Palaeo-Yare Catchment

Geoarchaeological Assessment
of Marine Aggregates Licence Areas 212, 240, 242/361 and 401/2

Ref: 220701.01
November 2020

wessexarchaeology

Portway House
Old Sarum Park
Salisbury
Wiltshire
SP4 6EB

www.wessexarch.co.uk

Wessex Archaeology Ltd is a Registered Charity no. 287786 (England & Wales) and SC042630 (Scotland)

Document Information

Document title	Palaeo-Yare Catchment
Document subtitle	Geoarchaeological Assessment of Marine Aggregates Licence Areas 212, 240, 242/361 and 401/2
Document reference	220701.01
Client name	Hanson Aggregates Marine Limited
Site location	Southern North Sea
Planning authority	Marine Management Organisation
WA project name	East Coast Marine Aggregates - MGA
WA project code	220701
Project management by	Euan McNeill
Document compiled by	Claire Mellett
Contributions from	Louise Tizzard, Lowri Roberts, Andrea Hamel and Richard Milwain
Graphics by	Kitty Foster

Quality Assurance

Issue and date		Status	Author	Approved by
1	13/11/2020	Draft to client	CM	DN/AEM

Contents

Summary ..... *iii*
Acknowledgements ..... *i*

1 INTRODUCTION **2**
1.1 Project background 2

2 BACKGROUND **2**
2.1 Summary of previous works 2

3 AIMS AND OBJECTIVES **8**

4 METHODS **9**
4.1 Introduction 9
4.2 Geotechnical vibrocore assessment 9
4.3 Updates to deposit model 9
4.4 Dredging history 10
4.5 Known Archaeology 10

5 RESULTS **10**
5.1 Area 212 10
5.2 Area 240 12
5.3 Area 242/361 15
5.4 Area 401/2 17

6 DISCUSSION **19**
6.1 Early Pleistocene (2.58 MA – 773 ka) 19
6.2 Middle Pleistocene (773 ka – 126 ka) 20
6.3 Late Pleistocene (126 ka – 11.7 ka) 21
6.4 Holocene (11.7 ka – present day) 22

7 CONCLUSIONS AND RECOMMENDATIONS **23**
7.1 Deposit extent and survival 23
7.2 Operational sampling 23
7.3 Archaeological potential 24
7.4 Future work 24

REFERENCES **26**

APPENDICES **28**
Appendix 1 28

List of Figures

Figure 1 Location of Hanson Aggregate Marine Licence Areas
Figure 2 Palaeo-Yare Catchment Assessment
Figure 3 Location of vibrocore survey data
Figure 4 Area 212: Review of deposit extent based on review of vibrocore data
Figure 5 Area 240: Review of deposit extent based on review of vibrocore data
Figure 6 Area 242/361: Review of deposit extent based on review of vibrocore data
Figure 7 Area 401/2: Review of deposit extent based on review of vibrocore data
Figure 8 Area 212: Dredging activity determined from Electronic Monitoring System data
Figure 9 Area 240: Dredging activity determined from Electronic Monitoring System data
Figure 10 Area 242/361: Dredging activity determined from Electronic Monitoring System data
Figure 11 Area 401/2: Dredging activity determined from Electronic Monitoring System data

List of Tables

Table 1 Summary of previous geoarchaeological works
Table 2 Summary of hypotheses (Fjordr 2016)
Table 3 Lithostratigraphy of the offshore Palaeo-Yare catchment
Table 4 Vibrocore survey data
Table 5 Data conflicts Area 240
Table 6 Data conflicts Area 242/361
Table 7 Data conflicts Area 401/2
Table 8 Archaeological potential of deposits

List of Datasheets

Sheet 1 Area 212
Sheet 2 Area 240
Sheet 3 Area 242/361
Sheet 4 Area 401/2

Summary

Wessex Archaeology have been commissioned by Hanson Aggregates Marine Limited to undertake a marine geoarchaeological assessment of deposits from the submerged Palaeo-Yare.

This work will build upon the regional-scale Palaeo-Yare Catchment Assessment undertaken by Wessex Archaeology (2013a) and supports the Palaeo-Yare catchment 5-year monitoring review (Wessex Archaeology 2020). The results will be used to inform decisions relating the management of future marine aggregate dredging activity.

The study area is located in the southern North Sea, between 10 km and 30 km east of Lowestoft, UK, and comprises Marine Aggregate Licence Areas 212, 240, 242/361 and 401/2. These licence areas are located within the offshore reaches of the Palaeo-Yare valley which contains key deposits from which a large number of Palaeolithic artefacts and faunal remains have been recovered.

A total of 184 geotechnical vibrocores logs from five surveys undertaken between 2012 and 2017 were reviewed in order to establish the nature and depth of deposits preserved in each licence area. Deposits were interpreted with reference to the stratigraphic framework defined during the Palaeo-Yare Catchment Assessment. Core photographs and the results from particle distribution analysis were also used to support interpretations.

The results of the vibrocore review were compared to the legacy deposit model constructed as part of the Palaeo-Yare Catchment Assessment. Instances where the vibrocore data disagreed from the legacy deposit model were investigated, and where necessary, the deposit model was updated. This assessment was undertaken considering any dredging activity, derived from Electronic Monitoring System (EMS) data, that occurred over the period 2016-2019 (date since last review).

In Area 212, Unit 2 (Yarmouth Roads) and Unit 8 (surficial sediments) were the only deposits recorded in vibrocores. The extent of Unit 2 in vibrocores agreed with the legacy deposit model and no updates were required. Middle Palaeolithic artefacts were recovered from Area 212 during operational sampling. This archaeology is younger than the expected age of Unit 2, therefore there is potential for isolated patches of Unit 3b to be preserved. However, this has never been proven with vibrocore data.

Unit 2, Unit 3b (Saalian Palaeo-Yare floodplain sediments), Unit 5 (Weichselian estuarine sediments), Unit 6 (Weichselian glaciofluvial sediments), Unit 7 (Holocene transgressive sediments) and Unit 8 were recorded in vibrocores assessed from Area 240. After comparing the results to the legacy deposit model, there was a slight reduction (0.07 km^2) in the extent of Unit 3b in the north-east of the Area 240. However, this did not correlate to any dredging activity recorded over the period 2016-2019 and this change is likely due to the addition of new ground-truth data in this region allowing refinement of the deposit model.

Vibrocores from Area 242/361 recovered Unit 2, Unit 3b and Unit 8. The legacy deposit model suggests Unit 4 (Brown Bank Formation) is preserved in Area 242/361 but Unit 4 was not recovered in vibrocores. Based on the assessment of new vibrocore data, a very minor (0.04 km^2) extension of Unit 3b was required in Area 242/361. This change was driven by an increase in ground-truth data and is not a result of dredging activity.

Unit 2, Unit 3b, Unit 4 and Unit 8 were recorded in vibrocores from Area 401/2. Based on the vibrocore data, changes were made to the extent of Unit 3b in the northwest of the licence area, with a reduction in the extent of Unit 3b by 3.8 km^2. In the southeast corner of the licence area, Unit 3b was extended by 2.3 km^2 while the area of Unit 4 was reduced by 2.8 km^2. In the northwest, there has been no dredging activity over the period 2016-2019 and the changes here reflect an increase

in ground-truth data. However, in the southwest, EMS data shows there has been dredging and it is possible dredging has removed Unit 4, exposing the underlaying Unit 3b.

Updates to the deposit model were made in Area 240, Area 242/361 and Area 401/2. These updates were considered alongside the Sampling Operation Groups and Thresholds for each licence area, previously defined in Wessex Archaeology (2013a). No changes to the grouping were required in Area 240 and 401/2. However, due to a change in licence extent, the Operational Sampling Groups and Thresholds for Area 242/361 were changed to reflect the local geology.

The vibrocore data assessed here were largely in agreement with the legacy deposit model increasing confidence in the original interpretation. Only minor changes were made to the extent of Unit 3b and Unit 4. These changes are largely due to increased data resolution that allowed the deposit model to be refined, although dredging activity may have been responsible for removing Unit 4 and exposing Unit 3b in Area 401/2.

To support ongoing operational sampling monitoring visits, it is recommended the data sheets for each licence area are updated on a yearly basis to include new operational sampling events, any new finds and EMS data for the last year.

Acknowledgements

Wessex Archaeology would like to thank Nigel Griffiths, Amy Stewart, Patrick Mallon and Bryn Lockwood of Hanson Aggregates Marine Ltd. for providing data and support. Kevin O'Shea at Royal Haskoning is thanked for providing Electronic Monitoring System data.

Palaeo-Yare Catchment

Geoarchaeological Assessment of Marine Aggregate Licence Areas 212, 240, 242/361 and 401/2

1 INTRODUCTION

1.1 Project background

1.1.1 Wessex Archaeology have been commissioned by Hanson Aggregates Marine Limited (HAML) to undertake a marine geoarchaeological assessment of deposits from the submerged Palaeo-Yare within Marine Aggregate Licence Areas 212, 240, 242/361 and 401/2. The results will be used to inform decisions relating the management of future marine aggregate dredging activity. This work will build upon the regional-scale Palaeo-Yare Catchment Assessment undertaken by Wessex Archaeology (2013a) and supports the Palaeo-Yare catchment 5-year monitoring review (Wessex Archaeology 2020).

1.2 Study Area

1.2.1 The study area is located in the southern North Sea, between 10 km and 30 km east of Lowestoft, UK, and comprises Marine Aggregate Licence Areas 212, 240, 242/361 and 401/2 (**Figure 1**). These licence areas are located within the offshore reaches of the Palaeo-Yare valley (**Figure 2**) which comprises key deposits from which a large number of Palaeolithic artefacts and faunal remains have been recovered.

2 BACKGROUND

2.1 Summary of previous works

2.1.1 Archaeological works in the region of the East Coast Marine Aggregate Licence Areas have been ongoing since 2007 and continue in the present day with the delivery of the operational sampling monitoring programme (Wessex Archaeology 2020) (**Table 1**).

Table 1 Summary of previous geoarchaeological works

Year	Report	Reference
2011	Seabed Prehistory: Site Evaluation Techniques (Area 240) Synthesis	Wessex Archaeology (2011a)
2011	East Coast Regional Environmental Characterisation	Limpenny (2011)
2011	Licence Area 240 Archaeological Monitoring of Dredging Activity'	Wessex Archaeology (2011b)
2013	Palaeo-Yare Catchment Assessment Technical Report (83740.04)	Wessex Archaeology (2013a)
2013	Palaeo-Yare Catchment Assessment Addendum Short-term Licence Areas	Wessex Archaeology (2013b)
2015	Palaeo-Yare Operational Sampling conducted under the short-term licencing provisional Written Scheme of Investigation: Interpretive Report.	Wessex Archaeology (2015)
2016	Written Scheme of Investigations Early Prehistoric Material in the Norfolk Block of the Anglian Region	Fjordr (2016)
2016	Licence Areas 212, 240, 242, 361 and 401/2: Monitoring Method Statements	Wessex Archaeology (2016)
2020	Paleo-Yare Catchment Monitoring: Interpretative Report Five Year Review of Operational Sampling: January 2015 to December 2019	Wessex Archaeology (2020)

2.1.2 In 2007/2008, 88 Palaeolithic artefacts, including handaxes, flakes and cores as well as a series of bones (woolly mammoth, woolly rhino, bison, reindeer and horse) were discovered by Mr Jan Meulmeester in stockpiles of gravel at the SBV Vlissingen (Flushing) Wharf. The finds were identified from stockpiles and reject piles between the 7th December 2007 to the 18th March 2008, dredged from the dredging Licence Area 240 between the 7th December 2007 and 5th February 2008. The fresh condition of some of the handaxes indicated that they came from relatively undisturbed deposits.

2.1.3 The discovery of the finds were reported to English Heritage and through the BMAPA *Protocol for Reporting Finds of Archaeological Importance* (BMAPA and English Heritage 2005). The place where the finds were dredged was relatively discrete, dredged specifically for aggregates for SBV Flushing. The correlation between the inspected stockpiles and the source of the aggregate, confirmed by the correspondence between the dates of his visits and the dates of aggregate dredging in Area 240, means that the provenance of the artefacts is secure. Moreover, a review of trackplots of dredging for the relevant dates has established the extent of a quite limited geographical area within which the artefacts are most likely to have been recovered.

2.1.4 Once the finds were reported, HAML, the licensee, stopped dredging in the immediate area and voluntary implemented a rectangular exclusion zone based on dredger trackplots in accordance with the BMAPA *Protocol for Reporting Finds of Archaeological Interest*.

2.1.5 An assessment of the flint assemblage was carried out by Dr Dimitri De Loecker of the University of Leiden (De Loecker 2011). The assemblage comprised a total of 33 handaxes, 47 complete and fragmented flakes and flake tools, and eight cores.

2.1.6 The condition and quality of the flint artefacts show that the material originates from several contexts. However, it is likely that some of the flint artefacts were dredged from undisturbed deposits. Generally, accumulated evidence of early human activity (a palimpsest) is suggested (De Loecker 2011). The flint raw material used is homogenous in character and was sourced from exposed gravel bar river deposits (De Loecker 2011).

2.1.7 The assessment of the 33 handaxes revealed that the assemblage is homogenous and show a considerable amount of workmanship. The handaxes are of cordiform or sub-cordiform type and can be described as Acheulean or as Mousterian of Acheulean Tradition (De Loecker 2011).

2.1.8 The faunal remains were assessed by Mr Jan Glimmerveen in Holland. Initial radiocarbon dating of a number of bones returned dates of between 31,000 and 43,000 BP and approximately 70 % of the bones recovered have been attributed to this date. The remaining 30 % are heavily fossilised and at the time it was estimated that the majority were thought to be older than 500 ka (J. Glimmerveen, pers. com. 21/07/2010).

2.1.9 Between October 2008 and March 2011 Wessex Archaeology undertook a multi-disciplinary project (*Seabed Prehistory: Site Evaluation Techniques (Area 240)*) with the aim of improving the future management of the potential effects of aggregate dredging on the marine historic environment by developing techniques to evaluate the source of prehistoric artefactual material discovered in the East Coast region. The project included the acquisition and interpretation of geophysical data, geotechnical data, seabed sampling, vibrocoring, palaeoenvironmental assessment, analysis and dating (Wessex Archaeology 2011a).

2.1.10 During the seabed sampling phase of the *Seabed Prehistory* project a further 11 worked flakes were recovered from the southern half of the exclusion zone. The worked flint were recovered using a clamshell grab with samples acquired from 31 locations along three transects. A total of 19 tons of sediments were processed (sieved to 10 mm, with sub-samples sieved to 4 mm). Although the number of flints recovered was low due to the methodology, the recovery of worked flint indicated that there was potential for further artefacts and that the sediment containing artefacts had not been completely removed by dredging activities.

2.1.11 During June 2009, prior to the seabed sampling phase of the *Seabed Prehistory* project, a piece of worked flint was recovered from a clamshell grab sample during the East Coast Regional Environmental Characterisation survey (Limpenny et al. 2011). The grab targeted sediments within the voluntary exclusion zone and confirmed the potential for further artefacts to be found.

2.1.12 The flint artefacts are interpreted as being principally associated with a specific glaciofluvial sediment Unit 3b. Deposited during the Saalian (MIS 8/7), Unit 3b forms a floodplain deposit of Channel A (Wessex Archaeology 2011a).

2.1.13 Further work carried out by Wessex Archaeology for HAML comprised a programme of archaeological monitoring of aggregate dredging within dredging licence Area 240 and its subsequent processing in Holland (Wessex Archaeology 2011b). The project was undertaken with agreement with Historic England with the aims of:

- trialling methods of bulk sampling the seabed using standard aggregate dredging plant with the goal of intercepting artefactual material in industrial processes for the purposes of evaluation, and;

- evaluating the presence/absence, distribution, character, quality and preservation of Palaeolithic artefacts within the Area 240 and specifically within the established exclusion zone.

2.1.14 Dredged material was assessed on the dredger, on the plant at the sorting table and the oversize stockpile. A total of 24 flint artefacts, including three handaxes, were recovered from the eight dredge loads (~40,000 tons) and confirmed the association of worked flint with the Saalian floodplain deposit. Monitoring of the dredged material indicated that archaeological material were present in the southern half of the exclusion zone and in dredging lanes situated to the east, indicating a possible wider distribution of material, than originally recovered.

2.1.15 The project concluded that in terms of the specific management of Area 240 it would seem appropriate to follow a combined approach of both managed access and monitoring, developed in consultation with English Heritage.

2.1.16 The flint artefacts from the original discovery and the flints recovered during clamshell grab sampling and during the monitoring of dredging activity are, henceforth, referred to as the Middle Palaeolithic Assemblage.

2.1.17 Given the distribution of artefactual material in Area 240 it was hypothesised that there would be potential in the wider region where there were remnants of Unit 3b deposits. This is supported by the small number of finds reported through the Marine Aggregate Industry *Protocol for Reporting Finds of Archaeological Interest*. Interpretation of the geology of Area

240 suggested that Unit 3b extended into adjacent licence areas, but it was not known how regionally extensive this unit was.

2.1.18 As such, the presence of the Middle Palaeolithic Assemblage in Area 240 and the association with specific deposits (Unit 3b) has implications not only for licencing of Area 240 but also licence areas within the wider East Coast region. This was acknowledged by the industry and the aggregate companies.

