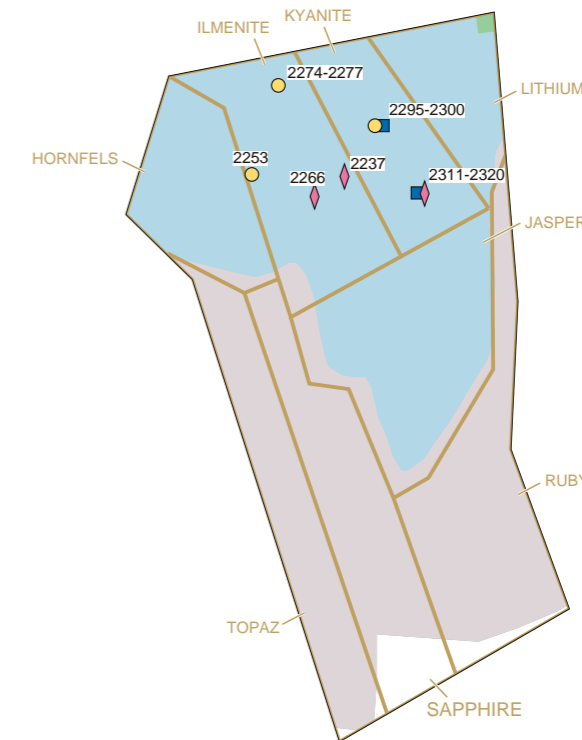
Sampling Operation Groups:

- Group 1:** Hornfels, Ilmenite, Kyanite, Lithium, Jasper: All areas and possible dredge lanes target Unit 3b deposits.
- Group 2:** Topaz, Sapphire, Ruby: All licensed areas and possible dredge lanes target Unit 2 deposits.

A. Interpretation and Operational Sampling tracks



B. Interpretation and known archaeology



	Hypothesis	Target Group 1		Target Group 2	
		Hypothesis tested	Threshold	Hypothesis tested	Threshold
Inhabitation	H1.1: Middle Palaeolithic material is recovered from units other than Unit 3b	Not testable	Maintain current rate of assessment (1 in 20 loads). On four consecutive sample operations within a single dredge lane with no recovered finds reduce rate to 1 in 40.	Testable	Within individual dredge lane if Unit 2 sediment is proved during sampling operation and no lithics recovered, no further operational assessment required.
	H1.2: Some of the Middle Palaeolithic material recovered from Unit 3b is <i>in situ</i>	Tested		Not testable	
	H1.3: Late Upper Palaeolithic material is recovered from other places in addition to the vicinity of Channel B	Tested		Testable	
	H1.4: Some Late Upper Palaeolithic material from the vicinity of Channel B is <i>in situ</i>	Not testable		Not testable	
	H1.5: Some <i>in situ</i> Lower Palaeolithic material is recovered from units other than Unit 3b	Not testable		Testable	
	H1.6: Artefactual material appears to be <i>in situ</i> in areas other than Unit 3b and the vicinity of Channel B	Not testable		Not testable	
	H1.7: Prehistoric material is recovered for periods later than the Later Upper Palaeolithic	Tested		Testable	
	H1.8: Faunal remains appear to be in primary contexts	Tested		Testable	
Choice and use of location	H2.1: Middle Palaeolithic material is recovered from the floodplain of Channel A, not from Channel A	Tested		Not testable	
	H2.2: Middle Palaeolithic material is recovered from outlying deposits of Unit 3b north and south of the floodplain	Not testable		Not testable	
	H2.3: Middle Palaeolithic material is clustered in relatively large quantities at discrete locations	Tested		Testable	
	H2.4: Middle Palaeolithic material is present in small quantities throughout Unit 3b deposits	Tested		Testable	
Natural Processes	H3.1: Middle Palaeolithic material is recovered in areas where Unit 3b has been reworked by natural processes	Not testable		Not testable	
	H3.2: Middle Palaeolithic material is recovered where Unit 3b appears to be covered by major bank structures	Not testable		Not testable	
Human Processes, including Dredging History	H4.1: Middle Palaeolithic material is recovered where dredging history indicates that a high level of dredging has taken place since the introduction of EMS	Not testable		Not testable	
	H4.2: Middle Palaeolithic material is recovered where geophysical data indicates that a high level of dredging has taken place	Not testable		Not testable	
Operational Sampling Methods	H5.1: Faunal and artefactual material is found at all wharves where Operational Sampling takes place	Tested		Testable	

Licence Area (2176 hectares)
 Dredging Sub Areas
 Operational Sampling tracks

Units subcropping surficial sediment (Unit 8):
 Unit 4 Middle Palaeolithic
 Unit 3b Middle Palaeolithic (floodplain)
 Unit 2 Lower Palaeolithic

Known archaeology:
● Bone / faunal
◆ Stone
■ Post-medieval / modern

0 5 km

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Area 513/1

Geology overview:

- The area is dominated by floodplain deposits (Unit 3b) overlying Unit 2 Yarmouth Roads Formation (fine-grained silts and sands).
- In the southwest of Area 513/1 the northern edge of the Middle Pleistocene channel (Channel A) is observed. The channel comprises sands and gravels of probable Wolstonian age and a secondary cut feature is observed infilled with fine-grained sediment unit (Unit 4).
- Three bank features are observed in the area. The banks are interpreted as reworked structures comprising reworked Unit 2, 3b and 4 sediments and are likely to have been formed subsequent to the deposition of Unit 4, most likely during the last marine transgression.
- In the east of Area 513/1 sediments comprise a veneer (generally <1 m) of reworked marine sediments overlying fine-grained silty sand (Unit 2; Yarmouth Roads Formation).
- Locally, Unit 3b may be absent in areas that have influenced by dredging activity

Known Archaeology:

- Six finds of archaeological interest have been reported through the Marine Aggregate Industry *Protocol for Reporting Finds of Archaeological Interest* and comprised a collection of worked flint, bone fragments and environmental remains (2177 - 2181), and various mammal bone fragments (2182 - 2187, 2166 and 2265).
- Operational Sampling was undertaken on the 23rd and 24th April 2013 and numerous faunal remains were recovered (2240). The bones were highly abraded and mineralised and are thought to be of considerable age.
- Operational Sampling undertaken in October 2014 recovered three fragments of bone, two unidentifiable mammal bone fragments and a mammal vertebra (2254 - 2256). Also, a Bi-polar core fragment was recovered (2257).
- In July 2017, a mineralised antler fragment was discovered along with 12 fragments of unidentified mineralised bones, and several fragments of wood not thought to be archaeologically significant.

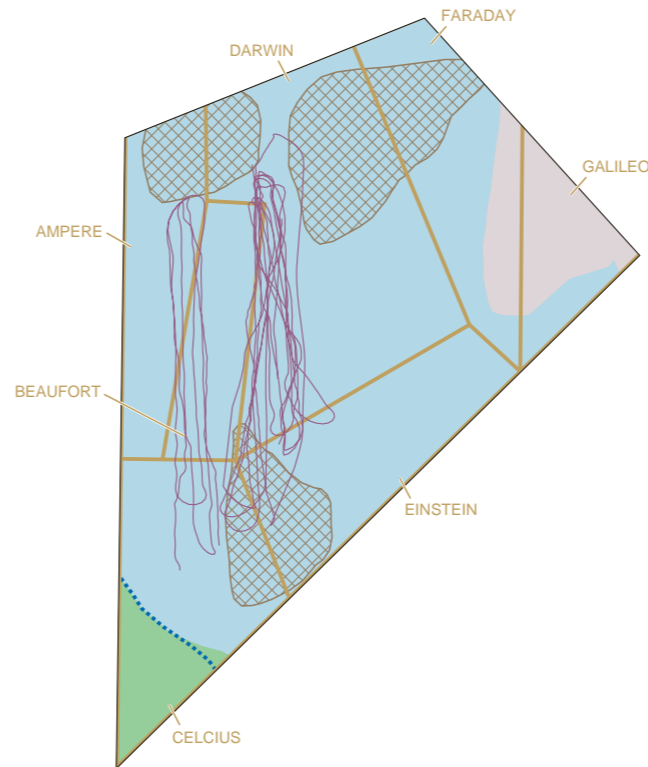
Operational sampling undertaken to date:

- Two operational sampling events have been undertaken in Area 513/1 targeting Unit 3b.

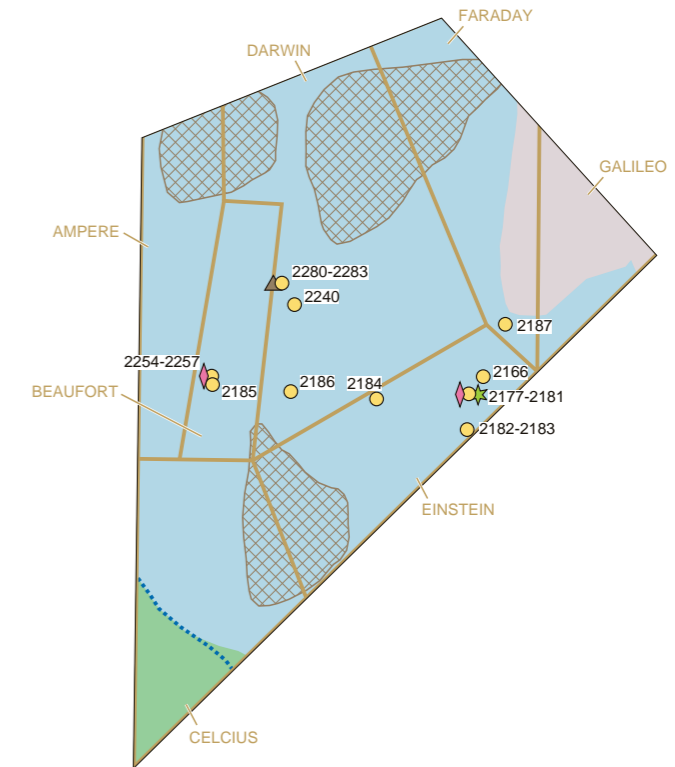
Sampling Operation Groups:

- Group 1:** Celcius, Einstein, Beaufort, Darwin, Faraday, Ampere: Licence sub-areas target Unit 3b deposits.
Group 2: Celcius, Einstein, Beaufort, Darwin, Faraday, Ampere: Licence sub-areas target reworked banks overlying Unit 3b deposits.
Group 3: Faraday, Galileo: Licence sub-areas target Unit 2 deposits.
Group 4: Celcius: Licence sub-areas target Unit 4 deposits within Channel A.