2.1.19 It was also acknowledged that the relationship between the apparently *in situ* archaeological material and the regional context of Unit 3b could not effectively be carried out on a licence by licence area basis and highlighted the need for a regional review to provide a better understanding of the prehistoric archaeological resource in the region in terms of its distribution, significance and the mitigation effects from dredging.

2.1.20 The Palaeo-Yare Catchment Assessment was undertaken in 2012/2013 with the aim of delineating the regional extent and survival of deposits from which a large number of flint artefacts and faunal remains have been recovered (Wessex Archaeology 2013a). This assessment provided a holistic review of the archaeological potential of surviving deposits in the onshore and offshore sections of the Palaeo-Yare, considering the catchment as a whole. The results were used to develop key hypothesis that could be tested through an operational sampling programme as a means of managing and mitigating future marine dredging activities in the East Coast region.

2.1.21 As an addendum to the Palaeo-Yare catchment assessment, each of the Licence Areas was reviewed independently and a series of methodologies designed to meet the individual needs of each Licence Area according to the deposits preserved and archaeology recovered (Wessex Archaeology 2013b).

2.1.22 A series of hypotheses were developed as part of the Palaeo-Yare Catchment Assessment (Wessex Archaeology 2013a) in order to test the following conclusions, and to address remaining uncertainties;

- The Middle Palaeolithic Assemblage is mixed, *i.e.* contains artefacts of *in situ* and secondary context.
- The Middle Palaeolithic Assemblage is primarily associated with Unit 3b within Area 240.
- There is potential for Palaeolithic material in secondary context associated with Units 2, 3b, 4, 7, 8 and the bank structures (of unknown age).
- Natural processes throughout transgressions and regressions subsequent to deposition have not completely removed sediment units. With regards to the *in situ* elements of the Middle Palaeolithic assemblage, remnants of *in situ* Unit 3b sediments are present within the region.
- Extensive dredging of the region has not necessarily completely removed Unit 3b sediments within the area.
- There is potential for *in situ* archaeological material to be present elsewhere within the region where remnants of Unit 3b are located.

- Faunal remains and palaeoenvironmental material are likely to be sourced from Units 2, 3b, 4 and 7. These could be *in situ* or secondary context and may be located throughout the region.

- Uncertainties remain due to the data limitations used for the assessment and the degree of dredging undertaken since the geophysics data were acquired.

2.1.23 The hypotheses were later reviewed in 2016 and defined in a Written Scheme of Investigation (Fjordr 2016). These hypotheses, listed below, underpin an operational sampling programme that has been ongoing since 2012 (summarised in Wessex Archaeology 2015 and Wessex Archaeology 2020). The hypotheses predominantly focus on the proven potential for artefacts within the Palaeo-Yare floodplain deposits (Unit 3b), divided into five key groups relating to specific issues as outlined in **Table 2**.

Table 2 Summary of hypotheses (Fjordr 2016)

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

2.2 Legacy deposit model

2.2.1 A deposit model was constructed as part of the Palaeo-Yare Catchment Assessment (Wessex Archaeology 2013a) by integrating over 2,500 line km of sub-bottom profiler data from 22 surveys that occurred between 1989 and 2011, and geotechnical information from 1,171 vibrocore logs acquired between 1988 and 2011. This vast data set was used to define the stratigraphy of key deposits in the region and map their extent (**Table 3**; **Figure 2**).

2.2.2 Each stratigraphic unit was correlated to a geological epoch or sub-epoch using British nomenclature (e.g. Saalian). However, here we adopt North West European nomenclature to align with the internationally recognised formal time subdivision of the Quaternary Period (Cohen and Gibbard 2011). As a result, the terms Anglian, Wolstonian, Ipswichian and Devensian have been replaced with Elsterian, Saalian, Eemian and Weichselian.

2.2.3 Eight stratigraphic units were identified, dating from the Late Pliocene/Early Pleistocene to the Holocene (**Table 3**). The area is dominated by two palaeochannel features: Channel A which is interpreted to have formed during the Late Anglian (~430 ka), and Channel B which is a younger, shallow channel that dates to the Early Holocene. Although these channels are of different ages, they both represent an offshore extension of the Palaeo-Yare river system (**Figure 2**).

2.2.4 The Palaeo-Yare valley developed at the end of the Anglian Glaciation ~430ka and has continued to develop through to the present day. During cooler periods when sea-levels were lower, sands and gravels were deposited and during warmer climatic periods, when the sea-level was higher, the lower reaches of the Palaeo-Yare valley was slowly inundated, changing from fluvial, to estuarine and where sea-levels were high enough, shallow marine environments.

2.2.5 During these times of high sea level the upper reaches of the Yare would have remained a river but with some tidal influence. The main phase of development of the floodplain occurred during the cooling period from MIS 9 interglacial to the MIS 8 glacial (~300 to ~250 ka) and the floodplain continued to develop during this cold phase. It is these sediments, classified as Unit 3b, from which the Middle Palaeolithic Assemblage was dredged in Area 240.

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

Table 3 Lithostratigraphy of the offshore Palaeo-Yare catchment

Unit	Interpretation	Age	Description
8	Marine deposits associated with the last transgression in the Holocene	Holocene	Shelly, gravelly medium to coarse sand.
7	Basal fill of a shallow under-filled channel feature (equivocal to onshore Lower Breydon Formation)	Early Holocene	Only observed to the northwest of Area 240 and also a small patch in the south western corner. It comprises a basal unit of peat approximately 0.2 m thick overlain by a unit of sandy or shelly clay. Infilling of Channel B.
6	Glaciofluvial alluvium	Possibly mid-Weichselian	Sandy gravel.
5	Possibly represents an estuarine or near coastal depositional environment	Unknown, possibly contemporary with unit 6	Slightly gravelly, slightly silty, fine to medium grained sand infilling depressions.
4	Brown Bank Formation	Early Weichselian	Unit 4 is a very distinctive unit generally associated with the buried channel feature

Unit	Interpretation	Age	Description
			in the north of Area 240 interpreted as the infilling of a cut sequence. It is comprised of fine-grained sediments (sands, silts and clays) deposited in a low-energy environment such as river or estuary.
3b	Reworked glaciofluvial outwash	Saalian glaciation	Unit 3b overlies Unit 3a in the channel and directly overlies Unit 2 throughout the central and western area. It is comprised of sands and gravels.
3a	Reworked glaciofluvial outwash	Saalian glaciation	A channel (Channel A) infill deposit that is associated with a channel feature probably cut into Unit 2 during the Late-Anglian glaciation. Unit 3a is the deepest, and oldest, fill primarily associated with the channel feature in the northeast and comprises gravel and sand.
2a/b	Yarmouth Roads Formation	Cromerian period	Unit 2a generally comprises silty, gravelly, fine to coarse sands. Observed throughout the majority of Area 240 and generally overlies Unit 1. To the south of Area 240 Unit 2b comprises silty sand with very frequent thin beds and laminae of firm to stiff clay and peaty organic clay.
1	Westkapelle Ground Formation	Pliocene/Early Pleistocene	The deepest unit and is observed across Area 240

3 AIMS AND OBJECTIVES

3.1.1 The principle aim of this project is to reappraise the regional extent and survival of key deposits from which known artefacts and faunal remains have been recovered. This will be achieved by building upon the Palaeo-Yare Catchment Assessment (Wessex Archaeology 2013a) and incorporating new geological, archaeological and dredging information, to inform and support decisions relating to the assessment and management of future marine aggregate operations.

3.1.2 Specific objectives are as follows:

- Update the existing deposit model (Wessex Archaeology 2013a) by incorporating new vibrocore data;
- Map changes in the extent and survival of key deposits taking into account any dredging activity that has occurred between 2016 and 2019;
- Update Operational Sampling Groups to reflect changes in deposit extent;
- Reappraise the archaeological potential of key deposits where necessary, based on the archaeological material recovered to date, and;
- Update datasheets for each licence area.

4 METHODS

4.1 Introduction

4.1.1 This report follows on from previous works as outlined in **Section 2.1** and includes a review of data acquired since the last review (Wessex Archaeology 2016) and the end of 2019, plus any additional data omitted from previous reviews.

4.1.2 Since the last review (Wessex Archaeology 2016) the extent of Marine Aggregate Licence Area 242/361 has changed. As a result, the existing Sampling Operation Groups and Thresholds for Area 242/361 do not reflect the local geology. As part of this review, the datasheet for Area 242/361 will be updated accordingly.

4.2 Geotechnical vibrocore assessment

4.2.1 A total of 184 geotechnical viborocore logs from 5 individual surveys undertaken between 2012 and 2017 were provided for review (**Figure 3**). Of these 128 were located within Licence Areas 212, 240, 242/361, 401/2A and 401/2B (**Table 4**). Core photographs and the results of particle size distribution analysis were also provided to support the assessment.

Table 4 Vibrocore survey data

Area	Year	No. of VCs included in assessment	Reference
212	2016	8	CMS Geotech Ltd. (2017)
212	2017	12	CMS Geotech Ltd (2018)
240	2012	30	Coastline Surveys Ltd (2013)
240	2016	18	CMS Geotech Ltd. (2017)
242/361	2012	10	Coastline Surveys Ltd (2012)
242/361	2015	5	CMS Geotech Ltd (2015)
401/2	2015	33	CMS Geotech Ltd (2015)
401/2	2017	12	CMS Geotech Ltd (2018)

4.2.2 Each of the 184 geotechnical vibrocore logs were reviewed by a trained geoarchaeologist in order to establish the nature and depth of deposits recovered. Deposits were interpreted with reference to the stratigraphic framework defined in **Table 3** (Wessex Archaeology 2013a) while recognising the potential for encountering different/new formations that were not previously captured. The results of the geotechnical log review are presented in **Appendix 1**.

4.3 Updates to deposit model

4.3.1 The geotechnical vibrocore data was used to ground truth the legacy deposit model. For each licence area, a comparison was made between the previously mapped extent of each of the Units defined in **Table 3,** with the exception of Unit 8 (surficial sediments), and the Units recorded in the vibrocores (**Figures 4-7**)**.** Instances where the vibrocore data disagreed from the legacy deposit model were investigated to determine if the deposit model required updating (**Tables 5-8**). The following considerations were taken into account before making any changes to the deposit model;

- Removal of deposits due to dredging activity;
- Length of vibrocore, relative to stratigraphy and depth of deposits;
- Proximity to boundaries considering the resolution and positional accuracy of the legacy deposit model, and;

- Localised variations.

4.3.2 The legacy deposit model was constructed using a variety of geotechnical and geophysical datasets acquired between 1989 and 2011. As a result, there is considerable variation in resolution (see Wessex Archaeology 2013a for full discussion). Line spacing of the geophysical data ranged from 100 m to 300 m. For the purpose of this assessment a buffer of 100 m (smallest line spacing) was applied to all boundaries as a margin of error.

4.4 Dredging history

4.4.1 When considering potential changes in the extent and depth of deposits across the licence areas, it is important to consider recent dredging activity to determine if a deposit has been removed or newly exposed due to dredging activity.

4.4.2 Information on dredging activity over the period of 2016-2019 was derived from Electronic Monitoring System (EMS) data for the East Coast region on a yearly basis from 2016-2019 (**Figure 8-11**). This data is amalgamated by the Crown Estate and BMAPA and underpins The Area Involved report series.

4.4.3 The EMS data was provided as a series of shapefiles showing dredge intensity gridded by 50 m cell size, defined as follows;

- Low: <15 minutes
- Medium: 15 minutes – 1 hour 15 minutes
- High: >1 hour 15 minutes

4.4.4 Dredging intensity as a measure of time dredged cannot be used to quantify volumetrically the amount of sediment removed. However, it can be used to qualitatively assess areas most likely impacted by dredging activity. The area dredged on a year by year basis was reviewed alongside the geotechnical data to establish if any changes in the deposits recorded may have occurred as a result dredging.

4.5 Known Archaeology

4.5.1 Finds reported through the BMAPA *Protocol for Reporting Finds of Archaeological Interest*, along with the results from operational sampling events were collated to provide a summary of archaeological discoveries for each of the licence areas. A full review of operational sampling results is given in Wessex Archaeology (2020).

5 RESULTS

5.1 Area 212

Vibrocore assessment

5.1.1 Unit 1 was not recorded in any of the vibrocores assessed from Area 212, likely due to Unit 1 being present at depths greater than the maximum penetration of the vibrocores (6 m).

5.1.2 Unit 2 was recorded in all 20 vibrocores within Area 212 and proven to a depth of 5.68 meters below sea floor (mbsf) (VC-01 [2017]). Unit 2 typically comprises slightly silty sand with occasional shell fragments and laminations of clay, and rare inclusions of organic fragments. In VC-212-02 (2016) a bed (0.15 m thick) of dense peat was recovered. Unit 2

is often exposed at seabed but can also be present below superficial sediments (Unit 8) which are typically <1 m thick and comprise gravelly shelly sand.

5.1.3 The original Palaeo-Yare catchment assessment (Wessex Archaeology 2013a; 2013b) recovered Unit 3b in a single vibrocore (VCA21) suggesting the possibility for localised occurrences of Unit 3b, most likely reworked. Unit 3b was not recovered in any of the vibrocores assessed here so their remains limited evidence for the presence of Unit 3b in Area 212.

Updates to deposit model

5.1.4 The legacy deposit model indicates Unit 2 is widespread across Area 212 outcropping at the seabed, or sub-cropping below surficial sediments (Unit 8) (**Figure 4**). Unit 2 was recovered in all vibrocores and no conflicts were recorded. Therefore, no changes have been made to the deposit model.

Dredging history

5.1.5 EMS data for the years 2016-2019 shows dredging intensity for this period was low to medium focussed on the eastern dredge lanes (**Figure 8**). Dredging activity in Area 212 targets Unit 2.

5.1.6 Vibrocore surveys in Area 212 occurred in 2016 and 2017 (**Table 4**). Dredging intensity for these years was predominantly low with isolated areas of medium intensity. Dredging intensity after 2017 was low.

Known Archaeology

5.1.7 No artefacts, faunal remains or environmental remains have been reported through the BMAPA *Protocol for Reporting Finds of Archaeological Interest* from Area 212.

5.1.8 Operational sampling was undertaken in September 2013 in the southern central zone of Area 212. Approximately 3,500 tonnes of aggregate were processed from a cargo of 4,500 tonnes.

5.1.9 Two flakes were recovered, both of which show signs of Levallois technique. This would place their age either approximately around the Early Middle Palaeolithic (before 180 ka), or in the Late Middle Palaeolithic (before 35 ka). Although the former date is more likely given the small number of Levallois flakes known within British contexts for the Late Middle Palaeolithic, two isolated examples are impossible to date accurately. **WA 2249** has a ‘chapeaux de gendarme’ butt and shows considerable patina and signs of rolling. **WA 2250** appears considerably fresher and shows relatively little damage. It also has signs of convergent flaking technique.

5.1.10 Additionally, a single mammoth tooth was recovered (**WA 2251**). This tooth is broken in two and does not appear to be complete. The condition of the broken surfaces suggests that the break occurred sometime prior to dredging.

5.1.11 Further operational sampling was undertaken in November 2013 and February 2015 in the southern central zone of Area 212 where no material was found.

5.2 Area 240

Vibrocore assessment

5.2.1 Unit 1 was not recorded in any of the vibrocores assessed from Area 240, likely due to Unit 1 being present at depths greater than the maximum penetration of the vibrocores (6 m).

5.2.2 Unit 2 is the oldest deposit recovered in vibrocores from Area 240. Unit 2 is characterised by typically well sorted, silty, gravelly, fine sands with rare shell and wood fragments. Unit 2 may contain thin beds or lamination of clay, organic silt and clay, and occasional organic material.

5.2.3 Unit 2 was identified in 39 of the 48 vibrocores assessed (**Figure 5**), although it is expected to be present across the entirety of Area 240 and is only absent from the remaining eight vibrocores due to a greater thickness of overlying deposits at these locations. Unit 2 is present at the seabed at five locations (VC 240-03, VC 240-15, VC-22, VC-25 and VC26), likely due to dredging of overlying sediments.

5.2.4 Unit 3b overlies Unit 2 and was recorded in 25 of the 48 vibrocores within Area 240 (**Figure 8**). Unit 3b comprises a poorly sorted, silty, gravelly, sand or silty, sandy, gravel. Unit 3b often has an orange to dark brown colour which may indicate oxidisation suggesting the deposit was once subaerially exposed.

5.2.5 Unit 4 was not recovered in any of the vibrocores assessed from Area 240. However, it is noted that no vibrocores were located in the area previously mapped as Unit 4 which is confined to Channel A in the north of Area 240 (**Figure 5**).

5.2.6 Unit 5 was recorded at five locations, VC-01, VC 240-08, VC 240-01, VC 240-02 and VC-21 (**Figure 5**). Unit 5 comprises silty gravelly sand with laminations of organic silt or silty clay recorded locally. In these vibrocores Unit 5 overlies Unit 2 and Unit 3b providing a stratigraphic context for this deposit.

5.2.7 Unit 6 was not recorded in any of the vibrocores from Area 240 (**Figure 5**).

5.2.8 Unit 7 was recovered in two vibrocores; VC-17 and VC-18. Unit 7 is characterised by clayey gravelly sand with laminations of silty clay, with wood fragments recorded in VC-17.

5.2.9 Unit 8 was recorded in 25 of the 48 vibrocores assessed from Area 240. Unit 8 comprises gravelly sand and sandy gravel.

Updates to deposit model

5.2.10 The legacy deposit model indicates the presence of Unit 2, Unit 3b, Unit 4, Unit 5, Unit 6 and Unit 7 below surficial deposits (Unit 8) in Area 240. The presence or absence of each Unit in the vibrocores was compared to the legacy deposit model and 18 conflicts were identified as outlined in (**Table 5**) (**Figure 5**).

Table 5 Data conflicts Area 240

VC ID	Conflict	Description	Change extent	Justification
UNIT 2				
VC-17	Unit 2 absent in VC that lies in	VC comprises Unit 7	No	Unit 2 is likely present at a greater depth
VC-18		VC comprises Unit 7	No	
VC-15		VC comprises Unit 8	No	

VC ID	Conflict	Description	Change extent	Justification
VC-27	area mapped as Unit 2	VC comprises Unit 8 and Unit 3b	No	
240-02		VC comprises Unit 5 and Unit 3b	No	
VC-05		VC comprises Unit 3b	No	
VC-01		VC comprises Unit 5	No	
UNIT 3b				
VC-18	Unit 3b absent in VC that lies in area of Unit 3b	VC lies 58 m from boundary of Unit 3b	No	Within 100 m of boundary, error acceptable
VC240-03		Unit 2 exposed at seabed	No	Isolated core, not enough information to change deposit model
VC-01		Unit 5 present below superficial sediment	No	Unit 3b may be present at greater depth below Unit 5
VC240-14		VC lies 40 m from boundary of Unit 3b	No	Within 100 m of boundary, error acceptable
VC-21		VC lies 32 m from boundary of Unit 3b	No	Within 100 m of boundary, error acceptable
VC-25		VC lies 53 m from boundary of Unit 3b	No	Within 100 m of boundary, error acceptable
VC-28		Unit 2 present below Unit 8	Yes	VC-28 and VC-30 are located next to one another and are located 550 m and 110 m away from an area where Unit 3b is absent, this area has been extended to include VC-28 and VC-30
VC-30		Unit 2 present below Unit 8	Yes	
UNIT 5				
VC240-01	Unit 5 present in VC located in an area where Unit 5 is mapped as absent	VC is not within 100 m of any boundaries	No	Isolated core, not enough information to change deposit model
UNIT 6				
VC240-16	Unit 6 absent in VC that lies in area mapped as Unit 6	VC lies 15 m from boundary of Unit 6	No	Within 100 m of boundary, error acceptable
UNIT 7				
VC-18	Unit 7 present in VC located in area mapped as Unit 7 absent	VC lies 37 m from boundary of Unit 7	No	Within 100 m of boundary, error acceptable

5.2.11 Based on the assessment of new vibrocore data, no changes in the extent of Unit 2 within Area 240 were required. However, in areas of dredging (**Figure 5**), Unit 2 is expected to be encountered at shallower depths due to the removal of overlying sediments and may even be present at seabed (e.g. VC240-03).

5.2.12 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 (**Figure 5**). A comparison between the vibrocore data assessed here and the previous deposit model shows the data largely agree, and only one update has been made to the extent of Unit 3b to account for the absence of Unit 3b in VC28 and VC30. This led to the removal of an area of Unit 3b (0.07 km^2) in the vicinity of these vibrocores (**Figure 5**).

5.2.13 Based on the vibrocore data, the thickness of Unit 3b is typically <1 m and does not exceed 1.73 m (VC240-02). Unit 3b may be present at seabed or within the shallow subsurface (<0.5 mbsf).

5.2.14 Unit 4 was not recorded in any vibrocores. However, it is noted that no vibrocores were located in an area were Unit 4 is expected to be present.

5.2.15 With the exception of VC 240-01, the presence of Unit 5 in vibrocores correlated to areas previously mapped as Unit 5 (**Figure 5**). VC 240-01 lies 250 m away from the nearest boundary of a mapped area of Unit 5 so is not within the error margin of previous mapping. However, as this is an isolated occurrence, there is not enough evidence to change the extent of Unit 5 with confidence and no changes were made to the deposit model.

5.2.16 Unit 6 was previously mapped in the south of Area 240 were it formed isolated patches. A single vibrocore (VC240-16) was located in an area of Unit 6. However, Unit 6 was not recorded in this vibrocore. VC 240-16 is located 15 m away from the boundary of Unit 6, therefore the absence in this vibrocore likely reflects the error margin of the legacy mapping and no changes were made.

5.2.17 Unit 7 was recorded in VC-17 and VC-18 which is in agreement with the previously mapped extent of Unit 7 (**Figure 5**). Therefore, no changes have been made to the extent of Unit 7.

Dredging history

5.2.18 EMS data for the years 2016-2019 shows dredging intensity in Area 240 ranged from low to high intensity (**Figure 9**). In 2016, dredging occurred predominantly in the southern dredge lanes and was high intensity targeting Unit 3b. In 2017, the same areas were targeted but dredging intensity was medium. The area dredged changed in 2018 and the central lanes were targeted (Unit 3b) with intensity varying from low to high. These central lanes continued to be dredged with high intensity in 2019.

5.2.19 In the central and southern area of Area 240 Unit 3b has been removed in areas due to historic dredging (Wessex Archaeology 2013a). The vibrocore surveys assessed here were undertaken in 2012 and 2016 (**Table 4**) and predate the EMS data (2016-2019). Therefore, it is possible that Unit 3b has been removed locally, especially where the deposit was relatively thin (<0.5 m), in the central and southern areas that were dredged between 2016 and 2019 (**Figure 9**).

Known Archaeology

5.2.20 Sixteen operational sampling events have been undertaken in Area 240 between 2011 and the end of 2019. The operational sampling trackplots are situated in the southwest of the Licence Area. The operational sampling primarily targeted Unit 3b with small areas of Unit 2 and 5 also targeted. An exclusion zone is in place to the south east of the area (**Figure 1**).

5.2.21 Several lithics have been discovered during the operational monitoring of this area (**WA 2229, WA 2230, 2243, 2244, 2246, 2252**). **WA 2243** and **2246** exhibit Levallois technology and are attributed to the Early Middle Palaeolithic (230–180 ka). **WA 2252** is probably of a similar date. **WA2229** and **2230** are Palaeolithic and all these lithics, in type and condition are consistent with other lithics previously recovered in Area 240 thought to be associated with Unit 3b. **WA 2244** is a large bipolar blade core but damage to the platforms and consequent loss of technical detail precludes the precise identification of the piece's age,

but its size, type, and the suggestions of faceting to the less damaged platform suggest very strongly that it is Upper Palaeolithic, and perhaps Creswellian (13–11.5 ka).

5.2.22 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 August of 2019 produced a Middle Palaeolithic handaxe (**WA 2034**). Sampling in October 2019 also produced 2 handaxes and 3 flakes (**WA 2305-2308, 2309**).

5.2.23 After a large complete mammoth tooth was reported through the BMAPA *Protocol for Reporting Finds of Archaeological Interest* from lane F10 in Area 240 in November 2019, enquiries were made as to which wharf would be receiving the cargo. The receiving wharf, Dagenham were vigilant, and several discoveries were made and reported through the Protocol, leading to an immediate deployment to carry out the sampling of the remaining cargoes. This sampling produced 30 flint artefacts including five handaxes dated to the Middle Palaeolithic and 111 animal bones (**WA 2321-2462**). One of the bones (**Hanson_0937/2325**) was identified as having unusual markings; some of which were possibly attributed to being butchery marks. The bone was taken to the Natural History Museum, where it was shown to animal bone specialist, Dr Simon Parfitt and a marking specialist, Dr Silvia Bello. The bone was positively identified as a woolly rhinoceros' scapula and was analysed under a microscope. It was determined that the bone was not butchered/modified by man but had been chewed by animals, possibly hyenas. Previously no faunal evidence belonging to hyenas have been found in Area 240.

5.2.24 Over 70 finds have been reported through the Marine Aggregate Industry Archaeological Protocol ranging from mammoth teeth to more modern pottery and bullets. **Hanson_0286**, **Hanson_0410**, **Hanson_0533** and **Hanson_0935/2321** 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.

5.3 Area 242/361

Vibrocore assessment

5.3.1 Unit 1 was not recorded in any of the vibrocores assessed from Area 242/361, likely due to Unit 1 being present at depths greater than the maximum penetration of the vibrocores (6 m).

5.3.2 Unit 2 was present in 7 of the 15 vibrocores assessed from Area 242/361(VC P1 017VC P2 055, VC P2 056, VC-17, VC-20, VC-23 and VC-38) (**Figure 6**) and comprises silty gravelly sand with rare shell recorded locally.

5.3.3 Unit 3b in Area 242/361 comprises silty, gravelly sand and sandy gravel, with localised inclusions of organic material. Unit 3b is present in nine vibrocores (VC P2 054, VC P2 057, VC P2 056, VC P1 040, VC P1 41, VC P1 042, VC-20, VC-23 and VC-25) (**Figure 6**).

5.3.4 Unit 8 was recorded in 10 of the vibrocores assessed from Area 242/361, and typically comprises silty gravelly sand with shell fragments. Unit 8 is absent from five vibrocores (VC P2 054, VC P2 057, VC P1 042, VC-23 and VC-25). At these locations, Unit 3b is exposed at seabed.

Updates to deposit model

5.3.5 The legacy deposit model indicates the presence of Unit 2, Unit 3b and Unit 4 below surficial deposits (Unit 8) in Area 242/361. The presence or absence of each Unit in the vibrocores was compared to the legacy deposit model and 14 conflicts were identified as outlined in (**Table 6**) (**Figure 6**).

Table 6 Data conflicts Area 242/361

VC ID	Conflict	Description	Change extent	Justification
UNIT 2				
VC P2 054	Unit 2 absent in VC that lies in area mapped as Unit 2	VC comprises Unit 3b	No	Unit 2 is likely present at a greater depth
VC P1 040		VC comprises Unit 8 and Unit 3b	No	
VC P1 041		VC comprises Unit 8 and Unit 3b	No	
VC P1 042		VC comprises Unit 3b	No	
VC P1 015		VC comprises Unit 8	No	
VC P1 057		VC comprises Unit 3b	No	
VC P1 016		VC comprises Unit 8	No	
VC-25			No	
UNIT 3b				
VC-17	Unit 3b absent in VC that lies in area of Unit 3b	VC comprises Unit 2 overlain by Unit 8	No	Isolated core, not enough information to change deposit model
VC-38		VC lies 2 m from boundary of Unit 3b	No	Within 100 m of boundary, error acceptable
VC P1 015		VC comprises Unit 8	No	Unit 3b may be present at greater depth below Unit 8
VC P2 056	Unit 3b present in VC located in an area where Unit 3b is mapped as absent	VC lies 176 m from boundary of Unit 3b	Yes	The presence of 3b in two vibrocores located in the same area gives confidence Unit 3b is present. Area of Unit 3b extended to include VC-20 and VC P2 056.
VC - 20		VC lies 225 m from boundary of Unit 3b	Yes	
UNIT 4				
VC P1 015	Unit 4 absent in VC located in an area of Unit 4	VC comprises Unit 8	No	Unit 4 may be present at greater depth below Unit 8

5.3.6 Based on the assessment of new vibrocore data, the extent of Unit 3b in Area 242/361 was extended to include the locations of VC-28 and VC-30 which both comprised Unit 3b deposits (**Figure 6**). This change was very minor and resulted in an increase in the area of Unit 3b of 0.04 km^2.

5.3.7 No changes were made the extent of Unit 2 and Unit 4 in Area 242/361.

Dredging history

5.3.8 There was no dredging activity in Area 242/361 in 2016 or 2017 (**Figure 10**). In 2018, dredging occurred in the south west lanes and was low to medium intensity. Dredging continued in this area in 2019, but the footprint was smaller and intensity was low. Unit 3b was the target of dredging.

5.3.9 Vibrocore surveys in Area 242/361 were undertaken in 2012 and 2015 (**Table 4**) which predate the EMS data reviewed here. Vibrocores in this area indicate Unit 3b is up to 4 m thick. Given the area was dredged over a period of 2 years at low to medium intensity, it is unlikely Unit 3b has been completely removed in this area.

Known Archaeology

5.3.10 Operational sampling was undertaken in the western short-term licence area within Area 242/361 in July 2013.

5.3.11 Approximately 3000 tonnes of aggregate were processed from a cargo of 4500 tonnes. The vast majority of this material (particularly in the 40-100 mm fraction) is believed to be derived from Unit 2, based on the dredging tracks, the degree of past dredging and the characteristics of the material (both colour and silt content), which differs from typical gravelly Unit 3b sediment.

5.3.12 A single mammoth tooth was recovered along with five fragments of large mammal bone (**WA 2248**). Many of these were abraded (lacking at least one surface) and/or mineralised, attesting to their considerable age. Similar mineralised and abraded faunal material recovered with the original 2007/2008 recovery was considered likely to associated with Unit 2.

5.3.13 Further operational sampling was undertaken in June 2018 in the western zone of Area 242/361 where no material was found.

5.4 Area 401/2

Vibrocore assessment

5.4.1 Unit 1 was not recorded in any of the vibrocores from Area 401/2 likely due to Unit 1 being present at depths greater than the maximum penetration of the vibrocores (6 m).

5.4.2 Of the 45 vibrocores assessed from Area 401/2, Unit 2 was recorded in 35 vibrocores and comprises slightly silty, occasionally gravelly sand with rare shell recorded locally. Unit 2 was absent in VC401/2-06A, VC401/2-05C, VC-21, VC-31, VC37, VC401/2-02, VC22, VC401/2-12, VC401/2-01A and VC-26 due to the presence overlying Unit 8, Unit 4 and Unit 3b.

5.4.3 Unit 3b overlies Unit 2 and was recovered in 28 vibrocores and is characterised by slightly silty gravelly sand and occasionally sandy gravel. Unit 3b is exposed at seabed in places (VC-04, VC-07, VC-14, VC-21, VC-23, VC-47, VC401/2-01A, VC401/2-03A, VC401/2-06A, VC401/2-07 and VC 401/2-08) and the deposit varies in thickness between 0.10 m and 3.15 m, although it may be thicker in places where it is below the maximum penetration depth of the vibrocore (6 m).

5.4.4 Unit 4 was recovered in 4 vibrocores (VC-27, VC-31, VC-36 and VC401/2-05C). In Area 401/2 Unit 4 comprises very silty sand, sandy clay or silt and clay with a characteristic dark grey colour. In VC-36, Unit 4 overlies Unit 2 providing a stratigraphic context.

5.4.5 Unit 5, Unit 6 and Unit 7 was not recorded in any of the vibrocores from Area 401/2.

5.4.6 Unit 8 comprises gravelly sand and sandy gravel with shell fragments and occasional whole shells. Unit 8 represents surficial seabed sediments and is present across most of the licence area with the exception of localised patches were Unit 3b is exposed at seabed.

Updates to deposit model

5.4.7 The legacy deposit model indicates the presence of Unit 2, Unit 3b and Unit 4 below surficial deposits (Unit 8) in Area 401/2. The presence or absence of each Unit in the vibrocores

was compared to the legacy deposit model and 28 conflicts were identified as outlined in (**Table 7**) (**Figure 7**).

Table 7 Data conflicts Area 401/2

VC ID	Conflict	Description	Change extent	Justification
UNIT 2				
VC401/2-06A	Unit 2 absent in VC that lies in area mapped as Unit 2	VC comprises Unit 3b	No	Unit 2 is likely present at a greater depth
VC401/2-05C		VC comprises Unit 8 and Unit 4	No	
VC-21		VC comprises Unit 3b	No	
VC-31		VC comprises Unit 8 and Unit 4	No	
VC-37		VC comprises Unit 8 and Unit 3b	No	
VC401/2-02			No	
VC22			No	
VC401/2-12			No	
VC401/2-01A			No	
VC-26		VC comprises Unit 8 and Unit 3b	No	
UNIT 3b				
VC-01	Unit 3b absent in VC that lies in area of Unit 3b	VC comprises Unit 2 overlain by Unit 8	Yes	Unit 3b absent in multiple cores. Area of Unit 3b reduced.
VC-01C			Yes	
VC-02		VC comprises Unit 2	Yes	
VC-06			No	Isolated core, not enough information to change deposit model
VC-13			No	
VC-30		VC comprises Unit 2 overlain by Unit 8	No	
VC-32			No	Isolated core, vibrocores in close proximity comprise Unit 3b
VC401/2-14			No	
VC401/2-13			No	
VC-16			No	Isolated core, not enough information to change deposit model
VC-05	Unit 3b present in VC located in an area where Unit 3b is mapped as absent	VC lies 390 m from nearest boundary of Unit 3b	No	
VC-07		VC lies 94 m from boundary of Unit 3b	No	
VC-24		VC lies 500 m from nearest boundary of Unit 3b	Yes	Two vibrocores in close proximity recovered Unit 3b, area of Unit 3b extended to reflect this.
VC401/2-06A		VC lies 600 m from nearest boundary of Unit 3b	Yes	
UNIT 4				
VC-24	Unit 4 absent in VC located in an area of Unit 4	VC comprises Unit 8 and Unit 2	Yes	Four vibrocores in close proximity did not recover Unit 4. Extent of Unit 4 reduced to reflect this.
VC-35			Yes	
VC-35A			Yes	
VC401/2-06A		VC comprises Unit 3b	Yes	

5.4.8 Based on the assessment of new vibrocore data, changes have been made to the extent of Unit 3b and Unit 4 in Area 401/2 (**Figure 7**). No changes were made to the extent of Unit 2.