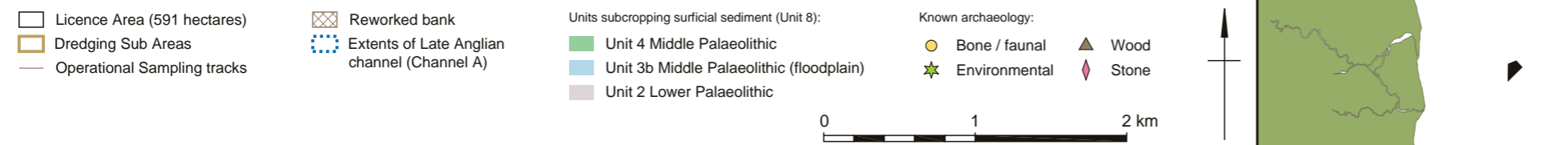
A. Interpretation and Operational Sampling tracks



B. Interpretation and known archaeology



Hypothesis	Target Group 1		Target Group 2		Target Group 3		Target Group 4	
	Hypothesis tested	Threshold	Hypothesis tested	Threshold	Hypothesis tested	Threshold	Hypothesis tested	Threshold
Inhabitation	H1.1: Middle Palaeolithic material is recovered from units other than Unit 3b	Not testable	Testable	Maintain current rate of assessment (1 in 20 loads).	Testable	Within individual dredge lane if Unit 2 sediment is proved during sampling operation and no lithics recovered, no further operational assessment required.	Testable	Maintain current rate of assessment (1 in 20 loads).
	H1.2: Some of the Middle Palaeolithic material recovered from Unit 3b is <i>in situ</i>	Tested	Not testable		Not testable			
	H1.3: Late Upper Palaeolithic material is recovered from other places in addition to the vicinity of Channel B	Tested	Testable		Testable			
	H1.4: Some Late Upper Palaeolithic material from the vicinity of Channel B is <i>in situ</i>	Not testable	Not testable		Not testable			
	H1.5: Some <i>in situ</i> Lower Palaeolithic material is recovered from units other than Unit 3b	Not testable	Testable		Testable			
	H1.6: Artefactual material appears to be <i>in situ</i> in areas other than Unit 3b and the vicinity of Channel B	Not testable	Testable		Testable			
	H1.7: Prehistoric material is recovered for periods later than the Later Upper Palaeolithic	Tested	Testable		Testable			
	H1.8: Faunal remains appear to be in primary contexts	Tested	Testable		Testable			
Choice and use of location	H2.1: Middle Palaeolithic material is recovered from the floodplain of Channel A, not from Channel A	Tested	Testable	On four consecutive sample operations within a single dredge lane with no recovered finds reduce rate to 1 in 40.	Not testable	On four consecutive sample operations within a single dredge lane with no recovered finds reduce rate to 1 in 40.	Not testable	On four consecutive sample operations within a single dredge lane with no recovered finds reduce rate to 1 in 40.
	H2.2: Middle Palaeolithic material is recovered from outlying deposits of Unit 3b north and south of the floodplain	Not testable	Not testable		Not testable			
	H2.3: Middle Palaeolithic material is clustered in relatively large quantities at discrete locations	Tested	Testable		Testable			
	H2.4: Middle Palaeolithic material is present in small quantities throughout Unit 3b deposits	Tested	Not testable		Not testable			
Natural Processes	H3.1: Middle Palaeolithic material is recovered in areas where Unit 3b has been reworked by natural processes	Not testable	Not testable	On four consecutive sample operations within a single dredge lane with no recovered finds reduce rate to 1 in 40.	Not testable	On four consecutive sample operations within a single dredge lane with no recovered finds reduce rate to 1 in 40.	Not testable	On four consecutive sample operations within a single dredge lane with no recovered finds reduce rate to 1 in 40.
	H3.2: Middle Palaeolithic material is recovered where Unit 3b appears to be covered by major bank structures	Not testable	Testable		Not testable			
Human Processes, including Dredging History	H4.1: Middle Palaeolithic material is recovered where dredging history indicates that a high level of dredging has taken place since the introduction of EMS	Tested	Testable	On four consecutive sample operations within a single dredge lane with no recovered finds reduce rate to 1 in 40.	Not testable	On four consecutive sample operations within a single dredge lane with no recovered finds reduce rate to 1 in 40.	Not testable	On four consecutive sample operations within a single dredge lane with no recovered finds reduce rate to 1 in 40.
	H4.2: Middle Palaeolithic material is recovered where geophysical data indicates that a high level of dredging has taken place	Not testable	Not testable		Not testable			
Operational Sampling Methods	H5.1: Faunal and artefactual material is found at all wharves where Operational Sampling takes place	Tested	Testable		Testable		Testable	



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Area 513/2

Geology overview:

- The northern section of Area 513/2 is dominated by Channel A and associated floodplain deposits. Unit 3b sediments generally comprise sand with some gravel up to 6 m thick in places.
- Unit 3b is overlain by Unit 4 sediments observed as cut and bank features.
- In the south fine-grained sands with localised coarse-grained sediments are observed and are generally interpreted as Unit 2 overlain by a marine gravel lag deposit (Unit 8). An outlier of Unit 3b is observed in the south up to 4 m thick.

Known Archaeology:

- A single fragment of bone (2165) and shell case (CEMEX_0855) has been reported through the Marine Aggregate Industry Protocol for Reporting Finds of Archaeological Interest. A further bullet (CEMEX_0854) was also reported however, whether this was recovered from Licence Area 513/2 or 458 is unknown.

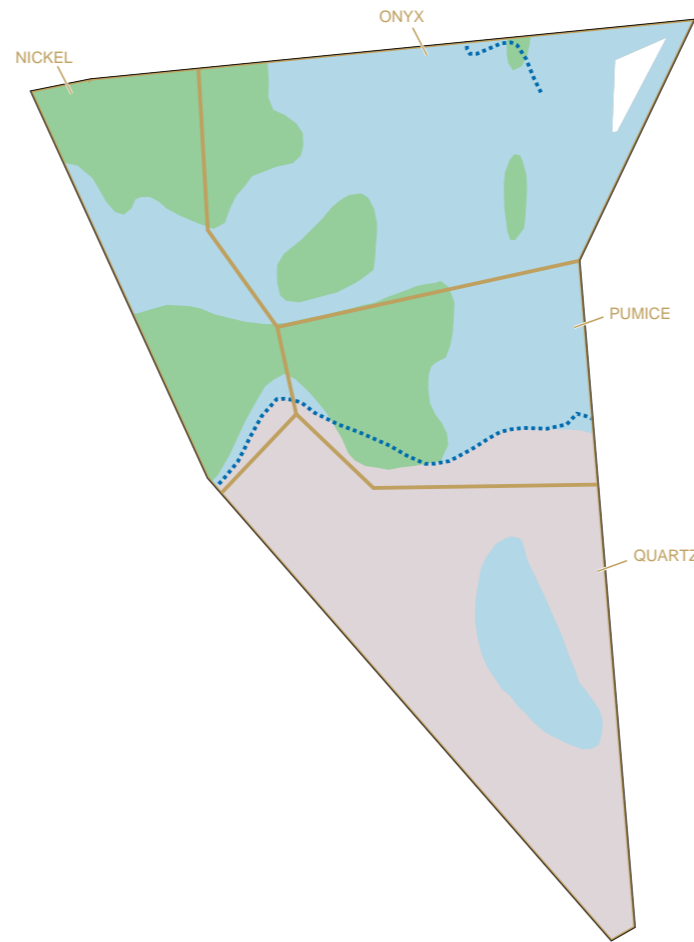
Operational sampling undertaken to date:

- No operational sampling has been undertaken in Area 513/2.

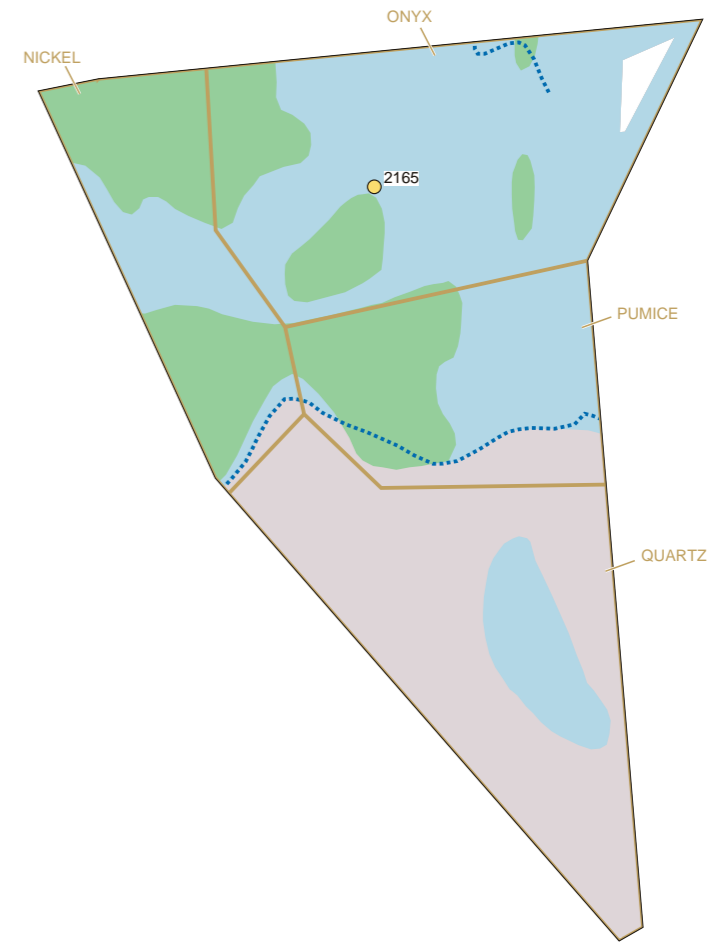
Sampling Operation Groups:

- Group 1:** Onyx, Pumice, Nickel: Licence sub-areas target Unit 3b deposits within Channel A.
Group 2: Onyx, Pumice, Nickel: Licence sub-areas target deposits within Channel A.
Group 3: Quartz: Licence sub-area targets Unit 2 or Unit 3b not from Channel A.