5.4.9 In the northwest, the extent of Unit 3b was reduced with the removal of an area covering 3.8 km^2. This reflected the absence of Unit 3b in 3 vibrocores in this region. In the southeast corner of Area 401/2, the extent of Unit 3b was extended by 2.3 km^2 as Unit 3b was recovered in VC-24 and VC401/2-06A.

5.4.10 In the southeast, the extent of Unit 4 was reduced by 2.8 km^2 to account for the absence of Unit 4 in four vibrocores (VC-24, VC401/2-06A, VC35 and VC-35A).

Dredging history

5.4.11 EMS data for the years 2016-2019 shows dredging activity in Area 401/2 was low to high intensity and focussed on dredge lanes in the eastern part of Area 401/2A (**Figure 11**). Dredging intensity was typically high in 2016 and 2017 and became low-medium in 2018. In 2019, dredging only occurred in the south eastern lanes and was typically low intensity. Unit 3b and Unit 4 are the target of dredging in Area 401/2.

5.4.12 The vibrocore surveys in Area 401/2 were undertaken in 2015 and 2017 (**Table 4**). In areas of dredging, the thickness of Unit 3b is <2.5 m and while it is not possible to quantify volumetrically how much deposit has been removed, it is expected the thickness of Unit 3b in these areas will be reduced as dredging has occurred since the date of the vibrocore survey.

Known Archaeology

5.4.13 Five operational sampling events have been undertaken in Licence Area 401/2; four in the north east zone of the area in 2014 and 2015 that targeted Unit 3b floodplain deposits and yielded no finds.

5.4.14 A further sampling was undertaken in May 2019 that targeted only Unit 4 sediments in the south east of Area 401/2. The cargo comprised 3000 tonnes of which approximately 30% was processed. Two fragments of unidentified mega-fauna were recovered during the sampling (**WA 2301-2302**).

5.4.15 Twelve finds have been reported through the BMAPA *Protocol for Reporting Finds of Archaeological Interest* from this area, although all were determined to be of a modern origin. They include a metal cylindrical object with four holes (**Hanson_0546**), , a long square nail (**LTM_0602**), a padlock and chain (**LTM_0604**), an iron nail or spike (**LTM_0606**), a possible fishing float (**NLTM_0607)**, a bone (**Hanson_0898**) and four pieces of munitions (**Hanson_0959-Hanson_0960**).

6 DISCUSSION

6.1 Early Pleistocene (2.58 MA – 773 ka)

6.1.1 Unit 1 correlates to Westkapelle 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 and has not been sampled by geotechnical surveys or operational sampling events.

6.1.2 Unit 2 is interpreted as Yarmouth Roads Formation, 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).

6.1.3 Unit 2 is present in all licence areas and can be found outcropping at seabed, or subgrouping below overlying deposits (Unit 3b, Unit 4, Unit 5, Unit 7 and Unit 8). 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 Early Middle

Palaeolithic (before 180 ka) or Late Middle Palaeolithic (before 35 ka) age. These finds are younger than the age of Unit 2 and were therefore interpreted to have come from reworked Unit 3b deposits (Fjordr 2016). Unit 3b was not recovered in any of the vibrocores assessed here from Area 212. Unit 8 superficial deposits were recorded in vibrocores. Typically, Unit 8 deposits were slightly gravelly sands with shell fragments but on occasion, very gravelly sand or sand and gravel deposits were recorded. The coarser-grained nature of these deposits shows similar characteristics to Unit 3b. However, they comprise shell fragments which implies if they were Unit 3b, they have been reworked by modern seabed processes.

6.1.4 A single mammoth tooth was recovered from Unit 2 through operational sampling (**WA 2251**). The tooth was broken and the condition suggested this occurred prior to dredging. While this tooth is likely reworked but does indicate the potential to recover faunal remains within Unit 2.

6.2 Middle Pleistocene (773 ka – 126 ka)

6.2.1 There is an unconformity between deposition of Unit 2 and overlying Unit 3b deposits. This unconformity 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 (e.g. Bytham river).

6.2.2 At the end of the Anglian period, during deglaciation, the Palaeo-Yare initially formed and has continued to develop through to the present day (**Figure 2**) (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.

6.2.3 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 southern North Sea lithostratigraphic framework (Stoker et al. 2011) as they are regional in extent, limited to the Palaeo-Yare catchment.

6.2.4 The extent of Unit 3a is 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.

6.2.5 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 between MIS 9-MIS 7 according to Optical Stimulated Luminescence (OSL) dating (Wessex Archaeology 2011; Limpenny et al. 2011)) but given the coarse-grained nature, it most likely formed during the cold climate of MIS 8. Unit 3b broadly correlates to the Yare Valley Formation onshore (Athurton et al. 1994).

6.2.6 Unit 3b is present in Area 240, Area 242/361 and Area 401/2. The thickness of Unit 3b varies and is difficult to establish due to historic dredging activity.

6.2.7 Unit 3b in Area 240 is extensive but is absent in patches due to dredging. Based on the assessment of vibrocores and EMS data here, there was a slight reduction (0.07 km^2) in

the extent of Unit 3b in the north-east of the Area 240 (**Figure 5**). However, this did not correlate to any dredging activity recorded over the period 2016-2019. It is likely this change in extent is due to the addition of new ground-truth data in this region allowing refinement of the deposit model.

6.2.8 In Area 242/361, Unit 3b is present in the south with a few isolated patches in the north. There was a slight increase (0.04 km^2) in the extent of Unit 3b (**Figure 6**). This change to the deposit model was driven by an increase in ground-truth data and is not a result of dredging activity.

6.2.9 The extent of Unit 3b in Area 401/2 was limited to the north-eastern parts of the licence area with a patchy distribution in the west. Moderate changes in the extent of Unit 3b have been made following the review of vibrocore data. In the northwest, the extent of Unit 3b has been reduced by 3.8 km^2, while in the southeast corner of the licence area, the extent of Unit 3b has increased by 2.3 km^2 (**Figure 7**). These changes were not driven by dredging activity. In the northwest, there has been no dredging activity over the period 2016-2019 and the changes here reflect an increase in ground-truth data. EMS data shows there has been dredging in the southeast in the area where the extent of Unit 3b has been increased. In this area Unit 3b is overlain by Unit 4 and it may be that dredging has removed Unit 4, exposing the underlaying Unit 3b. This is supported by vibrocores which do not record Unit 4 in this region.

6.2.10 The Middle-Palaeolithic assemblage discovered in Area 240 (**section 2.1**) was recovered from Unit 3b deposits. Lithic and faunal finds discovered through operational sampling events are also predominantly from Unit 3b deposits (see Wessex Archaeology 2020). The archaeological potential of Unit 3b therefore remains high.

6.3 Late Pleistocene (126 ka – 11.7 ka)

6.3.1 After development of the Palaeo-Yare, most likely during MIS 9 - MIS 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 of Eemian deposits in Area 212, Area 240, Area 242/361 or Area 401/2 (Wessex Archaeology 2013b).

6.3.2 As climate deteriorated into the Weichselian glacial period (MIS 5d – MIS 2; 110 ka – 11.7 ka) and sea-levels started to fall, the lower reaches of the Palaeo-Yare would have become exposed and it is during the early parts of the Weichselian, 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, silt and sands.

6.3.3 Unit 4 directly overlies Unit 3b and is present in Area 240, Area 242/361 and 401/2. In Area 240, the extent of Unit 4 is restricted to Channel A (**Figure 5**). In Area 242/361, Unit 4 is present as an isolated patch in the eastern corner of the licence area (**Figure 6**). No vibrocores were recovered within the region of Unit 4 in Area 240 or Area 361/242, therefore there are no changes to the extent of Unit 4.

6.3.4 In Area 401/2, Unit 4 is present in the southeast corner of the licence area (**Figure 7**). The presence of Unit 4 was determined from previous mapping (Cameron et al. 1989; Limpenny et al. 2011) as Unit 4 was not identified on geophysical data, and no vibrocores were located in this area when the legacy deposit model was constructed (Wessex Arcaheology 2013a). Due to the absence of Unit 4 in four vibrocores, the extent of Unit 4 was reduced by 2.8 km^2. This area correlates to an area of active dredging between 2016 and 2019 and it is possible dredging activity removed Unit 4 exposing underlying Unit 3b. However, Unit 4 is

present to the north, also in an area of active dreding and their it survives. Therefore, it is not possible to determine if Unit 4 is absent due to dredging activity, or if it has always been absent in this area.

6.3.5 In Area 240 and Area 242/361, no operational sampling events have been undertaken within the extent of Unit 4 and no finds have been recorded through the BMAPA *Protocol for Reporting Finds of Archaeological Interest*. In Area 401/2, two fragments of unidentified mega-fauna were recovered during operational sampling (**WA 2301-2302**). These are likely reworked but indicate the potential for Unit 4 to preserve archaeology.

6.3.6 Unit 5 is only observed in Area 240 where it infills small depressions cut into Unit 3b. These units are interpreted as estuarine sediments deposited or exposed during MIS 3 according to a single OSL date of 36±3 ka (GL100044) (Wessex Archaeology 2013a). Unit 5 was recorded at five locations, four of which that correlated to the mapped extent of Unit 5 (**Figure 5**). No changes in the extent of Unit 5 were made.

6.3.7 A number of faunal remains and lithics have been recovered within areas comprising Unit 5. However, these finds also correlate to areas of Unit 3b and given the volume of dredged material assessed during operational sampling it is not possible to determine if they originated from Unit 5 or Unit 3b.

6.3.8 Unit 6 is also only present in Area 240, again infilling small depressions cut into unit 3b. However, 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, this mostly likely occurred during the coldest parts of the Weichselian (MIS 3 – MIS 2) when sea levels were lower. Unit 6 was not recorded in any vibrocores assessed and therefore no changes have been made to its extent. No finds have been recovered from Unit 6.

6.4 Holocene (11.7 ka – present day)

6.4.1 At the end of the Weichselian glacial period, climate started 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, Channel B, a meandering channel in the northwest of Area 240, formed cutting into underlying Unit 3b deposits (**Figure 5**). Unit 7, characterised by a basal peat overlain by silty, clayey, sand is confined to Channel B in Area 240. These deposits reflect infilling of Channel B under the influence of rising sea level during the early Holocene and correlate to the Breydon Formation onshore (Moorlock et al. 2000).

6.4.2 Unit 7 was recorded in two vibrocores that lie within the previously mapped extent of Unit 7 (**Figure 5**). Therefore, no changes were made to the extent of Unit 7.

6.4.3 No operational sampling events have targeted Unit 7 in Area 240. However, a number of environmental finds, largely peat deposits considered to be Mesolithic age, have been recorded through the BMAPA *Protocol for Reporting Finds of Archaeological Interest*.

6.4.4 Final inundation of the lower reaches of the Palaeo-Yare is expected to have occurred ~8.5 ka (Wessex Archaeology 2103a) after which marine processes began to rework and redistribute deposits forming Unit 8, seabed sediments. Given historic dredging activity, in some areas the surficial sediments (Unit 8) may be a palimpsest of marine process and localised remobilisation due to dredging activity. Therefore, it is possible for reworked archaeological material to be present in Unit 8.

7 CONCLUSIONS AND RECOMMENDATIONS

7.1 Deposit extent and survival

7.1.1 Based on the review of geotechnical vibrocores and EMS data (2016-2019), updates to the extent of Unit 3b were made in Area 240, Area 242/361 and Area 401/2. Changes were also made to the extent of Unit 4 in Area 401/2.

7.1.2 In Area 240, the extent of Unit 3b was reduced slightly (0.07 km^2). These changes were due to an increase in ground-truth data that allowed the legacy deposit model to be refined. They are not due to removal of Unit 3b as a result of dredging activity.

7.1.3 In Area 242/361, the extent of Unit 3b increased slightly (0.04 km^2) in an area not effected by dredging over the period of 2016-2019. These changes to the legacy deposit model were due to the addition of new geotechnical information.

7.1.4 The extent of Unit 3b was reduced by 3.8 km^2 in the northwest of Area 401/2 whereas in the southeast, it increased by 2.3 km^2 resulting in a net loss of 1.5 km^2 across Area 401/2. The extent of Unit 4 also changed in the southeast with a reduction in the area of Unit 4 by 2.8 km^2.

7.1.5 In the northwest of Area 401/2, changes to the deposit model were driven by the addition of new ground-truth data. However, in the southwest, it is possible dredging activity removed Unit 4 exposing underlying Unit 3b deposits. However, given Unit 4 is present to the north in an area of dredging, these changes may simply reflect an increase in ground-truth data that was absent from this region when the legacy deposit model was constructed.

7.1.6 No changes have been made to the extent of Unit 2, Unit 3a, Unit 5, Unit 6, Unit 7 or Unit 8.

7.2 Operational sampling

7.2.1 The subdivision of each licence area into Sampling Operation Groups was undertaken alongside the production of the legacy deposit model (Wessex Archaeology 2013a). Therefore, any changes in the extent of key deposits needs to be reflected in the Sampling Operation Groups.

7.2.2 In Area 240, changes to the extent of Unit 3b were made within Group 1 (eastern dredge lanes, predominantly Unit 3b sediments on southern limit of Channel A). These changes were minor resulting in a localised reduction in area of Unit 3b and given elsewhere within Group 1, there are localised patches were Unit 3b is absent, no changes are recommended.

7.2.1 In Area 242/361 the extent of the licence area had changed since 2016 and the existing Sampling Operation Groups and Thresholds did not reflect the local geology. Sampling Operation Groups and Thresholds for this area were redefined as;

- Group 1: Sampled western dredge lanes, predominantly Unit 2 with Unit 3b present below reworked bank feature.
    - Threshold: 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.

- Group 2: Eastern dredge lanes, unsampled, predominantly Unit 3b

  - Threshold: Sample at rate of assessment (1 in 20 loads). On two consecutive sample operations within a single dredge lane with no recovered finds, assessment on requirement for further sampling will be required based on the results.

7.2.2 A reduction in the extent of Unit 3b in Area 401/2 occurred within Group 2 (unsampled northern dredge lanes targeting Unit 3b). No changes to this group are recommended as Unit 3b is still present in this region. Group 3 (southern area: unsampled areas targeting Unit 4 sediments) includes an area where Unit 3b increased in extent while the area of Unit 4 decreased. In this case, the Threshold needs to account for encountering both Unit 3b and Unit 4. Given the threshold for Unit 3b and Unit 4 in Area 401/2 are the same (see datasheet), no changes are recommended.

7.3 Archaeological potential

7.3.1 The archaeological potential of each deposit within the submerged Palaeo-Yare catchment is summarised in **Table 8**;

Table 8 Archaeological potential of deposits

Unit	Archaeological Potential	Present or absent in Licence Area			
		212	240	242/361	401/2
8	Potential to comprise reworked archaeology	✓	✓	✓	✓
7	Highly likely to contain environmental archaeology (e.g. peat) and may preserve Mesolithic archaeology (faunal and lithic)	X	✓	X	X
6	Potential to contain Middle Palaeolithic archaeology but no evidence found to date	X	✓	X	X
5	Potential to contain Middle Palaeolithic archaeology but no evidence found to date	X	✓	X	X
4	Can contain reworked Middle Palaeolithic archaeology (e.g. faunal remains)	X	✓	✓	✓
3b	Highly likely to preserve Middle Palaeolithic archaeology (faunal remains and lithics)	?	✓	✓	✓
2	Potential to preserve Lower Palaeolithic archaeology but no evidence found to date	✓	✓	✓	✓
1	None – predates hominin occupation of Britain	Sub crops at depth below Unit 2			

7.4 Future work

7.4.1 The assessment of vibrocore and EMS data was undertaken to review and update the legacy deposit model constructed for the submerged Palaeo-Yare catchment assessment (Wessex Archaeology 2013a). A total of 184 vibrocores were reviewed and only minor changes were made to the extent of Unit 3b and Unit 4. Furthermore, the changes were largely the result of increased data resolution that allowed the deposit model to be refined, although dredging activity may have been responsible for removing Unit 4 and exposing Unit 3b in Area 401/2.

7.4.2 While EMS data was important for identifying areas of recent dredge activity, due to differences between vibrocore survey years and dredging activity on a year by year basis, it was not always possible to test if discrepancies between observations in the vibrocores and the legacy deposit model were the result of sediment removal due to dredging.

Establishing deposit thickness was also problematic where dredging had occurred after the date of the vibrocore survey.

7.4.3 Despite some of the challenges the data presented, the new vibrocore data were largely in agreement with the legacy deposit model increasing confidence in the original interpretation (Wessex Archaeology 2013a). Only minor changes were made to the extent of Unit 3b and Unit 4, leading to a change in Operational Sampling Group 3 in Area 401/2. However, no changes to the Threshold for each group were required. Consideration of the outcomes of this assessment and the effectiveness of using geotechnical data to update the legacy deposit model should be given when planning future data reviews.

7.4.4 To support ongoing operational sampling monitoring visits, it is recommended the data sheets for each licence area are updated on a yearly basis to include new operational sampling events, any new finds and EMS data for the last year. This is especially important in case where the extent of the licence area has changed since publication of the datasheet (e.g. Area 242/361). These updates should coincide with the release of the Area Involved report published by the Crown Estate and BMAPA.