A. Interpretation and Operational Sampling tracks



B. Interpretation and known archaeology



	Hypothesis	Target Group 1		Target Group 2		Target Group 3	
		Hypothesis tested	Threshold	Hypothesis tested	Threshold	Hypothesis tested	Threshold
Inhabitation	H1.1: Middle Palaeolithic material is recovered from units other than Unit 3b	Not testable	Maintain current rate of assessment (1 in 20 loads). On four consecutive sample operations within a single dredge lane with no recovered finds reduce rate to 1 in 40.	Testable	Maintain current rate of assessment (1 in 20 loads). On four consecutive sample operations within a single dredge lane with no recovered finds reduce rate to 1 in 40.	Testable	If Unit 3b use Group 1 threshold. Within individual dredge lane if Unit 2 sediment is proved during sampling operation and no lithics recovered, no further operational assessment required.
	H1.2: Some of the Middle Palaeolithic material recovered from Unit 3b is <i>in situ</i>	Testable		Not testable		Testable	
	H1.3: Late Upper Palaeolithic material is recovered from other places in addition to the vicinity of Channel B	Testable		Testable		Testable	
	H1.4: Some Late Upper Palaeolithic material from the vicinity of Channel B is <i>in situ</i>	Not testable		Not testable		Not testable	
	H1.5: Some <i>in situ</i> Lower Palaeolithic material is recovered from units other than Unit 3b	Not testable		Testable		Testable	
	H1.6: Artefactual material appears to be <i>in situ</i> in areas other than Unit 3b and the vicinity of Channel B	Not testable		Testable		Testable	
	H1.7: Prehistoric material is recovered for periods later than the Later Upper Palaeolithic	Testable		Testable		Testable	
	H1.8: Faunal remains appear to be in primary contexts	Testable		Testable		Testable	
Choice and use of location	H2.1: Middle Palaeolithic material is recovered from the floodplain of Channel A, not from Channel A	Not testable	On four consecutive sample operations within a single dredge lane with no recovered finds reduce rate to 1 in 40.	Not testable	On four consecutive sample operations within a single dredge lane with no recovered finds reduce rate to 1 in 40.	Testable	Within individual dredge lane if Unit 2 sediment is proved during sampling operation and no lithics recovered, no further operational assessment required.
	H2.2: Middle Palaeolithic material is recovered from outlying deposits of Unit 3b north and south of the floodplain	Not testable		Not testable		Not testable	
	H2.3: Middle Palaeolithic material is clustered in relatively large quantities at discrete locations	Testable		Testable		Testable	
	H2.4: Middle Palaeolithic material is present in small quantities throughout Unit 3b deposits	Testable		Not testable		Testable	
Natural Processes	H3.1: Middle Palaeolithic material is recovered in areas where Unit 3b has been reworked by natural processes	Testable	On four consecutive sample operations within a single dredge lane with no recovered finds reduce rate to 1 in 40.	Not testable	On four consecutive sample operations within a single dredge lane with no recovered finds reduce rate to 1 in 40.	Testable	Within individual dredge lane if Unit 2 sediment is proved during sampling operation and no lithics recovered, no further operational assessment required.
	H3.2: Middle Palaeolithic material is recovered where Unit 3b appears to be covered by major bank structures	Not testable		Not testable		Not testable	
Human Processes, including Dredging History	H4.1: Middle Palaeolithic material is recovered where dredging history indicates that a high level of dredging has taken place since the introduction of EMS	Not testable	On four consecutive sample operations within a single dredge lane with no recovered finds reduce rate to 1 in 40.	Not testable	On four consecutive sample operations within a single dredge lane with no recovered finds reduce rate to 1 in 40.	Not testable	Within individual dredge lane if Unit 2 sediment is proved during sampling operation and no lithics recovered, no further operational assessment required.
	H4.2: Middle Palaeolithic material is recovered where geophysical data indicates that a high level of dredging has taken place	Not testable		Not testable		Not testable	
Operational Sampling Methods	H5.1: Faunal and artefactual material is found at all wharves where Operational Sampling takes place	Testable		Testable		Testable	

Licence Area (861 hectares)
 Dredging Sub Areas
 Extents of Late Anglian channel (Channel A)
 Unit 4 Middle Palaeolithic
 Unit 3b Middle Palaeolithic (floodplain)
 Unit 2 Lower Palaeolithic
 Known archaeology:
 Bone / faunal

0 1 2 km

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Plate 1: 2304



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Plate 2: 2278



Plate 3: 2279

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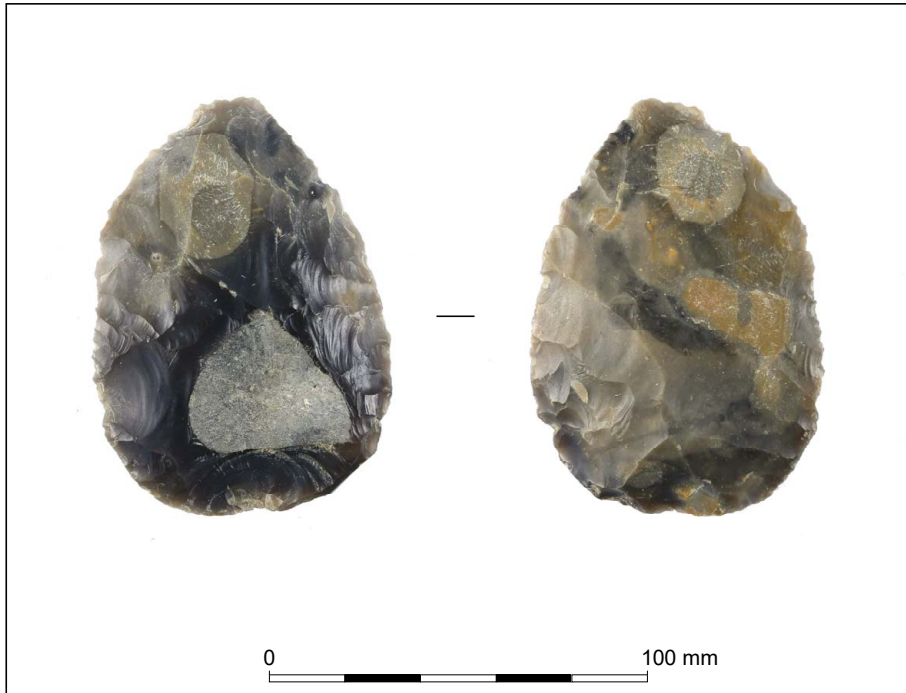


Plate 4: 2303

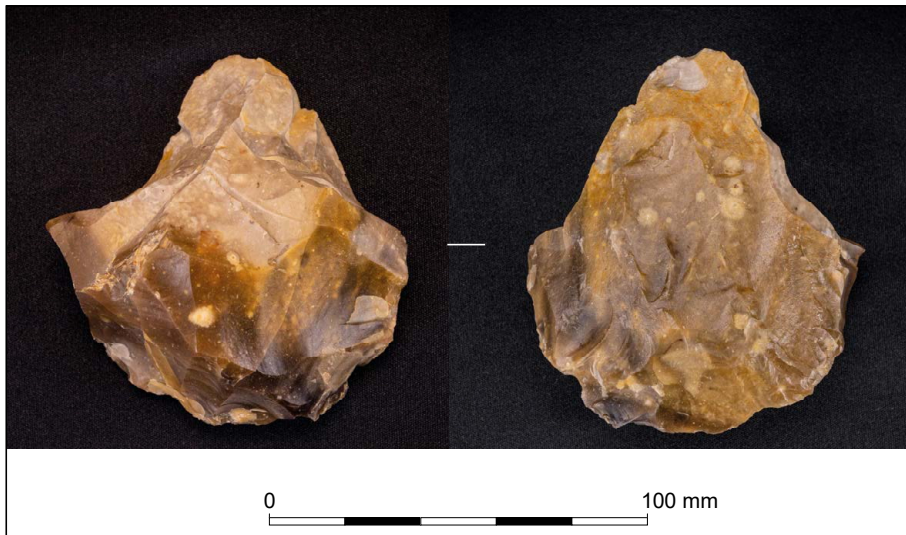



Plate 5: 2304

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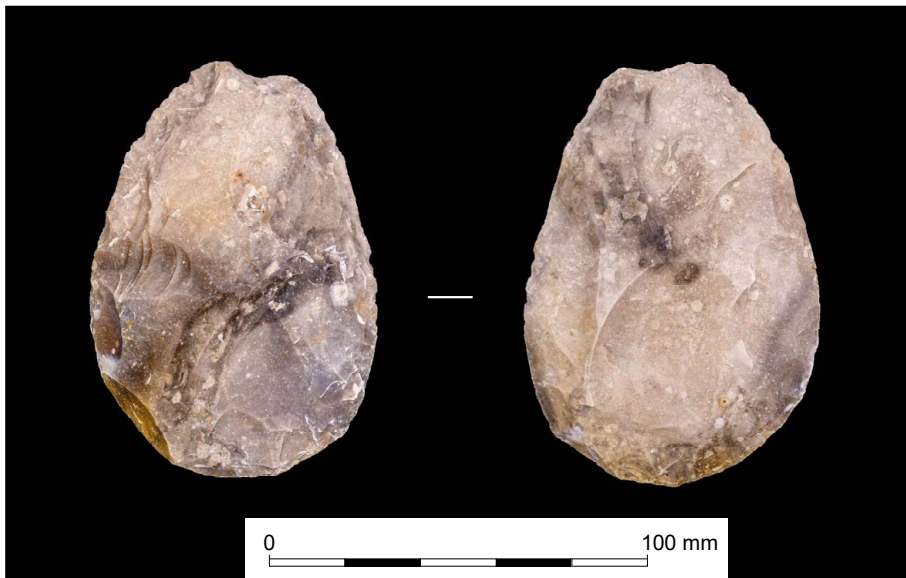


Plate 6: 2305



Plate 7: 2306


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Plate 8: 2307



Plate 9: 2308



Plate 10: 2309

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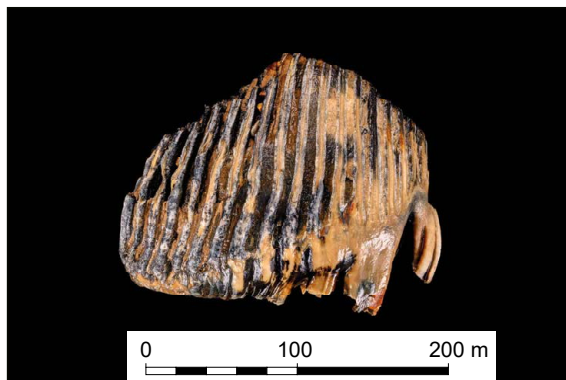


Plate 11: 2321

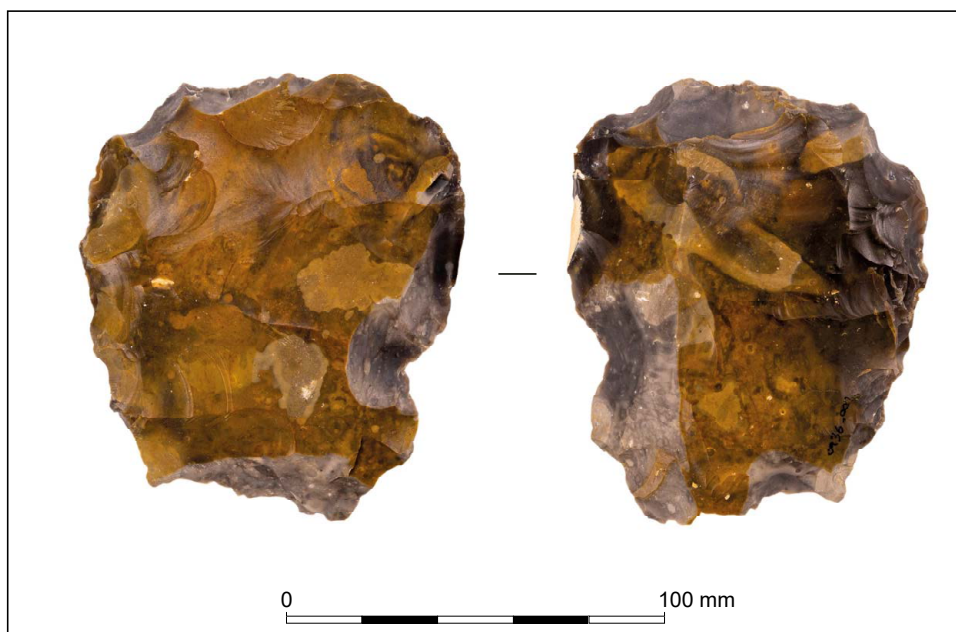


Plate 12: 2322

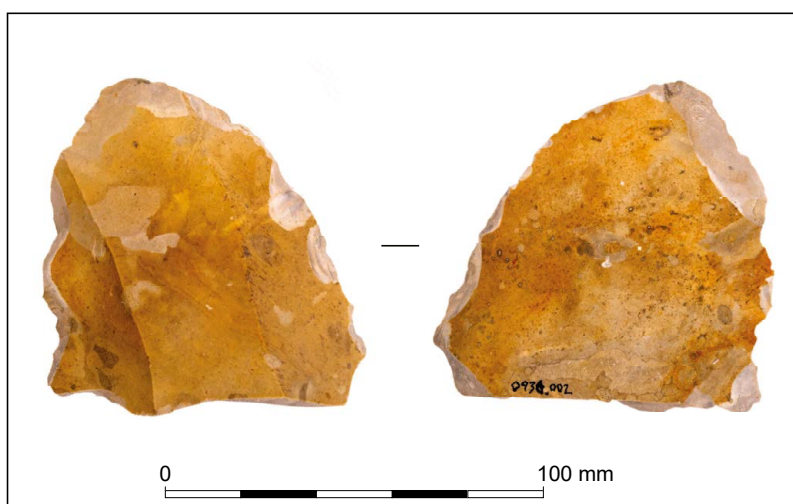



Plate 13: 2323

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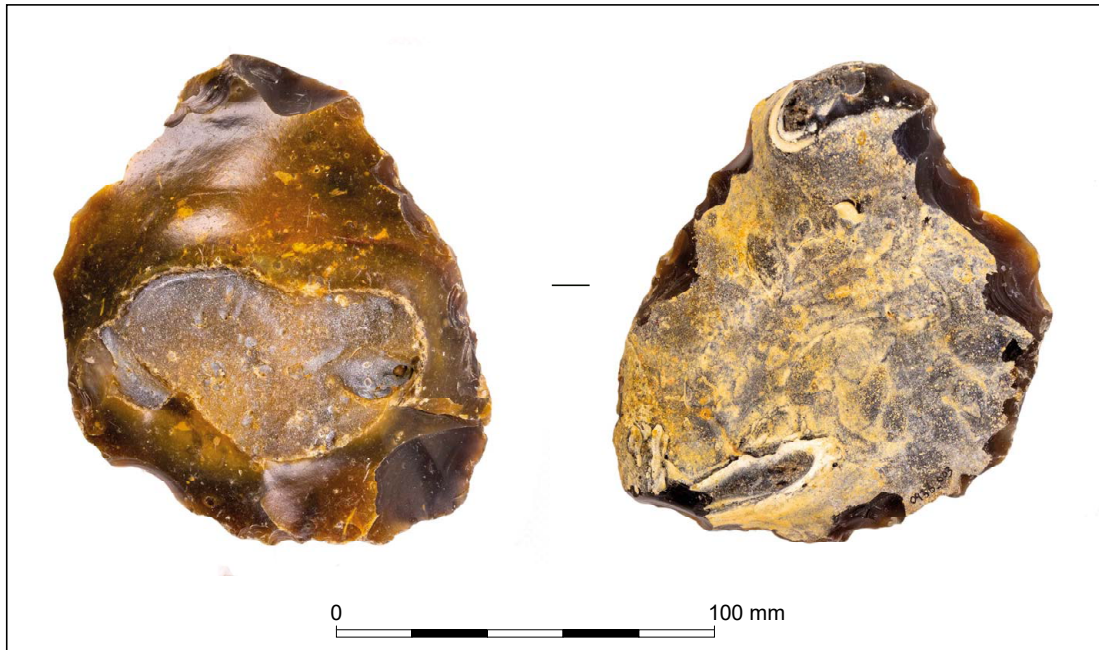


Plate 14: 2324

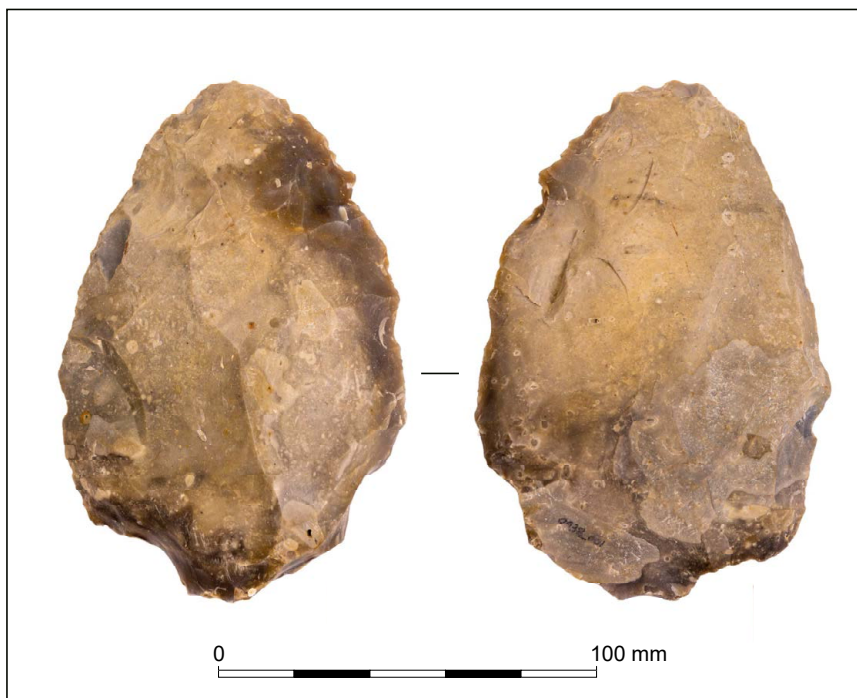



Plate 15: 2351

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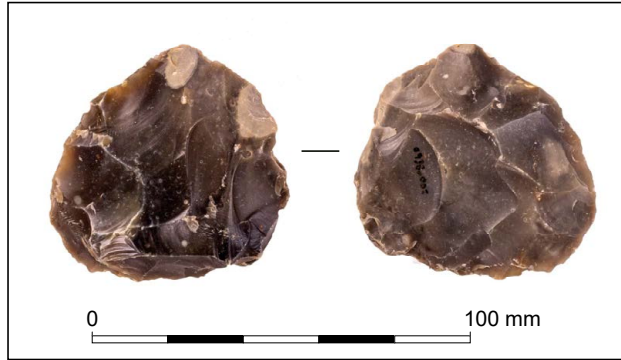


Plate 16: 2352

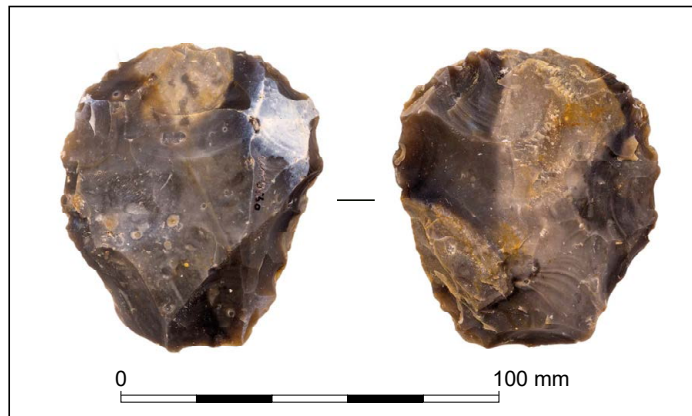


Plate 17: 2353

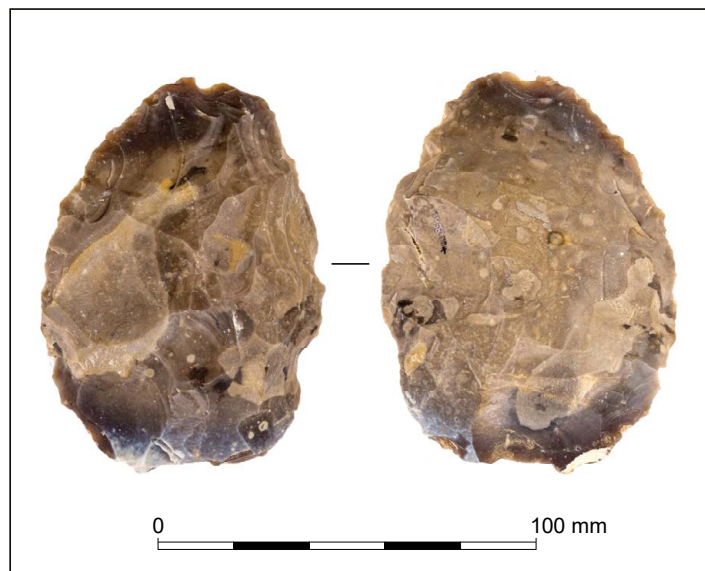



Plate 18: 2354

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	Path:	W:\Projects\220700\Graphics_Office\Rep figs\Mitigation_sampling\2020_01_07_Area240		