REFERENCES

Arthurton, 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

BMAPA and English Heritage, 2005 *Marine Aggregate Dredging and the Historic Environment*, English Heritage, pp18

Cameron, T D J, Schuttenhelm, R T E, Laban, C, 1989, Middle and Upper Pleistocene and Holocene stratigraphy in the southern North Sea between 52° and 54°N, 2° to 4°E' in J P Henriet and G de Moor (eds) *The Quaternary and Tertiary Geology of the Southern Bight, North Sea*, Ministry of Economic Affairs – Belgian Geological Survey, 119 – 136

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

Coastline Surveys 2012 *Factual Report of Geotechnical Survey April 2012 Licence Areas 328 and 361/242 East coast of Norfolk Vibrocore Survey*

Coastline Surveys Ltd 2013 *Factual Report of Geotechnical Survey December 2012 Area 240 Vibrocore Survey*

CMS Geotech Ltd 2015 *Factual Report of Geotechnical Vibrocore Survey East Coast / Norfolk Banks*. Unpubl rep 2015-156

CMS Geotech Ltd. (2017) *Factual Report of Geotechnical Vibrocore Survey, Norfolk Banks, Licence Areas 212 & 240*. Unpubl rep 2016-240

CMS Geotech Ltd (2018) *Factual Report of Geotechnical Vibrocore Survey Norfolk Banks Licence Areas 212 & 401/2*. Unpubl rep 2017394

Fjordr 2016 *Written Scheme of Investigations Early Prehistoric Material in the Norfolk Block of the Anglian Region*. Unpubl rep 181215

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

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.

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.

Wessex Archaeology 2011a *Seabed Prehistory: Site evaluation techniques (Area 240) – Synthesis*. Unpubl rep 70754.04.

Wessex Archaeology 2001b *Licence Area 240 Archaeological Monitoring of Dredging Activity*, Unpubl rep 77860.02

Wessex Archaeology 2013a *Palaeo-Yare Catchment Assessment technical Report*. Unpubl rep 83740.04

Wessex Archaeology 2013b *Palaeo-Yare Catchment Assessment Addendum Report Short-Term Licence Areas*. Unpubl rep 83740.05

Wessex Archaeology 2015 *Palaeo-Yare Operational Sampling conducted under the short-term licencing provisional Written Scheme of Investigation: Interpretive Report.* Unpubl rep 83742.01

Wessex Archaeology 2016 *Licence Areas Method Statement. Licence Areas 212, 240, 242, 361 and 401/2: Monitoring Method Statements*. Unpubl rep 77860.17

Wessex Archaeology 2020 *Paleo-Yare Catchment Monitoring: Interpretative Report Five Year Review of Operational Sampling: January 2015 to December 2019* Unpubl rep 226020.03

APPENDICES

Appendix 1

Easting (m)	Northing (m)	id	Depth from (m)	Depth to (m)	Description	Unit
437422.1	5826116.6	VC P1 001	0.00	0.28	silty gravelly SAND with rare shell	8
437422.1	5826116.6	VC P1 001	0.28	1.00	SAND with rare wood fragments	2
437422.1	5826116.6	VC P1 001	1.00	4.30	SAND with rare shell	2
436438.2	5826665	VC P1 002	0.00	0.12	SAND	8
436438.2	5826665	VC P1 002	0.12	0.32	soft laminated sandy CLAY	2
436438.2	5826665	VC P1 002	0.32	0.98	silty SAND	2
436438.2	5826665	VC P1 002	0.98	1.33	silty gravelly SAND with rare shell fragments	2
436438.2	5826665	VC P1 002	1.33	4.84	thinly and thickly laminated silty SAND	2
437237.4	5828567.2	VC P1 003	0.00	1.00	silty gravelly SAND with shells and shell fragments	8
437237.4	5828567.2	VC P1 003	1.00	1.84	SAND and GRAVEL with shell fragments	8
437237.4	5828567.2	VC P1 003	1.84	4.37	silty SAND with rare shell	2
437237.6	5827892.5	VC P1 004	0.00	1.60	silty SAND	8
437237.6	5827892.5	VC P1 004	1.60	3.50	SAND and GRAVEL with shell fragments	8
437237.6	5827892.5	VC P1 004	3.50	4.79	silty gravelly SAND with shell fragments	2
437926.1	5827564.4	VC P1 005	0.00	3.70	silty very gravelly SAND with frequent shell	8
437926.1	5827564.4	VC P1 005	3.70	4.60	silty SAND	2
439632.6	5826466.4	VC P1 006	0.00	0.82	silty very gravelly SAND with occasional shell	8
439632.6	5826466.4	VC P1 006	0.82	2.07	silty SAND with rare shell and beds of laminated organic clay	2
439632.6	5826466.4	VC P1 006	2.07	3.00	silty very gravelly SAND with frequent shell and black clay laminations	2
439632.6	5826466.4	VC P1 006	3.00	4.65	silty very gravelly SAND with occasional shell	2
439631.7	5827065.4	VC P1 007	0.00	1.47	silty gravelly SAND with rare shell	8
439631.7	5827065.4	VC P1 007	1.47	3.78	silty gravelly SAND with rare shell and beds of laminated silt	2
439631.7	5827065.4	VC P1 007	3.78	4.07	silty SAND	2
439329.97	5827830.5	VC P1 008	0.00	1.05	silty very gravelly SAND oxidised	2
439329.97	5827830.5	VC P1 008	1.05	3.75	silty AND	2
439329.97	5827830.5	VC P1 008	3.75	4.59	silty very gravelly SAND	2
438643.72	5827551.9	VC P1 009	0.00	1.50	silty gravelly SAND with shell fragments	8
438643.72	5827551.9	VC P1 009	1.50	4.10	silty gravelly SAND with rare shell fragments	2
438240.05	5826389.1	VC P1 010	0.00	1.30	silty gravelly SAND with rare shell fragments	8
438240.05	5826389.1	VC P1 010	1.30	2.95	silty very gravelly SAND with rare shell fragments	2
438128.44	5826635.8	VC P1 011	0.00	1.05	silty very gravelly SAND	8
438128.44	5826635.8	VC P1 011	1.05	3.50	silty gravelly SAND	2

Easting (m)	Northing (m)	id	Depth from (m)	Depth to (m)	Description	Unit
437936.6	5826129.7	VC P1 012	0.00	0.90	silty gravelly SAND with occasional shell fragments	8
437936.6	5826129.7	VC P1 012	0.90	2.50	silty SAND with beds of organic silty sand and wood fragments	2
437936.6	5826129.7	VC P1 012	2.50	4.39	silty SAND	2
437741.4	5826813.9	VC P1 013	0.00	1.30	silty gravelly SAND with rare shell	8
437741.4	5826813.9	VC P1 013	1.30	3.38	silty SAND with beds of clayey silty sand	2
437741.4	5826813.9	VC P1 013	3.38	4.86	silty gravelly SAND with frequent shell	2
438041.6	5828794.6	VC P1 014	0.00	0.18	silty gravelly SAND	8
438041.6	5828794.6	VC P1 014	0.18	1.18	silty gravelly laminated SAND	2
438041.6	5828794.6	VC P1 014	1.18	4.83	silty gravelly SAND with beds of laminated organic silty clay	2
443037.9	5825310.7	VC P1 015	0.00	2.85	silty gravelly SAND with rare shell	8
443037.9	5825310.7	VC P1 015	2.85	3.10	silty gravelly SAND with frequent shell fragments	8
440837.2	5826013.9	VC P1 016	0.00	1.40	silty gravelly SAND with rare shell fragments	8
440837.2	5826013.9	VC P1 016	1.40	3.40	silty very gravelly SAND	8
441038.1	5826681.4	VC P1 017	0.00	1.11	silty very gravelly SAND with rare shell fragments	8
441038.1	5826681.4	VC P1 017	1.11	3.85	silty gravelly SAND with beds of organic silty clay	2
440837	5827196	VC P1 018	0.00	3.30	silty gravelly SAND with rare shell	8
440936.16	5827629.5	VC P1 019	0.00	0.50	silty very gravelly SAND	8
440936.16	5827629.5	VC P1 019	0.50	1.22	sandy SILT	8
440430.27	5828167.5	VC P1 020	0.00	0.60	silty SAND	8
440430.27	5828167.5	VC P1 020	0.60	1.00	sandy SILT	8
440430.27	5828167.5	VC P1 020	1.00	2.84	silty SAND with beds of laminated organic sand	2
440430.27	5828167.5	VC P1 020	2.84	3.20	silty SAND with shell fragments	2
440036.48	5828145.6	VC P1 021A	0.40	0.95	silty very gravelly SAND with rare shell fragments	8
440036.48	5828145.6	VC P1 021A	0.95	1.60	sandy PEAT	7
440036.48	5828145.6	VC P1 021A	1.60	1.90	gravelly sandy SILT	7
437551.66	5822499.5	VC P1 022A	0.00	1.67	silty gravelly SAND with shell fragments, thickly laminated in places	2
437771.19	5823003.2	VC P1 023	0.00	1.60	silty very gravelly SAND	8
437771.19	5823003.2	VC P1 023	1.60	3.54	very sandy SILT thickly bedded in places	4
437748.2	5822663.9	VC P1 024A	0.00	2.10	silty gravelly SAND with shell fragments	8
437748.2	5822663.9	VC P1 024A	2.10	4.17	silty CLAY with rare shell fragments	4
437702.53	5822202.8	VC P1 025A	0.00	1.64	silty gravelly SAND with rare shell fragments	8
437702.53	5822202.8	VC P1 025A	1.64	1.98	silty gravelly SAND with cobbles	8
437684.34	5821755.2	VC P1 026A	0.00	0.40	silty gravelly SAND	8
437684.34	5821755.2	VC P1 026A	0.40	3.58	silty gravelly SAND	2
437647.74	5821208.9	VC P1 027A	0.00	0.78	silty very gravelly SAND	8

Easting (m)	Northing (m)	id	Depth from (m)	Depth to (m)	Description	Unit
438006.93	5823457.5	VC P1 028	0.00	0.60	silty SAND and GRAVEL with shell fragments	8
438006.93	5823457.5	VC P1 028	0.60	3.65	silty gravelly SAND with shell fragments	8
438006.93	5823457.5	VC P1 028	3.65	3.75	silty CLAY	4
438006.93	5823457.5	VC P1 028	3.75	4.41	clayey SAND	4
437952.6	5822429.3	VC P1 029A	0.00	0.47	silty gravelly SAND	8
437914.62	5822106	VC P1 030	0.00	0.12	silty gravelly SAND	8
437914.62	5822106	VC P1 030	0.12	0.54	organic gravelly SAND	3b
437914.62	5822106	VC P1 030	0.54	1.44	silty very sandy GRAVEL	3b
437914.62	5822106	VC P1 030	1.44	4.12	silty gravelly SAND with rare shell fragments	2
437893.97	5821853.6	VC P1 031	0.00	0.43	silty gravelly SAND	8
437893.97	5821853.6	VC P1 031	0.43	0.74	organic silty gravelly SAND	3b
437893.97	5821853.6	VC P1 031	0.74	4.00	silty gravelly SAND	2
437893.97	5821853.6	VC P1 031	4.00	4.20	silty SAND and GRAVEL	2
438068.3	5821422	VC P1 032	0.00	1.77	silty gravelly SAND	2
438825.18	5822551.9	VC P1 033	0.00	3.20	silty gravelly SAND	2
438725.92	5823303	VC P1 034	0.00	0.27	silty SAND with organic laminations	3b
438725.92	5823303	VC P1 034	0.27	0.34	silty gravelly SAND	3b
438725.92	5823303	VC P1 034	0.34	0.70	clayey very gravelly SAND	3b
438725.92	5823303	VC P1 034	0.70	0.82	silty very gravelly SAND	3b
438725.92	5823303	VC P1 034	0.82	1.00	silty very sandy GRAVEL	3b
438725.92	5823303	VC P1 034	1.00	1.45	silty gravelly SAND	3b
438725.92	5823303	VC P1 034	1.45	1.78	silty SAND	4
438725.92	5823303	VC P1 034	1.78	1.92	silty CLAY	4
438725.92	5823303	VC P1 034	1.92	2.82	silty SAND with shell fragments	4
438725.92	5823303	VC P1 034	2.82	3.45	silty SAND	4
438599.89	5823768.5	VC P1 035	0.00	1.00	silty gravelly SAND with shell fragments	8
438599.89	5823768.5	VC P1 035	1.00	1.30	silty gravelly SAND	8
438599.89	5823768.5	VC P1 035	1.30	2.38	silty SAND	2
438968.5	5824098.1	VC P1 036	0.00	0.40	silty gravelly SAND	8
438968.5	5824098.1	VC P1 036	0.40	0.78	silty sandy GRAVEL with shell fragments	8
438968.5	5824098.1	VC P1 036	0.78	1.00	clayey SAND	4
438968.5	5824098.1	VC P1 036	1.00	2.42	silty SAND finely laminated	4
438968.5	5824098.1	VC P1 036	2.42	4.12	silty gravelly SAND	2
439395.23	5824371.5	VC P1 037A	0.00	1.00	silty very sandy GRAVEL	8
439395.23	5824371.5	VC P1 037A	1.00	1.68	silty gravelly SAND	8
439395.23	5824371.5	VC P1 037A	1.68	2.00	silty SAND slightly organic	4
439395.23	5824371.5	VC P1 037A	2.00	2.45	silty SAND with rare shell fragments	4
439395.23	5824371.5	VC P1 037A	2.45	3.42	clayey SAND finely laminated with occasional shell fragments	4
439395.23	5824371.5	VC P1 037A	3.42	4.18	clayey SAND slightly organic	4

Easting (m)	Northing (m)	id	Depth from (m)	Depth to (m)	Description	Unit
439572.15	5823407.7	VC P1 038	0.00	0.18	silty gravelly SAND with rare shells	8
439572.15	5823407.7	VC P1 038	0.18	1.50	silty slightly gravelly SAND	4
439572.15	5823407.7	VC P1 038	1.50	3.00	silty SAND with rare shell fragments	4
439572.15	5823407.7	VC P1 038	3.00	3.15	silty SAND finely laminated	4
439572.15	5823407.7	VC P1 038	3.15	3.20	sandy silty CLAY	4
439572.15	5823407.7	VC P1 038	3.20	4.20	silty gravelly SAND with rare shell fragments	2
439844.27	5824352.7	VC P1 039	0.00	1.00	silty slightly gravelly SAND	8
439844.27	5824352.7	VC P1 039	1.00	1.75	silty sandy GRAVEL	3b
439844.27	5824352.7	VC P1 039	1.75	2.06	slightly silty very sandy GRAVEL	3b
440039.3	5824161.1	VC P1 040	0.00	0.54	silty SAND	8
440039.3	5824161.1	VC P1 040	0.54	2.00	slightly silty very gravelly SAND	3b
440039.3	5824161.1	VC P1 040	2.00	2.38	silty gravelly SAND	3b
440039.3	5824161.1	VC P1 040	2.38	2.42	sandy CLAY	3b
440039.3	5824161.1	VC P1 040	2.42	3.00	clayey SAND with cobbles	3b
440039.3	5824161.1	VC P1 040	3.00	3.65	silty SAND finely laminated	3b
440039.3	5824161.1	VC P1 040	3.65	3.75	silty clayey SAND	3b
440039.3	5824161.1	VC P1 040	3.75	4.30	silty slightly gravelly SAND	3b
440591.29	5823677	VC P1 041	0.00	1.00	slightly silty gravelly SAND	8
440591.29	5823677	VC P1 041	1.00	2.00	silty very gravelly SAND	3b
440591.29	5823677	VC P1 041	2.00	2.58	silty SAND and GRAVEL	3b
440591.29	5823677	VC P1 041	2.58	2.80	clayey silty gravelly SAND	3b
440591.29	5823677	VC P1 041	2.80	3.40	silty gravelly SAND	3b
440591.29	5823677	VC P1 041	3.40	3.53	silty SAND and GRAVEL	3b
440847.55	5824077.2	VC P1 042	0.00	1.40	silty very gravelly SAND	3b
440847.55	5824077.2	VC P1 042	1.40	2.30	silty sandy GRAVEL	3b
436436.49	5830663	VC P2 001	0.00	2.00	silty gravelly SAND	2
436436.49	5830663	VC P2 001	2.00	2.28	silty gravelly SAND thinly laminated	2
436436.49	5830663	VC P2 001	2.28	3.98	silty SAND	2
437631.54	5828968.1	VC P2 004	0.00	0.66	silty gravelly SAND	8
437631.54	5828968.1	VC P2 004	0.66	0.98	silty sandy GRAVEL	3b
437631.54	5828968.1	VC P2 004	0.98	2.10	silty gravelly SAND	2
437631.54	5828968.1	VC P2 004	2.10	3.98	silty SAND	2
436632.23	5828987.4	VC P2 007	0.00	0.14	silty SAND	8
436632.23	5828987.4	VC P2 007	0.14	0.74	silty gravelly SAND with rare shell fragments	8
436632.23	5828987.4	VC P2 007	0.74	3.54	silty gravelly SAND with frequent shell	8
436632.23	5828987.4	VC P2 007	3.54	3.68	silty SAND	2
435848.78	5829077.4	VC P2 008	0.00	0.25	silty gravelly SAND with occasional shells and shell fragments	8
435848.78	5829077.4	VC P2 008	0.25	1.28	silty very gravelly SAND	3b
435848.78	5829077.4	VC P2 008	1.28	1.78	silty gravelly SAND with lamination of clayey sand	2