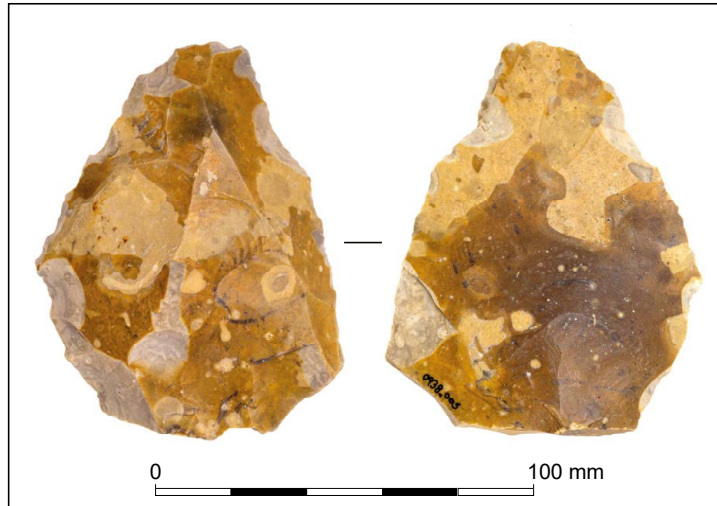



Plate 19: 2355



Plate 20: 2356



Plate 21: 2357

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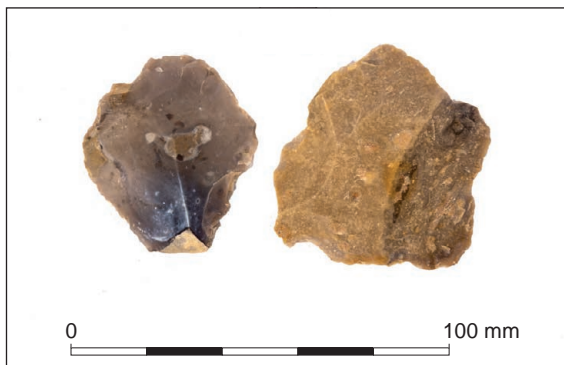


Plate 22: 2358, 2374

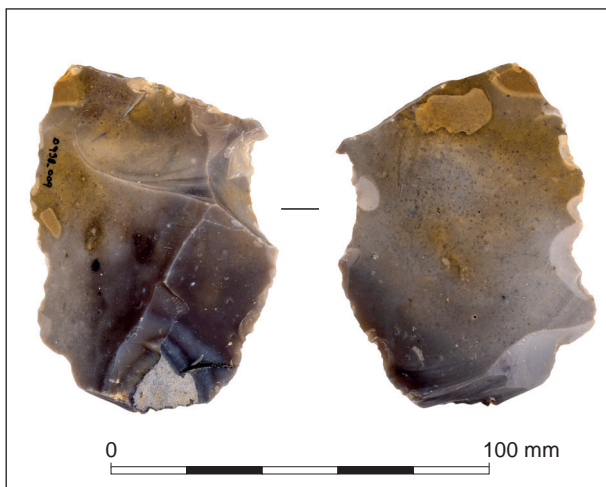


Plate 23: 2359

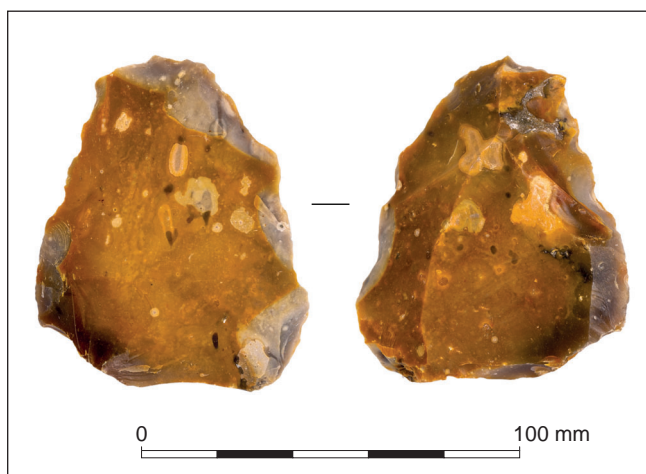



Plate 24: 2360

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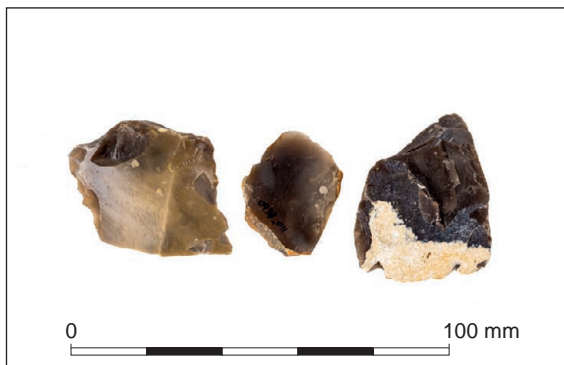


Plate 25: 2361, 2362, 2375

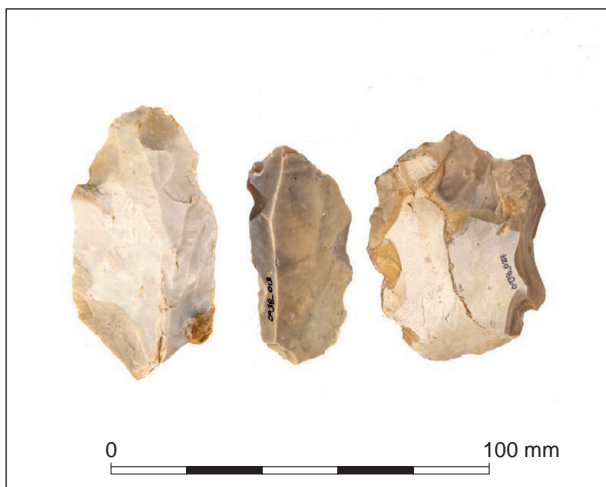


Plate 26: 2363, 2372, 2377

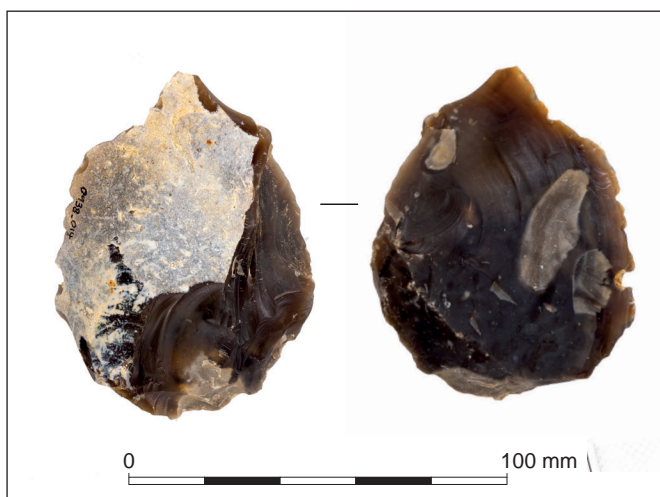



Plate 27: 2364

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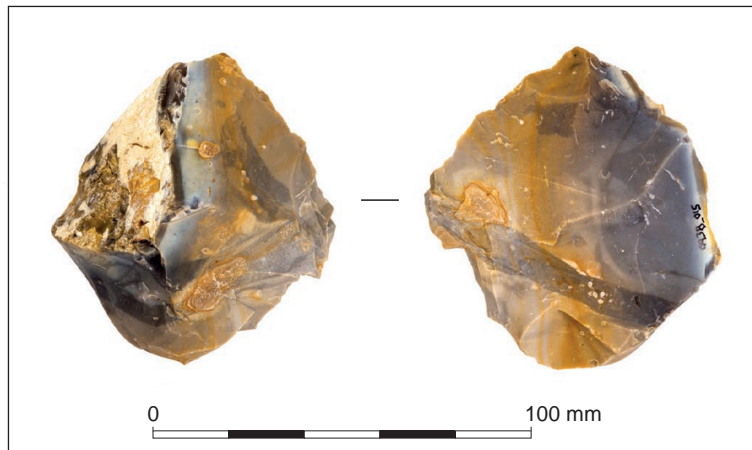