Easting (m)	Northing (m)	id	Depth from (m)	Depth to (m)	Description	Unit
436638.48	5830012.2	VC P2 009	0.00	0.40	silty gravelly SAND	3b
436638.48	5830012.2	VC P2 009	0.40	0.68	clayey silty sandy GRAVEL	3b
436638.48	5830012.2	VC P2 009	0.68	1.60	silty gravelly SAND	2
436638.48	5830012.2	VC P2 009	1.60	5.00	silty SAND	2
437237.01	5829669	VC P2 010	0.00	0.88	silty gravelly SAND	8
437237.01	5829669	VC P2 010	0.88	2.00	silty very sandy GRAVEL	3b
437237.01	5829669	VC P2 010	2.00	2.36	silty gravelly SAND	3b
437237.01	5829669	VC P2 010	2.36	4.34	silty SAND	2
437040.63	5830849.5	VC P2 011	0.00	1.75	silty gravelly SAND	3b
437040.63	5830849.5	VC P2 011	1.75	4.06	silty gravelly SAND occasionally laminated	2
435648.97	5831292.2	VC P2 012	0.00	1.60	silty gravelly SAND	8
435648.97	5831292.2	VC P2 012	1.60	1.96	gravelly silty SAND with lamination of organic sandy silty clay	2
435648.97	5831292.2	VC P2 012	1.96	2.13	very stiff silty sandy CLAY	2
435648.97	5831292.2	VC P2 012	2.13	3.90	silty SAND	2
435648.97	5831292.2	VC P2 012	3.90	4.70	silty gravelly SAND	2
435636.91	5832168.6	VC P2 013	0.00	1.00	silty gravelly SAND	8
435636.91	5832168.6	VC P2 013	1.00	3.90	silty very gravelly SAND with rare shell fragments	8
440031.42	5825224.6	VC P2 054	0.00	0.17	silty gravelly SAND	3b
440031.42	5825224.6	VC P2 054	0.17	1.00	silty clayey gravelly SAND	3b
440031.42	5825224.6	VC P2 054	1.00	1.45	silty gravelly SAND slightly organic	3b
440031.42	5825224.6	VC P2 054	1.45	2.00	silty sandy GRAVEL	3b
440031.42	5825224.6	VC P2 054	2.00	2.65	silty gravelly SAND	3b
440031.42	5825224.6	VC P2 054	2.65	4.52	silty SAND and GRAVEL	3b
441566.8	5824563.1	VC P2 055	0.00	1.65	silty gravelly SAND	8
441566.8	5824563.1	VC P2 055	1.65	2.82	silty very gravelly SAND with occasional shell fragments	8
441566.8	5824563.1	VC P2 055	2.82	3.75	silty SAND with occasional shell fragments	8
441566.8	5824563.1	VC P2 055	3.75	4.10	silty SAND	2
441446.68	5825064.4	VC P2 056	0.00	0.40	slightly silty slightly gravelly SAND	8
441446.68	5825064.4	VC P2 056	0.40	1.40	slightly silty slightly gravelly sand	3b
441446.68	5825064.4	VC P2 056	1.40	1.45	silty SAND	3b
441446.68	5825064.4	VC P2 056	1.45	2.00	slightly silty very gravelly SAND	3b
441446.68	5825064.4	VC P2 056	2.00	2.89	silty gravelly SAND	3b
441446.68	5825064.4	VC P2 056	2.89	4.15	silty SAND	2
442015.42	5825334.1	VC P2 057	0.00	1.00	slightly silty very gravelly SAND	3b
442015.42	5825334.1	VC P2 057	1.00	3.10	slightly silty slightly gravelly SAND	3b
442015.42	5825334.1	VC P2 057	3.10	4.45	slightly silty very gravelly SAND slightly organic	3b
435636.91	5832168.6	VC P2 013	3.90	4.20	silty SAND	2
433051.32	5826677.6	VC P2 058	0.00	0.18	silty gravelly SAND	3b
433051.32	5826677.6	VC P2 058	0.18	1.52	silty SAND	3b

Easting (m)	Northing (m)	id	Depth from (m)	Depth to (m)	Description	Unit
433051.32	5826677.6	VC P2 058	1.52	2.58	silty SAND	3b
433051.32	5826677.6	VC P2 058	2.58	3.74	gravelly silty SAND	3b
433720.15	5826650.3	VC P2 059	0.00	0.07	silty SAND and GRAVEL organic stained	8
433720.15	5826650.3	VC P2 059	0.07	1.00	silty SAND with silty clay laminations	3b
433720.15	5826650.3	VC P2 059	1.00	1.25	silty gravelly SAND with pockets of black silty clay	3b
433720.15	5826650.3	VC P2 059	1.25	1.40	silty gravelly SAND	3b
433720.15	5826650.3	VC P2 059	1.40	3.42	silty gravelly SAND with laminations of silty clay	3b
433720.15	5826650.3	VC P2 059	3.42	4.28	silty gravelly SAND	3b
432435.7	5824208.8	VC P2 060	0.00	2.00	silty gravelly SAND with occasional shells and shell fragments	8
432435.7	5824208.8	VC P2 060	2.00	4.89	silty gravelly SAND	8
436324.3	5819249	VC - 01	0.00	0.35	dense slightly gravelly SAND	8
436324.3	5819249	VC - 01	0.35	0.60	dense gravelly SAND	2
436324.3	5819249	VC - 01	0.60	0.90	dense silty gravelly SAND	2
436323	5819233	VC - 01C	0.00	0.20	very sandy slightly silty GRAVEL	8
436323	5819233	VC - 01C	0.20	0.90	slightly silty very gravelly SAND	2
436323	5819233	VC - 01C	0.90	4.90	slightly silty gravelly SAND with shell fragments	2
437103.1	5820464	VC - 02	0.00	4.80	Medium dense slightly silty very gravelly SAND	2
437544.2	5818383	VC - 03	0.00	1.20	dense silty gravelly SAND with shell fragments and whole shell	8
437544.2	5818383	VC - 03	1.20	1.80	dense silty very sandy GRAVEL	3b
437544.2	5818383	VC - 03	1.80	2.95	dense slightly silty very gravelly SAND	2
437544.2	5818383	VC - 03	2.95	3.58	dense SAND	2
437819.8	5819734	VC - 04	0.00	2.95	medium dense becoming dense slightly silty slightly gravelly SAND	3b
437819.8	5819734	VC - 04	2.95	3.48	dense silty slightly gravelly SAND	2
438005.6	5816541	VC - 05	0.00	0.15	loose slightly silty slightly gravelly SAND	8
438005.6	5816541	VC - 05	0.15	0.50	dense slightly silty very gravelly SAND	3b
438005.6	5816541	VC - 05	0.50	0.78	dense SAND	2
438005.6	5816541	VC - 05	0.78	1.40	dense slightly silty gravelly SAND	2
438005.6	5816541	VC - 05	1.40	1.48	firm CLAY	2
438417.9	5815037	VC - 06	0.00	2.16	medium dense slightly silty very gravelly SAND	2
438417.9	5815037	VC - 06	2.16	2.23	stiff sandy CLAY	2
438622.2	5820037	VC - 07	0.00	0.75	medium dense silty gravelly SAND	3b
438622.2	5820037	VC - 07	0.75	1.15	medium dense slightly silty gravelly SAND	3b
438622.2	5820037	VC - 07	1.15	5.85	medium dense silty sand with occasional shell fragments	2
438859.2	5817261	VC - 08	0.00	0.13	loose sandy GRAVEL	8
438859.2	5817261	VC - 08	0.13	0.60	medium dense slightly silty gravelly SAND	3b

Easting (m)	Northing (m)	id	Depth from (m)	Depth to (m)	Description	Unit
438859.2	5817261	VC - 08	0.60	2.40	medium dense slightly silty very gravelly SAND	3b
438859.2	5817261	VC - 08	2.40	5.00	medium dense silty SAND with occasional shell fragments	2
439427.4	5829878	VC - 09	0.00	0.70	medium dense slightly silty very gravelly SAND with occasional shell fragments	2
439427.4	5829878	VC - 09	0.70	4.72	medium dense slightly silty SAND with occasional shell fragments	2
439538.1	5815871	VC - 10	0.00	0.20	loose sandy GRAVEL	8
439538.1	5815871	VC - 10	0.20	1.50	medium dense slightly silty gravelly SAND	2
439538.1	5815871	VC - 10	1.50	3.35	dense slightly silty SAND	2
439749.9	5814713	VC - 11	0.00	0.25	loose slightly silty gravelly SAND	2
439749.9	5814713	VC - 11	0.25	1.20	medium dense slightly silty very gravelly SAND	2
439749.9	5814713	VC - 11	1.20	1.46	dense silty SAND	2
440165.7	5817326	VC - 12	0.00	0.25	loose slightly sandy GRAVEL	8
440165.7	5817326	VC - 12	0.25	0.50	medium dense slightly silty gravelly SAND	3b
440165.7	5817326	VC - 12	0.50	2.00	medium dense slightly silty very gravelly SAND	3b
440165.7	5817326	VC - 12	2.00	2.10	loose silty sandy GRAVEL	3b
440165.7	5817326	VC - 12	2.10	2.40	medium dense silty sandy GRAVEL	3b
440165.7	5817326	VC - 12	2.40	3.20	medium dense slightly silty slightly gravelly SAND	2
440165.7	5817326	VC - 12	3.20	3.90	dense silty SAND	2
440405.7	5819050	VC - 13	0.00	0.20	loose gravelly SAND	2
440405.7	5819050	VC - 13	0.20	0.60	medium dense slightly silty slightly gravelly SAND	2
440405.7	5819050	VC - 13	0.60	1.10	medium dense slightly silty gravelly SAND	2
440405.7	5819050	VC - 13	1.10	4.01	dense slightly silty SAND	2
440513.2	5818151	VC - 14	0.00	0.15	loose silty sandy GRAVEL	3b
440513.2	5818151	VC - 14	0.15	0.45	medium dense slightly silty slightly gravelly SAND	3b
440513.2	5818151	VC - 14	0.45	1.45	medium dense slightly silty very gravelly SAND with occasional shell fragments	2
440513.2	5818151	VC - 14	1.45	3.50	medium dense slightly silty gravelly SAND with occasional shell fragments	2
440513.2	5818151	VC - 14	3.50	5.04	dense silty SAND	2
440854.5	5816706	VC - 15	0.00	0.20	loose silty sandy GRAVEL	3b
440854.5	5816706	VC - 15	0.20	0.79	medium dense gravelly SAND	2
440850.6	5816711	VC - 15A	0.00	0.15	loose silty SAND	3b
440850.6	5816711	VC - 15A	0.15	0.70	medium dense slightly silty very gravelly SAND	3b
440850.6	5816711	VC - 15A	0.70	2.30	medium dense slightly silty very gravelly SAND	3b
440850.6	5816711	VC - 15A	2.30	3.95	medium dense slightly silty gravelly SAND	2
440850.6	5816711	VC - 15A	3.95	4.89	dense slightly silty SAND	2

Easting (m)	Northing (m)	id	Depth from (m)	Depth to (m)	Description	Unit
440871.7	5822241	VC - 16	0.00	1.95	loose slightly silty very sandy GRAVEL with occasional shell fragments	8
440871.7	5822241	VC - 16	1.95	2.18	medium dense slightly gravelly SAND with occasional shell fragments	2
440871.7	5822241	VC - 16	2.18	2.60	medium dense slightly silty very gravelly SAND with occasional shell fragments	2
440871.7	5822241	VC - 16	2.60	2.80	dense silty SAND with occasional whole shell and shell fragments	2
440871.7	5822241	VC - 16	2.80	3.65	dense slightly silty very gravelly SAND with frequent shell fragments	2
440871.7	5822241	VC - 16	3.65	4.20	laminated SAND and SILT	2
441108.8	5823620	VC - 17	0.00	0.25	loose SAND with shell fragments	8
441108.8	5823620	VC - 17	0.25	1.00	dense slightly silty very gravelly SAND with occasional shell fragments	8
441108.8	5823620	VC - 17	1.00	2.97	dense slightly silty SAND with occasional whole shells	2
441108.8	5823620	VC - 17	2.97	3.14	dense very sandy GRAVEL	2
441108.8	5823620	VC - 17	3.14	3.40	medium dense silty gravelly SAND	2
441128.5	5827950	VC - 18	0.00	0.15	loose SAND with occasional shell fragments	8
441128.5	5827950	VC - 18	0.15	1.70	medium dense slightly silty very gravelly SAND with frequent shell fragments	8
441128.5	5827950	VC - 18	1.70	2.19	medium dense slightly silty very gravelly SAND	2
441256.5	5829680	VC - 19	0.00	3.20	loose becoming dense slightly silty SAND with occasional shell and organic patches	2
441256.5	5829680	VC - 19	3.20	4.33	dense slightly silty gravelly SAND with frequent shell fragments and whole shell	2
441494.8	5825077	VC - 20	0.00	1.40	medium dense slightly silty slightly gravelly SAND with occasional shell fragments	8
441494.8	5825077	VC - 20	1.40	1.95	dense silty gravelly SAND	3b
441494.8	5825077	VC - 20	1.95	2.35	medium dense gravelly SAND	3b
441494.8	5825077	VC - 20	2.35	2.80	medium dense slightly silty very gravelly SAND	3b
441494.8	5825077	VC - 20	2.80	3.20	medium dense slightly silty SAND	2
441494.8	5825077	VC - 20	3.20	3.75	dense slightly silty gravelly SAND	2
441494.8	5825077	VC - 20	3.75	4.37	very dense silty SAND	2
441676	5817956	VC - 21	0.00	0.60	medium dense slightly silty very gravelly SAND	3b
441676	5817956	VC - 21	0.60	1.45	medium dense slightly silty very gravelly SAND	3b
441676	5817956	VC - 21	1.45	2.30	dense slightly gravelly SAND	3b
441676	5817956	VC - 21	2.30	4.65	dense slightly silty very gravelly SAND	3b
441973.6	5821409	VC - 22	0.00	0.85	loose SAND	8
441973.6	5821409	VC - 22	0.85	2.60	medium dense gravelly SAND	3b
441973.6	5821409	VC - 22	2.60	3.20	dense slightly silty very gravelly SAND	3b

Easting (m)	Northing (m)	id	Depth from (m)	Depth to (m)	Description	Unit
441973.6	5821409	VC - 22	3.20	3.95	dense gravelly SAND	3b
441973.6	5821409	VC - 22	3.95	4.37	dense slightly silty very sandy GRAVEL	3b
441997.8	5824153	VC - 23	0.00	0.60	loose slightly silty very sandy GRAVEL	3b
441997.8	5824153	VC - 23	0.60	1.40	medium dense silty very gravelly SAND	3b
441997.8	5824153	VC - 23	1.40	2.40	dense very gravelly SAND	2
441997.8	5824153	VC - 23	2.40	3.20	dense slightly silty SAND	2
441997.8	5824153	VC - 23	3.20	3.82	dense silty gravelly SAND	2
442187.1	5815890	VC - 24	0.00	0.20	loose sandy GRAVEL with occasional shell fragments	8
442187.1	5815890	VC - 24	0.20	0.80	dense silty SAND with organic odour	3b
442187.1	5815890	VC - 24	0.80	2.28	dense slightly silty very gravelly SAND	3b
442318.6	5825051	VC - 25	0.00	0.15	loose slightly gravelly SAND	3b
442318.6	5825051	VC - 25	0.15	2.10	dense very gravelly SAND	3b
442318.6	5825051	VC - 25	2.10	3.02	dense slightly silty gravelly SAND	3b
442322.5	5823020	VC - 26	0.00	1.15	loose silty gravelly SAND with occasional shell fragments	8
442322.5	5823020	VC - 26	1.15	1.87	medium dense very gravelly SAND	3b
442321.2	5817281	VC - 27	0.00	0.20	medium dense silty very sandy GRAVEL	8
442321.2	5817281	VC - 27	0.20	5.85	dense silty SAND with occasional shell fragments	4
442424.1	5828386	VC - 28	0.00	2.70	medium dense slightly silty slightly gravelly SAND with organic laminations	3b
442474.3	5826771	VC - 29	0.00	1.00	dense slightly silty very gravelly SAND with frequent shell fragments	8
442474.3	5826771	VC - 29	1.00	2.30	dense slightly silty slightly gravelly SAND with occasional shell fragments	8
442474.3	5826771	VC - 29	2.30	3.15	dense slightly silty slightly gravelly SAND	3b
442507	5819855	VC - 30	0.00	0.55	loose gravelly SAND	8
442507	5819855	VC - 30	0.55	2.20	dense slightly silty gravelly SAND	8
442507	5819855	VC - 30	2.20	2.60	dense slightly silty gravelly SAND with occasional shell fragments	2
442507	5819855	VC - 30	2.60	2.92	dense slightly silty very gravelly SAND with occasional shell fragments	2
442507	5819855	VC - 30	2.92	3.85	dense slightly silty gravelly SAND	2
442507	5819855	VC - 30	3.85	5.05	dense slightly silty slightly gravelly SAND	2
442695.5	5818422	VC - 31	0.00	0.90	medium dense slightly silty very gravelly SAND with frequent shell fragments and whole shells	8
442695.5	5818422	VC - 31	0.90	1.92	medium dense very silty SAND with occasional shell fragments	4
442695.5	5818422	VC - 31	1.92	2.48	dense silty SAND	4
442695.5	5818422	VC - 31	2.48	3.20	dense very silty SAND	4
442773.5	5820955	VC - 32	0.00	1.28	medium dense slightly silty gravelly SAND with occasional shell fragments	8