Plate 28: 2365

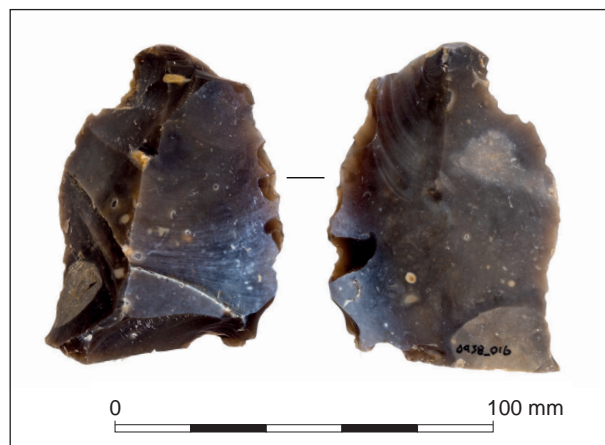


Plate 29: 2366

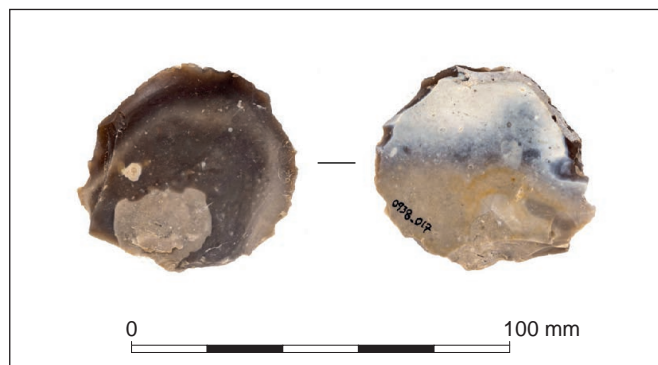


Plate 30: 2367


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Plate 31: 2368

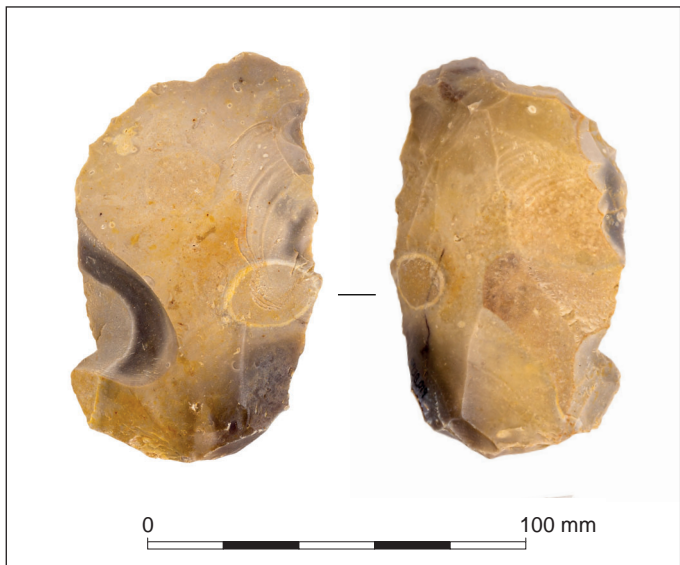


Plate 32: 2369

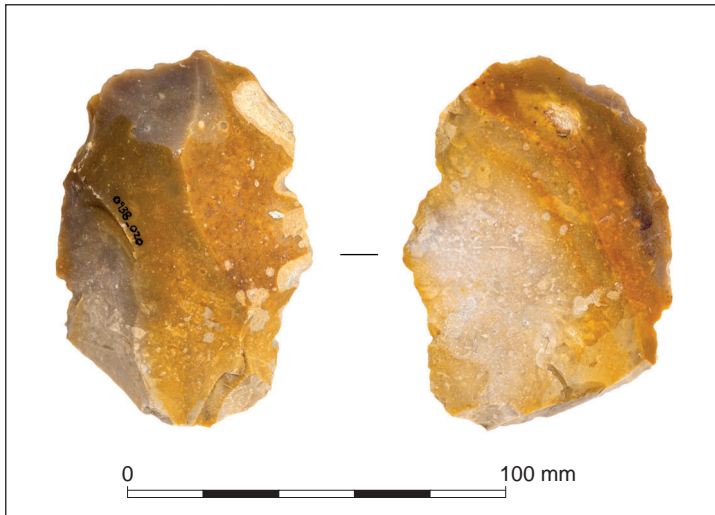



Plate 33: 2370

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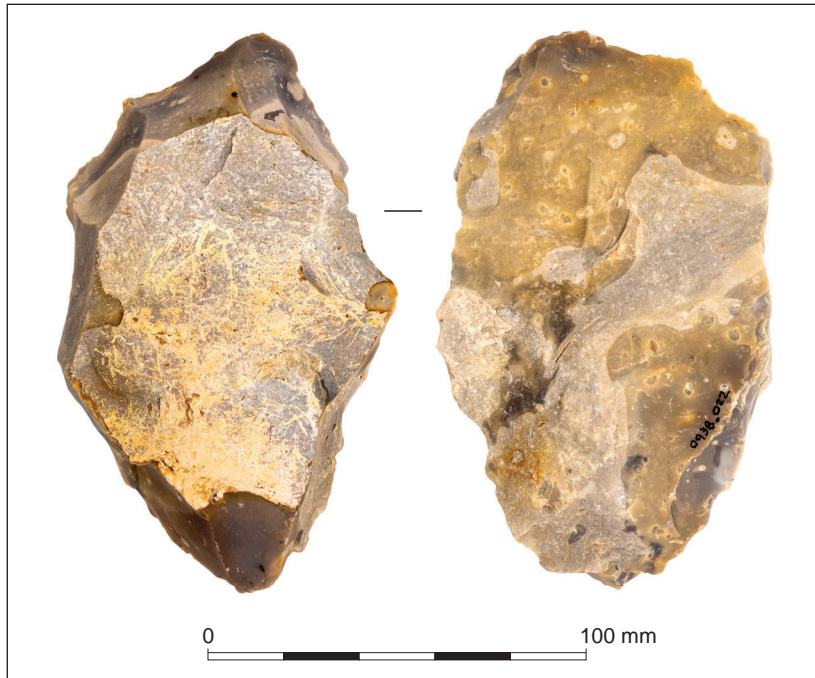



Plate 34: 2372



Plate 35: 2373



Plate 36: 2376

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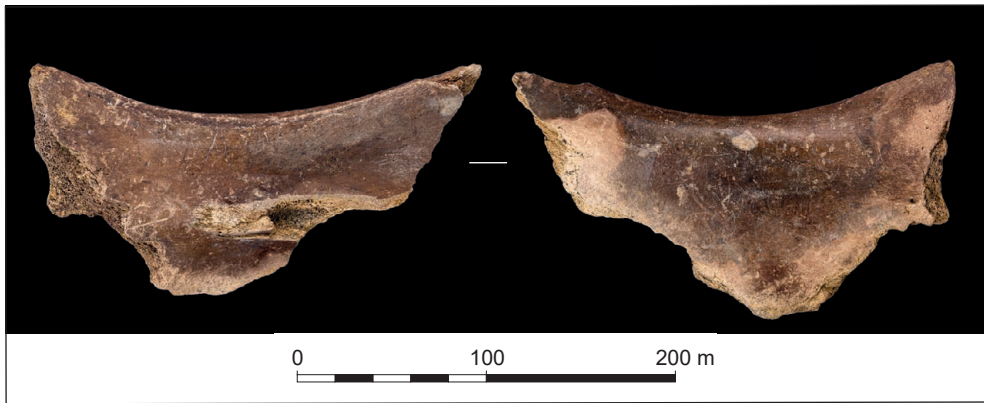


Plate 37: 2325



Plate 38: 2325


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Plate 39: 2337



Plate 40: 2348

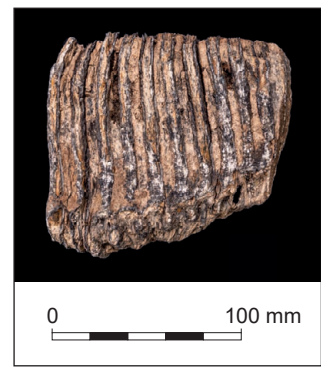


Plate 41: 2349




Plate 42: 2382



Plate 43: 2383



Plate 44: 2418

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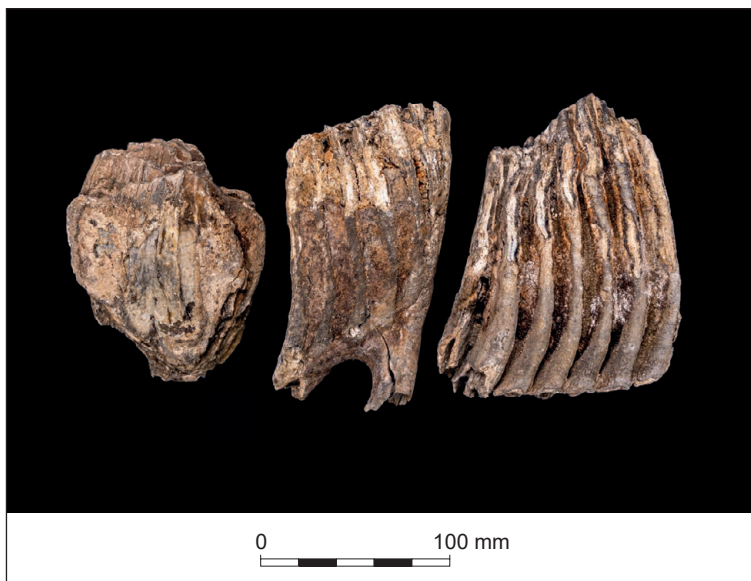


Plate 45: 2443



Plate 46: 2444



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Plate 47: 2301-2302

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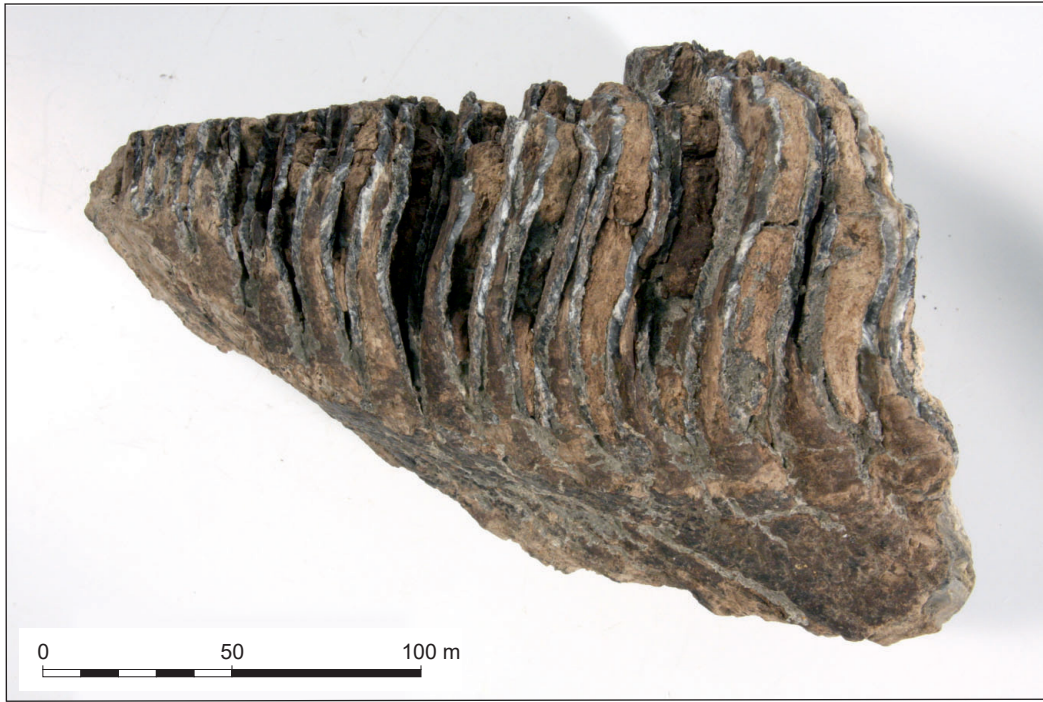


Plate 48: 2261



Plate 49: 2262



Plate 50: 2263



Plate 51: 2264


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Plate 52: 2267



Plate 53: 2268



Plate 54: 2269



Plate 55: 2270



Plate 56: 2271



Plate 57: 2272



Plate 58: 2273


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Plate 59: 2285

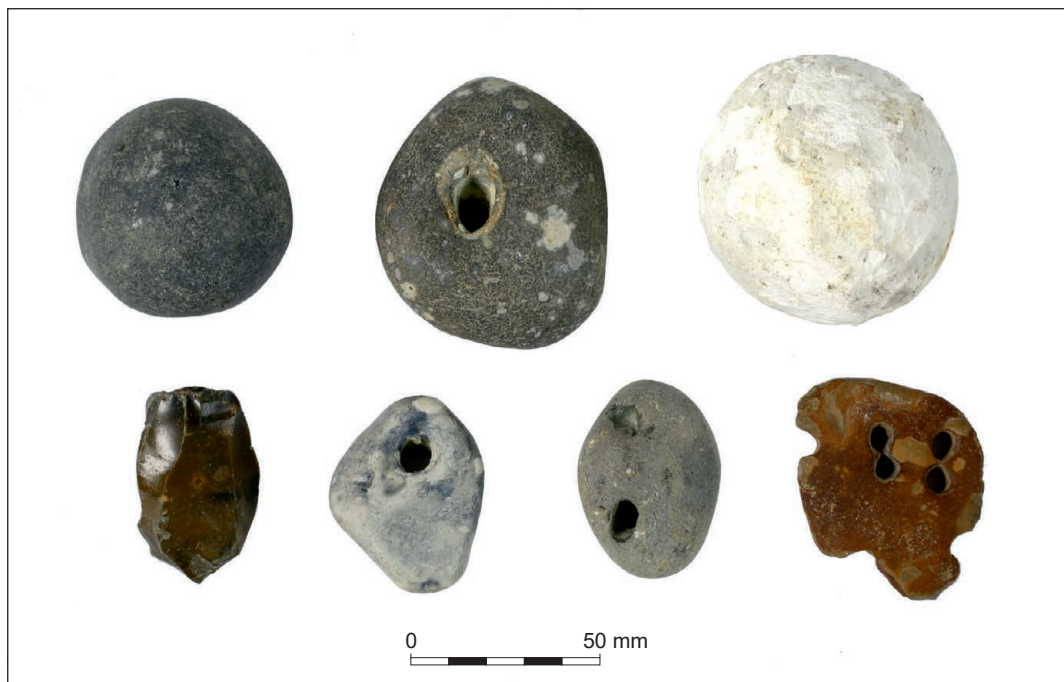



Plate 60: 2287

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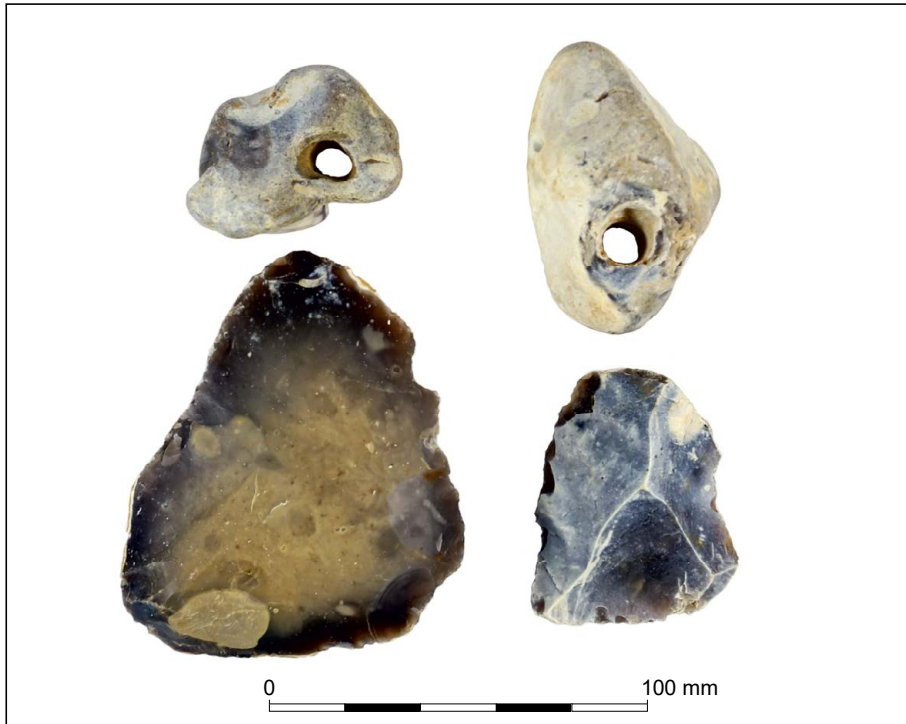


Plate 61: 2289



Plate 62: 2290


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Plate 63: 2291, 2292 and 2293

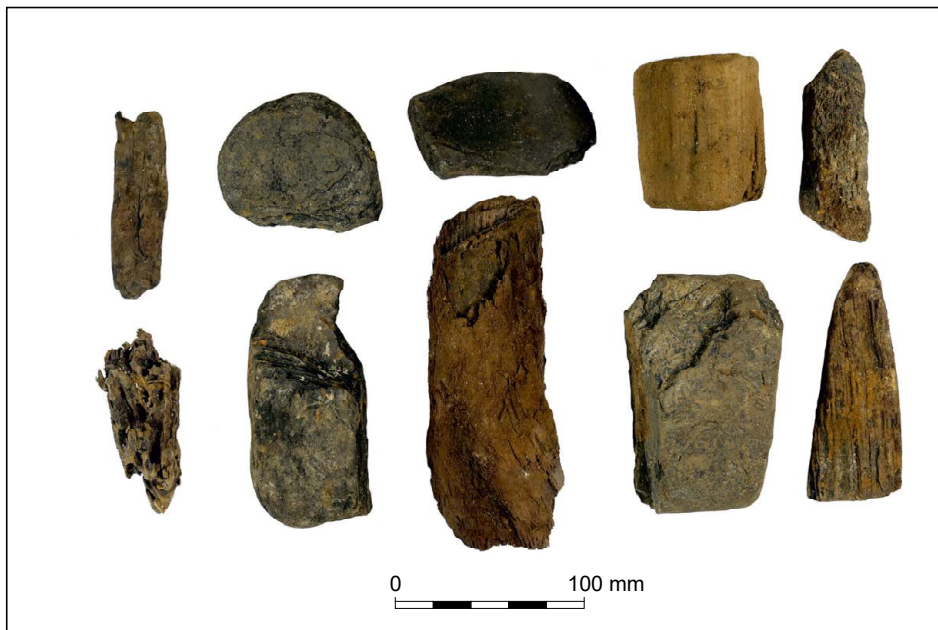



Plate 64: 2293

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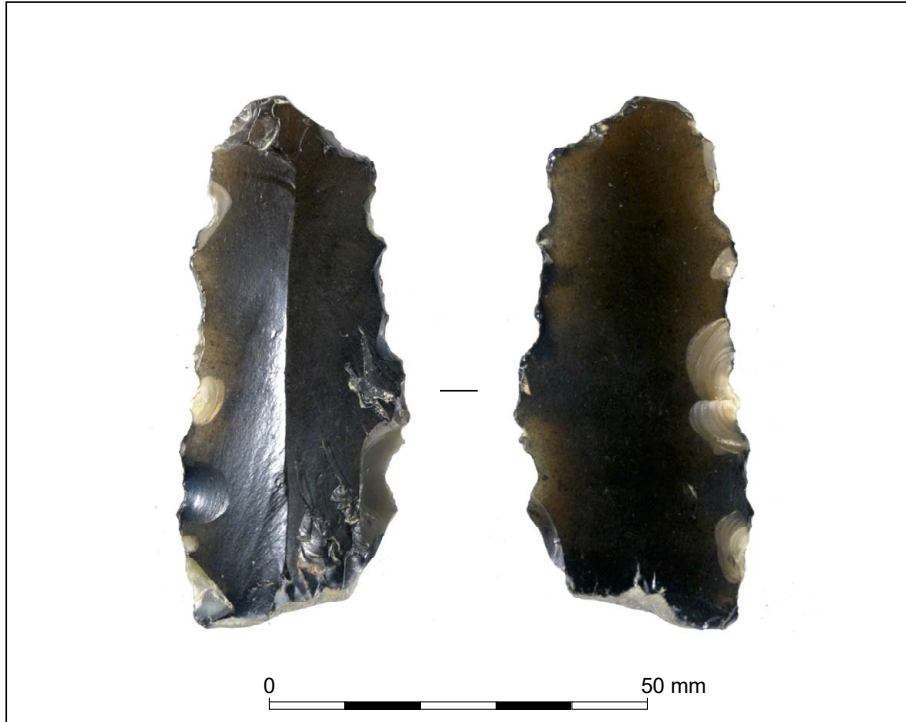