Easting (m)	Northing (m)	id	Depth from (m)	Depth to (m)	Description	Unit
442773.5	5820955	VC - 32	1.28	2.50	dense slightly silty very gravelly SAND with frequent shell fragments and whole shells	8
442773.5	5820955	VC - 32	2.50	3.28	slightly silty SAND	2
442855.2	5823938	VC - 33	0.00	0.70	loose very gravelly SAND with occasional shell fragments	8
442855.2	5823938	VC - 33	0.70	1.20	dense slightly silty SAND	3b
442855.2	5823938	VC - 33	1.20	2.05	dense very gravelly SAND	3b
442855.2	5823938	VC - 33	2.05	2.20	medium dense SAND	3b
442855.2	5823938	VC - 33	2.20	2.60	dense very sandy GRAVEL	3b
442855.2	5823938	VC - 33	2.60	2.65	dense very silty SAND	3b
442855.2	5823938	VC - 33	2.65	3.20	dense slightly silty slightly gravelly SAND	3b
442855.2	5823938	VC - 33	3.20	3.55	dense slightly silty very sandy GRAVEL	3b
442855.2	5823938	VC - 33	3.55	3.82	dense slightly silty SAND	2
442855.2	5823938	VC - 33	3.82	3.90	dense silty very gravelly SAND	2
442945.9	5822195	VC - 34	0.00	0.08	loose slightly silty very sandy GRAVEL	8
442945.9	5822195	VC - 34	0.08	1.00	dense slightly silty gravelly SAND	3b
442945.9	5822195	VC - 34	1.00	1.65	dense slightly silty very gravelly SAND	2
442945.9	5822195	VC - 34	1.65	2.89	dense slightly silty SAND	2
442959	5816802	VC - 35	0.00	0.45	medium dense slightly silty very gravelly SAND with occasional fragments	8
442959	5816802	VC - 35	0.45	0.73	dense SILT and SAND laminated	2
442950.2	5816812	VC - 35A	0.00	0.50	dense slightyl silty gravelly SAND with frequent shell fragments	8
442950.2	5816812	VC - 35A	0.50	1.42	very dense silty SAND	2
443130.7	5818837	VC - 36	0.00	0.25	medium dense slightyl silty gravelly SAND with occasional shell fragments	8
443130.7	5818837	VC - 36	0.25	0.80	dense silty SAND with occasional shell fragments	4
443130.7	5818837	VC - 36	0.80	1.25	medium dense gravelly SAND with organic silty laminations	4
443130.7	5818837	VC - 36	1.25	2.28	medium dense slightly silty SAND	2
443175	5820932	VC - 37	0.00	2.70	medium dense slightly silty gravelly SAND with frequent shell fragments and whole shells	8
443175	5820932	VC - 37	2.70	3.00	medium dense slightly silty gravelly SAND	3b
443175	5820932	VC - 37	3.00	3.40	medium dense slightly silty gravelly SAND	3b
443175	5820932	VC - 37	3.40	3.65	medium dense silty sandy GRAVEL	3b
443175	5820932	VC - 37	3.65	3.98	dense silty gravelly SAND	3b
443293.2	5824901	VC - 38	0.00	2.65	loose slightly silty very gravelly SAND with occasional shell fragments	8
443293.2	5824901	VC - 38	2.65	2.73	dense silty very gravelly SAND	2
443357.3	5822997	VC - 39	0.00	0.35	medium dense slightly silty gravelly SAND with occasional shell fragments	8
443357.3	5822997	VC - 39	0.35	0.45	dense silty SAND	3b

Easting (m)	Northing (m)	id	Depth from (m)	Depth to (m)	Description	Unit
443357.3	5822997	VC - 39	0.45	2.60	dense slightly silty very gravelly SAND	3b
443357.3	5822997	VC - 39	2.60	3.40	medium dense slightly silty slightly gravelly SAND with occasional shell fragments	2
443357.3	5822997	VC - 39	3.40	4.17	medium dense slightly silty very gravelly SAND	2
443498.1	5824331	VC - 40	0.00	0.60	loose slightly gravelly SAND with occasional shell fragments	8
443498.1	5824331	VC - 40	0.60	1.45	dense slightly silty very gravelly SAND	3b
443498.1	5824331	VC - 40	1.45	1.65	very dense silty SAND	3b
443498.1	5824331	VC - 40	1.65	2.00	very dense silty very gravelly Sand with occasional shell fragments and lamination of silt	2
443498.1	5824331	VC - 40	2.00	2.35	very dense slightly silty very gravelly SAND	2
443498.1	5824331	VC - 40	2.35	2.65	very dense slightly silty SAND	2
443498.1	5824331	VC - 40	2.65	2.75	very dense silty very sandy GRAVEL with occasional shell fragments	2
443498.1	5824331	VC - 40	2.75	3.05	very sense silty SAND	2
443847.1	5825690	VC - 41	0.00	0.20	loose slightly silty slightly gravelly SAND	8
443847.1	5825690	VC - 41	0.20	1.08	medium dense silty SAND	3b
443847.1	5825690	VC - 41	1.08	1.27	medium dense silty SAND	3b
443877.7	5828468	VC - 42	0.00	1.38	loose slightly silty gravelly SAND with occasional shell fragments	8
443877.7	5828468	VC - 42	1.38	4.88	firm SILT and CLAY	4
443877.7	5828468	VC - 42	4.88	5.01	stiff sandy CLAY	4
443879.2	5824072	VC - 43	0.00	0.65	loose slightly silty gravelly SAND with frequent shell fragments	8
443879.2	5824072	VC - 43	0.65	0.88	firm sandy SILT	7
443879.2	5824072	VC - 43	0.88	1.31	dense silty SAND with occasional shell fragments	2
443900	5819906	VC - 44	0.00	0.75	loose slightly silty gravelly SAND with occasional shell fragments and whole shells	8
443900	5819906	VC - 44	0.75	1.98	medium dense slightly silty slightly gravelly SAND	8
443900	5819906	VC - 44	1.98	2.75	medium dense slightly silty gravelly SAND	3b
443900	5819906	VC - 44	2.75	4.42	dense slightly silty SAND	2
443975.3	5829773	VC - 45	0.00	3.95	loose slightly silty gravelly SAND with occasional shell fragments	8
443975.3	5829773	VC - 45	3.95	4.15	dense silty SAND	3b
444049.8	5821608	VC - 46	0.00	1.10	loose slightly silty gravelly SAND	3b
444038.4	5821620	VC - 46A	0.00	0.50	loose slightly silty very gravelly SAND with frequent shell fragments	8
444038.4	5821620	VC - 46A	0.50	1.00	medium dense slightly silty sandy GRAVEL	3b
444038.4	5821620	VC - 46A	1.00	1.30	medium dense slightly silty very gravelly SAND	3b
444038.4	5821620	VC - 46A	1.30	2.30	dense slightly silty SAND	3b
444038.4	5821620	VC - 46A	2.30	4.00	dense slightly silty gravelly SAND s	3b

Easting (m)	Northing (m)	id	Depth from (m)	Depth to (m)	Description	Unit
444038.4	5821620	VC - 46A	4.00	4.73	loose slightly silty very sandy GRAVEL	3b
444218.3	5827059	VC - 47	0.00	1.20	loose slightly silty gravelly SAND	3b
444218.3	5827059	VC - 47	1.20	4.97	firm laminated SILT and CLAY	4
444405.3	5823092	VC - 48	0.00	0.10	firm sandy clayey SILT	3b
444405.3	5823092	VC - 48	0.10	3.18	medium dense slightly silty slightly gravelly SAND	3b
444667	5824303	VC - 49	0.00	2.53	loose slightly silty slightly gravelly SAND with frequent shell fragments	8
444667	5824303	VC - 49	2.53	2.67	firm sandy SILT	3b
444667	5824303	VC - 49	2.67	3.00	dense slightly silty gravelly SAND	3b
444667	5824303	VC - 49	3.20	3.66	dense slightly silty very gravelly SAND	3b
444667	5824303	VC - 49	3.66	4.30	dense slightly silty SAND with occasional shell fragments	2
444834.8	5821122	VC - 50	0.00	1.20	loose slightly silty gravelly SAND with frequent shell fragments	8
444834.8	5821122	VC - 50	1.20	2.60	firm laminated SILT and SAND	4
444834.8	5821122	VC - 50	2.60	5.52	medium dense slightly silty slightly gravelly SAND with occasional shell fragments and silt laminations	2
445389.6	5827069	VC - 51	0.00	0.27	dense slightly silty slightly gravelly SAND	8
445389.6	5827069	VC - 51	0.27	5.65	firm laminated SILT and CLAY with occasional shell fragments	4
445419.1	5825852	VC - 52	0.00	2.42	loose slightly silty gravelly SAND with occasional shell fragments	8
445419.1	5825852	VC - 52	2.42	5.00	medium dense very silty SAND with occasional shell fragments	4
431801.9	5832323	VC 212-01	0.00	1.90	medium dense slightly silty gravelly SAND with occasional shell fragments	8
431801.9	5832323	VC 212-01	1.90	3.32	dense slightly silty SAND	2
432737.1	5832561	VC 212-02	0.00	0.95	loose slightly silty slightly gravelly SAND	8
432737.1	5832561	VC 212-02	0.95	2.45	dense slightly silty SAND	2
432737.1	5832561	VC 212-02	2.45	2.60	dense organic PEAT	2
432737.1	5832561	VC 212-02	2.60	3.45	dense silty SAND	2
432691.7	5832053	VC 212-03	0.00	1.95	loose slightly silty SAND with pockets of organic material	2
432691.7	5832053	VC 212-03	1.95	3.80	dense slightly silty slightly gravelly SAND with occasional laminations of clay and woody fragments	2
432691.7	5832053	VC 212-03	3.80	4.60	dense slightly silty SAND with occasional shell fragments	2
432593.5	5831522	VC 212-04	0.00	1.50	dense silty gravelly SAND with occasional shell fragments and pockets of sandy silt	2
432593.5	5831522	VC 212-04	1.50	3.90	dense silty SAND	2
432615.6	5830788	VC 212-05	0.00	2.00	loose slightly silty gravelly SAND	2
432615.6	5830788	VC 212-05	2.00	3.80	dense slightly silty SAND with occasional laminations of organic silt	2
432409.5	5830643	VC 212-06	0.00	1.05	medium dense slightly silty slightly gravelly SAND	2

Easting (m)	Northing (m)	id	Depth from (m)	Depth to (m)	Description	Unit
432409.5	5830643	VC 212-06	1.05	3.20	dense slightly silty SAND with occasional pockets of organic clay	2
432395.9	5831363	VC 212-07	0.00	3.87	loose becoming dense slightly silty SAND with occasional thin laminations of organic clay	2
432226.3	5831526	VC 212-08	0.00	0.80	medium dense slightly silty very gravelly SAND with occasional shell fragments	2
432226.3	5831526	VC 212-08	0.80	3.80	medium dense slightly silty slightly gravelly SAND with occasional shell fragments and patches of organic fragments	2
432226.3	5831526	VC 212-08	3.80	4.40	dense silty SAND with frequent laminations of organic clay	2
425685	5823067	VC 240-01	0.00	1.85	medium dense slightly silty gravelly SAND	5
425685	5823067	VC 240-01	1.85	2.35	medium dense slightly silty slightly gravelly SAND	5
425685	5823067	VC 240-01	2.35	3.20	dense slightly silty SAND	2
425893.1	5822811	VC 240-02	0.00	2.08	medium dense slightly silty slightly gravelly SAND	5
425893.1	5822811	VC 240-02	2.08	3.81	medium dense slightly silty gravelly SAND	3b
425815.3	5822190	VC 240-03	0.00	0.20	medium dense slightly silty slightly gravelly SAND	2
425815.3	5822190	VC 240-03	0.20	1.72	dense slightly silty SAND with occasional laminations of silt	2
425534.6	5822318	VC 240-04	0.00	1.15	medium dense slightly silty slightly gravelly SAND	8
425534.6	5822318	VC 240-04	1.15	3.28	dense laminated SILT and SAND	2
425665.3	5821685	VC 240-05	0.00	1.28	medium dense silty slightly gravelly SAND	3b
425665.3	5821685	VC 240-05	1.28	4.28	dense slightly silty SAND	2
425841.5	5821220	VC 240-06	0.00	0.30	medium dense silty SAND and GRAVEL	3b
425841.5	5821220	VC 240-06	0.30	2.14	dense slightly silty sand with laminations of organic silt	2
425601.1	5821008	VC 240-07	0.00	1.05	medium dense slightly silty very gravelly SAND	8
425601.1	5821008	VC 240-07	1.05	2.65	medium dense slightly silty gravelly SAND	8
425601.1	5821008	VC 240-07	2.65	3.28	dense slightly silty SAND with occasional laminations of organic material	2
425427.8	5820491	VC 240-08	0.00	1.10	medium dense slightly silty gravelly SAND with laminations of organic silt	5
425427.8	5820491	VC 240-08	1.10	2.75	medium dense slightly silty very gravelly SAND	3b
425427.8	5820491	VC 240-08	2.75	2.95	firm CLAY	2
425427.8	5820491	VC 240-08	2.95	3.72	dense slightly silty sand with laminations of organic silt	2
425485.8	5819608	VC 240-09	0.00	1.95	medium dense silty gravelly SAND	3b
425485.8	5819608	VC 240-09	1.95	2.57	dense slightly silty SAND	2
425395.9	5821462	VC 240-10	0.00	0.74	loose slightly silty gravelly SAND	3b
425395.9	5821462	VC 240-10	0.74	2.74	dense slightly silty SAND with occasional laminations of organic silt	2

Easting (m)	Northing (m)	id	Depth from (m)	Depth to (m)	Description	Unit
424981.2	5821451	VC 240-11	0.00	1.05	loose slightly silty gravelly SAND	3b
424981.2	5821451	VC 240-11	1.05	2.85	dense slightly silty SAND with occasional think laminations of silt	2
424753	5821046	VC 240-12	0.00	2.40	medium dense slightly silty very gravelly SAND	3b
424753	5821046	VC 240-12	2.40	2.80	dense silty gravelly SAND	3b
424753	5821046	VC 240-12	2.80	4.55	dense slightly silty SAND with laminations of silt	2
425030.1	5820680	VC 240-13	0.00	0.13	medium dense slightly silty gravelly SAND	8
425030.1	5820680	VC 240-13	0.13	0.42	medium dense slightly silty very sandy GRAVEL	3b
425497.9	5820575	VC 240-13	0.42	2.80	dense slightly silty SAND with occasional laminations of silt	2
425183	5821061	VC 240-14	0.00	0.30	dense slightly silty slightly gravelly SAND	8
425183	5821061	VC 240-14	0.30	0.80	dense silty SAND	2
425183	5821061	VC 240-14	0.80	2.09	dense slightly silty SAND with occasional pockets of clay	2
425497.9	5820575	VC 240-15	0.00	3.17	dense slightly silty SAND with occasional laminations of organic silt	2
425654	5820046	VC 240-16	0.00	2.90	medium dense slightly silty gravelly SAND with laminations of silt	3b
425654	5820046	VC 240-16	2.90	3.52	dense silty very gravelly SAND	3b
425654	5820046	VC 240-16	3.52	4.15	dense silty SAND with occasional pockets of organic material	2
425051.4	5820315	VC-01	0.00	0.30	SAND	8
425051.4	5820315	VC-01	0.30	1.00	silty SAND with lamination of silty clay	5
425051.4	5820315	VC-01	1.00	4.00	SAND with frequent shell fragments and laminations of silty clay	5
425917.5	5820833	VC-02	0.00	0.90	gravelly SAND	8
425917.5	5820833	VC-02	0.90	1.60	slightly silty slightly gravelly SAND	8
425917.5	5820833	VC-02	1.60	2.55	very gravelly SAND	3b
425917.5	5820833	VC-02	2.55	3.00	silty SAND	2
425366.8	5820920	VC-03	0.00	0.13	loose slightly gravelly SAND	8
425366.8	5820920	VC-03	0.13	0.78	SAND and GRAVEL	3b
425366.8	5820920	VC-03	0.78	5.10	silty SAND	2
425612.4	5821318	VC-04	0.00	0.40	loose SAND	8
425612.4	5821318	VC-04	0.40	1.40	very sandy GRAVEL	3b
425612.4	5821318	VC-04	1.40	2.00	silty SAND	2
425107.6	5821669	VC-05	0.00	0.50	silty gravelly SAND	3b
425107.6	5821669	VC-05	0.50	1.00	very sandy GRAVEL	3b
425107.6	5821669	VC-05	1.00	1.35	silty gravelly SAND	3b
425107.6	5821669	VC-05	1.35	2.05	very sandy GRAVEL	3b
425107.6	5821669	VC-05	2.05	2.70	gravelly SAND	3b
425107.6	5821669	VC-05	2.70	3.10	slightly silty gravelly SAND	3b
425107.6	5821669	VC-05	4.00	4.20	gravelly SAND	3b
425107.6	5821669	VC-05	4.20	4.70	clayey very sandy GRAVEL	3b