Plate 65: 2266



Plate 66: 2274

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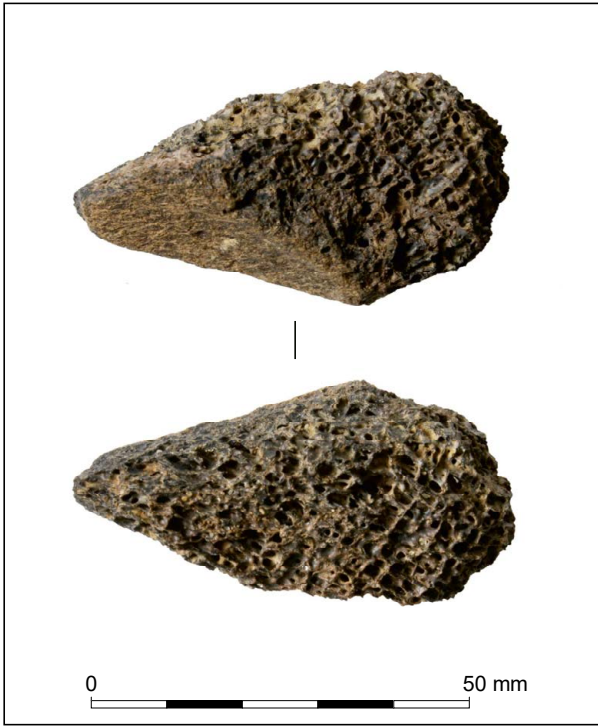


Plate 67: 2275

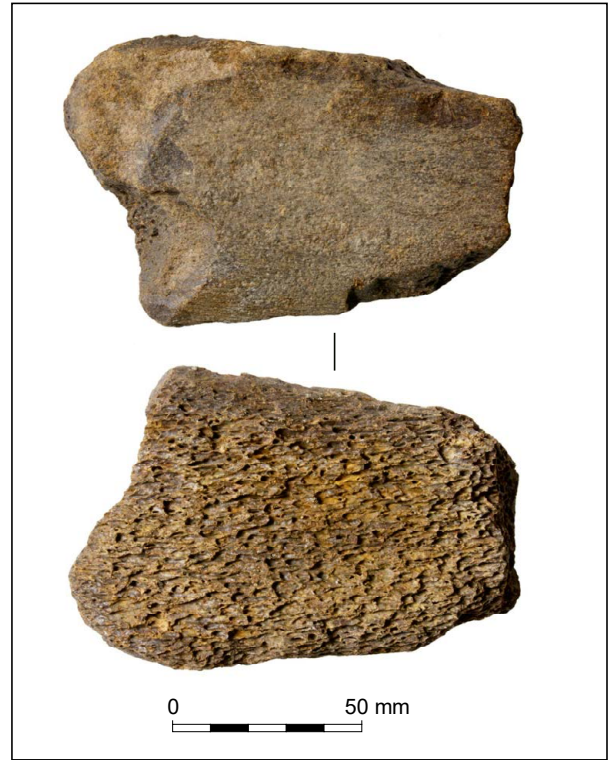


Plate 68: 2276

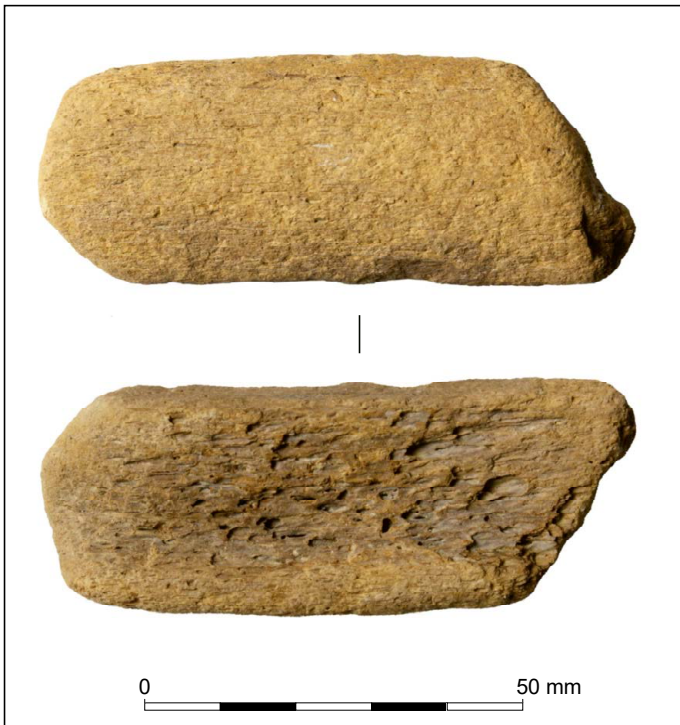



Plate 69: 2277



Plate 70: 2298



Plate 71: 2318

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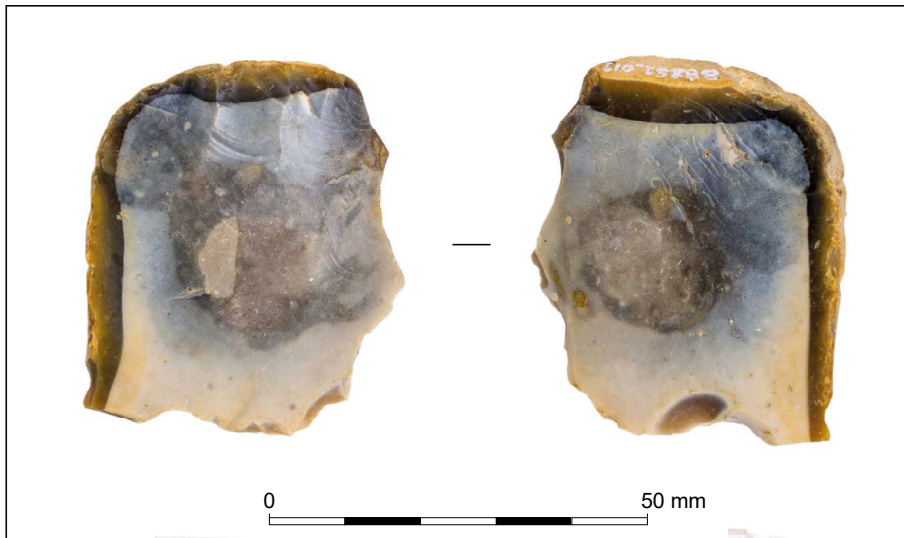



Plate 72: 2317



Plate 73: 2313-2316

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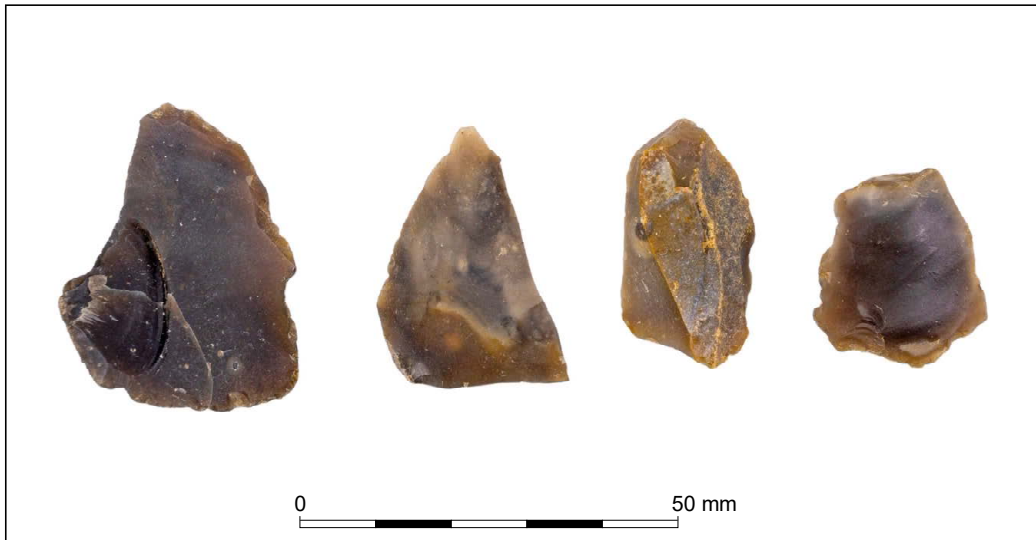



Plate 74: 2319-2020, 2311-2312

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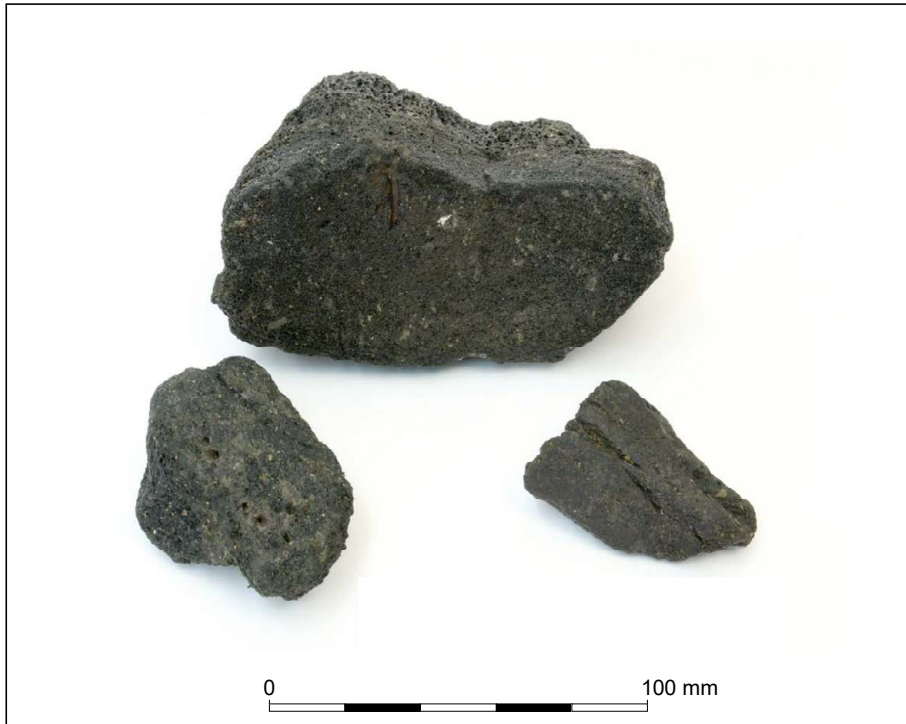


Plate 75: 2254-2256



Plate 76: 2257



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Plate 77: 2280



Plate 78: 2281

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