Easting (m)	Northing (m)	id	Depth from (m)	Depth to (m)	Description	Unit
425107.6	5821669	VC-05	4.70	5.10	slightly gravelly SAND	3b
425910.4	5822012	VC-06	0.00	0.15	SAND	8
425910.4	5822012	VC-06	0.15	0.45	very sandy GRAVEL	3b
425910.4	5822012	VC-06	0.45	1.30	gravelly SAND	3b
425910.4	5822012	VC-06	1.30	1.75	very gravelly SAND	3b
425910.4	5822012	VC-06	1.75	2.30	gravelly SAND	3b
425910.4	5822012	VC-06	2.30	3.00	slightly gravelly very silty SAND with thin laminations of clayey silt	2
425910.4	5822012	VC-06	3.00	3.20	silty SAND	2
425910.4	5822012	VC-06	3.20	5.00	very silty SAND with laminations of clayey silt	2
425005.6	5822321	VC-07	0.00	0.20	slightly gravelly SAND	3b
425005.6	5822321	VC-07	0.20	1.75	sandy GRAVEL	3b
425005.6	5822321	VC-07	1.75	2.80	slightly silty SAND with lamination of clayey sand	2
425327.6	5822599	VC-08	0.00	1.05	SAND with rare shell fragments and pockets of silty clay	8
425327.6	5822599	VC-08	1.05	4.70	silty SAND with occasional bands of thinly laminated silty clay	2
425695.7	5822527	VC-09	0.00	1.20	slightly gravelly SAND	8
425695.7	5822527	VC-09	1.20	1.80	slightly silty very sandy GRAVEL	3b
425695.7	5822527	VC-09	1.80	3.55	silty SAND with frequent laminations of silty clay	2
425695.7	5822527	VC-09	3.55	4.15	silty SAND	2
425695.7	5822527	VC-09	4.15	4.75	SAND with occasional laminations of organic clay	2
425322.3	5823035	VC-10	0.00	0.65	slightly gravelly SAND	8
425322.3	5823035	VC-10	0.65	0.90	silty very gravelly SAND	3b
425322.3	5823035	VC-10	0.90	1.60	slightly silty SAND	3b
425322.3	5823035	VC-10	1.60	1.75	SAND	3b
425322.3	5823035	VC-10	1.75	2.15	very shelly SAND	3b
425322.3	5823035	VC-10	1.75	2.15	silty SAND with laminations of silty clay	2
424967.2	5823126	VC-11	0.00	0.30	loose slightly silty slightly gravelly SAND	3b
424967.2	5823126	VC-11	0.30	0.50	very gravelly SAND	3b
424967.2	5823126	VC-11	0.50	1.17	slightly silty SAND	3b
424967.2	5823126	VC-11	1.17	2.00	slightly silty gravelly SAND	3b
424967.2	5823126	VC-11	2.00	2.43	slightly clayey gravelly SAND	3b
424967.2	5823126	VC-11	2.43	2.80	SAND	2
424967.2	5823126	VC-11	2.80	3.09	clayey silty SAND	2
424967.2	5823126	VC-11	3.09	3.40	SAND	2
425925.3	5823164	VC-12	0.00	0.20	slightly gravelly SAND	8
425925.3	5823164	VC-12	0.20	0.50	very sandy GRAVEL	3b
425925.3	5823164	VC-12	0.50	1.40	slightly silty very gravelly SAND	3b
425925.3	5823164	VC-12	1.40	1.60	gravelly SAND	2

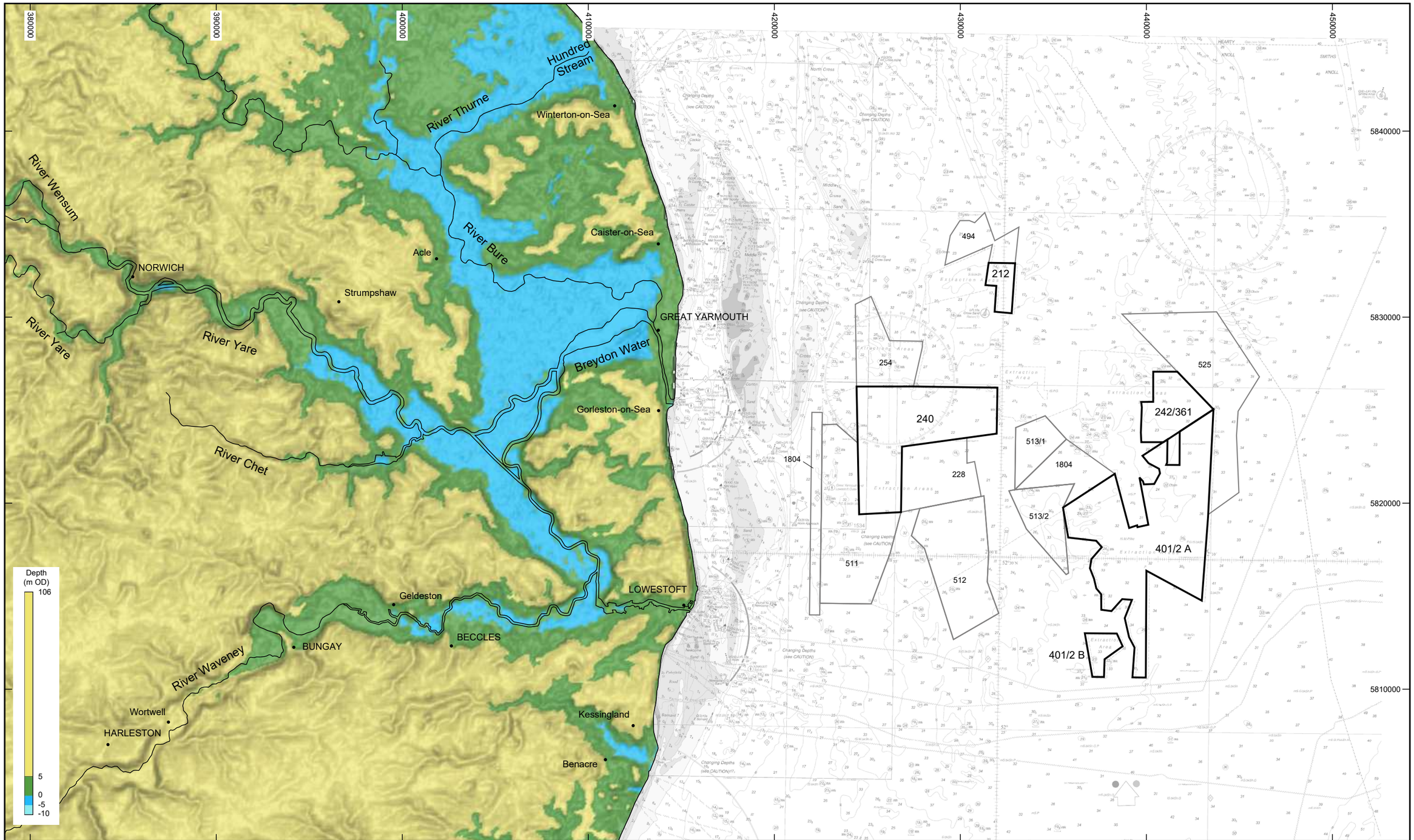
Easting (m)	Northing (m)	id	Depth from (m)	Depth to (m)	Description	Unit
425925.3	5823164	VC-12	1.60	2.20	slightly silty SAND	2
425925.3	5823164	VC-12	2.20	3.30	SAND	2
425534.5	5823513	VC-13	0.00	2.40	slightly gravelly SAND	8
425534.5	5823513	VC-13	2.40	3.15	very gravelly SAND	8
425534.5	5823513	VC-13	3.15	3.55	SAND	2
425534.5	5823513	VC-13	3.55	4.25	slightly silty shelly SAND	2
424788	5823684	VC-14	0.00	0.10	sandy GRAVEL	3b
424788	5823684	VC-14	0.10	0.30	slightly silty slightly gravelly SAND	3b
424788	5823684	VC-14	0.30	0.70	SAND	3b
424788	5823684	VC-14	0.70	2.40	slightly silty slightly gravelly SAND	3b
424788	5823684	VC-14	2.40	3.60	slightly silty SAND	3b
424788	5823684	VC-14	3.60	4.90	slightly gravelly SAND	3b
424788	5823684	VC-14	4.90	5.10	slightly silty SAND	3b
424788	5823684	VC-14	5.10	6.00	slightly silty SAND with laminations of silty clay	2
425888.2	5823783	VC-15	0.00	1.00	SAND	8
425877.5	5824183	VC-16	0.00	0.05	sandy GRAVEL	8
425877.5	5824183	VC-16	0.05	1.35	laminated silty SAND	2
425877.5	5824183	VC-16	1.35	1.45	SAND	2
425877.5	5824183	VC-16	1.45	2.00	laminated silty SAND	2
425877.5	5824183	VC-16	2.00	3.00	SAND	2
425877.5	5824183	VC-16	3.00	4.00	laminated SAND	2
424866.7	5824673	VC-17	0.00	0.25	very gravelly SAND	7
424866.7	5824673	VC-17	0.25	0.70	laminated silty clay with wood fragments and rare shell fragments	7
424866.7	5824673	VC-17	0.70	2.00	slightly clayey gravelly SAND with frequent shell fragments	7
424866.7	5824673	VC-17	2.00	2.30	very sandy GRAVEL	3b
424866.7	5824673	VC-17	2.30	3.30	very sandy GRAVEL	3b
425412.9	5824818	VC-18	0.00	0.20	slightly gravelly SAND	8
425412.9	5824818	VC-18	0.20	1.00	very gravelly SAND	8
425412.9	5824818	VC-18	1.00	1.20	slightly gravelly SAND with occasional shell fragments	8
425412.9	5824818	VC-18	1.20	2.00	very gravelly SAND with frequent shell fragments	8
425412.9	5824818	VC-18	2.00	2.90	very gravelly SAND	8
425412.9	5824818	VC-18	2.90	3.70	very sandy GRAVEL	8
425412.9	5824818	VC-18	3.70	3.85	Sand with laminations of silty clay	7
426095.1	5824440	VC-19	0.00	1.20	slightly silty SAND	8
426095.1	5824440	VC-19	1.20	1.55	slightly gravelly SAND	3b
426095.1	5824440	VC-19	1.55	2.20	slightly silty very gravelly SAND	3b
426095.1	5824440	VC-19	2.30	3.00	slightly silty slightly gravelly SAND	3b
426095.1	5824440	VC-19	3.00	3.35	very silty SAND	2
426464.8	5823931	VC-20	0.00	0.70	SAND with frequent shell fragments	8

Easting (m)	Northing (m)	id	Depth from (m)	Depth to (m)	Description	Unit
426464.8	5823931	VC-20	0.70	1.50	slightly gravelly SAND	8
426464.8	5823931	VC-20	1.50	2.30	silty SAND	2
426464.8	5823931	VC-20	2.30	4.10	slightly silty SAND	2
426464.8	5823931	VC-20	4.10	5.15	SAND	2
426626.3	5824385	VC-21	0.00	1.05	slightly gravelly SAND	5
426626.3	5824385	VC-21	1.05	1.80	SAND with rare shell fragments	5
426626.3	5824385	VC-21	1.80	2.10	gravelly SAND	3b
426626.3	5824385	VC-21	2.10	2.30	slightly gravelly SAND	3b
426626.3	5824385	VC-21	2.30	2.90	very gravelly SAND	3b
426626.3	5824385	VC-21	2.90	3.00	silty slightly gravelly SAND	3b
426626.3	5824385	VC-21	3.00	3.25	slightly silty slightly gravelly SAND	3b
426626.3	5824385	VC-21	3.25	3.50	sandy GRAVEL	3b
426626.3	5824385	VC-21	3.50	4.85	silty SAND	2
426903.9	5823757	VC-22	0.00	4.78	SAND	2
426903.9	5823757	VC-22	4.78	5.65	SAND with lamination of silty clay	2
427161.7	5823230	VC-23	0.00	2.20	gravelly SAND	8
427161.7	5823230	VC-23	2.20	3.80	very gravelly SAND	8
427161.7	5823230	VC-23	3.80	4.25	gravelly SAND	8
427161.7	5823230	VC-23	4.25	5.65	SAND	2
427191.9	5824128	VC-24	0.00	0.30	very gravelly SAND	8
427191.9	5824128	VC-24	0.30	1.30	sandy GRAVEL	8
427191.9	5824128	VC-24	1.30	1.50	slightly gravelly SAND	8
427191.9	5824128	VC-24	1.50	4.00	slightly silty slightly gravelly SAND	2
427191.9	5824128	VC-24	4.00	4.50	slightly silty SAND	2
427511.1	5824554	VC-25	0.00	5.20	slightly silty SAND with occasional laminations of silty clay	2
428015.8	5823809	VC-26	0.00	3.45	slightly silty SAND	2
428742.8	5823913	VC-27	0.00	0.90	slightly gravelly SAND	8
428742.8	5823913	VC-27	0.90	1.10	SAND	8
428742.8	5823913	VC-27	1.10	1.40	sandy GRAVEL	3b
428742.8	5823913	VC-27	1.40	1.80	very gravelly SAND	3b
428742.8	5823913	VC-27	1.80	2.25	slightly silty gravelly SAND	3b
428742.8	5823913	VC-27	2.25	3.30	very sandy GRAVEL	3b
428742.8	5823913	VC-27	3.30	3.85	slightly gravelly SAND	3b
428742.8	5823913	VC-27	3.85	5.35	very gravelly SAND	3b
429001.8	5824546	VC-28	0.00	0.40	slightly gravelly SAND	8
429001.8	5824546	VC-28	0.40	1.00	gravelly SAND	8
429001.8	5824546	VC-28	1.00	4.30	slightly gravelly SAND with occasional shell fragments	8
429001.8	5824546	VC-28	4.30	4.70	very gravelly SAND with occasional shell fragments	8
429001.8	5824546	VC-28	4.70	5.20	silty SAND with laminations of silty clay	2

Easting (m)	Northing (m)	id	Depth from (m)	Depth to (m)	Description	Unit
429127	5823805	VC-29	0.00	2.30	very gravelly SAND	3b
429127	5823805	VC-29	2.30	2.90	very gravelly SAND	3b
429127	5823805	VC-29	2.90	3.20	very sandy gravel	3b
429127	5823805	VC-29	3.20	3.55	gravelly SAND	3b
429127	5823805	VC-29	3.55	4.40	slightly silty SAND with laminations of silty clay	2
429348.6	5824293	VC-30	0.00	0.70	slightly gravelly SAND	8
429348.6	5824293	VC-30	0.70	5.50	silty sand with occasional laminations of silty clay	2
432380.6	5830762	VC 212-01	0.00	5.68	Medium dense grey slightly silty fine to medium sand with occasional gravel, plat remains at 0.4 m	2
432572.7	5831066	VC 212-02	0.00	4.10	Dense interbedded grey slightly gravelly to gravelly fine to coarse sand. Fine to coarse sub-rounded to sub-angular gravel. Occasional thick grey silt laminations	2
432476.9	5831463	VC 212-03	0.00	2.37	Very dense light grey fine sand	2
432544.7	5831982	VC 212-04A	0.00	0.20	Loose light brown very gravelly fine to medium sand. Gravel sub-rounded to sub-angular	8
432544.7	5831982	VC 212-04A	0.20	1.89	Dense light grey slightly silty fine to medium sand	2
432635.9	5832201	VC 212-05	0.00	0.91	Very dense brown sand and gravel. Gravel is fine to coarse, sub-rounded to sub-angular	8
432635.9	5832201	VC 212-05	0.91	1.01	Dark grey clay	2
432337.9	5832563	VC 212-06	0.00	3.70	Dense light grey silty fine to medium sand	2
432076.1	5832364	VC 212-07	0.00	3.20	Dense light grey silty fine to medium sand	2
432122.9	5832004	VC 212-08	27.8	4.42	Dense light grey silty fine to medium sand	2
432304.2	5831021	VC 212-09	0.00	0.34	Loose brown slightly silty very gravelly fine to coarse sand. Gravel is fine to coarse, sub-rounded to sub-angular. Thin lamination of brown silt	8
432304.2	5831021	VC 212-09	0.34	0.86	Medium dense brownish grey silty fine sand	8
432304.2	5831021	VC 212-09	0.86	1.10	Medium dense brown slightly silty very gravelly fine to coarse sand. Gravel is fine to coarse sub rounded to sub-angular	8
432304.2	5831021	VC 212-09	1.10	2.79	Dense light brown slightly silty fine to medium sand	2
432752.7	5831157	VC 212-10	0.00	0.40	Loose to medium dense light brown gravelly fine to coarse sand. Gravel is fine to coarse sub rounded	8
432752.7	5831157	VC 212-10	0.40	1.25	Dense light grey very sandy silt. Sand free	2
432752.7	5831157	VC 212-10	1.25	2.74	Dense light brown gravelly fine to medium sand. Gravel is fine to medium sub rounded to sub-angular	2
440985.7	5822871	VC 401/2-01A	0.00	3.15	Medium dense to dense brown very sandy gravel. Gravel is fine to coarse sub-rounded to sub-angular	3b

Easting (m)	Northing (m)	id	Depth from (m)	Depth to (m)	Description	Unit
442215	5820845	VC 401/2-02	0.00	2.78	Medium dense to dense yellowish brown to grey slightly gravelly to gravelly coarse sand. Gravel is fine to medium sub-rounded to sub-angular	8
442215	5820845	VC 401/2-02	2.78	3.05	Loose very sandy gravel. Gravel is fine to medium sub-angular to sub-rounded	3b
442215	5820845	VC 401/2-02	3.05	3.49	Dense greyish brown sand and gravel. Gravel is fine to coarse sub-angular to angular	3b
443201.4	5820337	VC 401/2-03A	0.00	0.22	Loose light brown slightly silty gravelly fine to medium sand. Gravel is fine sub-rounded	3b
443201.4	5820337	VC 401/2-03A	0.22	1.58	Dense grey very gravelly sand. Gravel is fine to coarse sub-rounded to sub-angular	3b
443201.4	5820337	VC 401/2-03A	1.58	1.96	Dense grey slightly silty gravelly fine to medium sand. Gravel is medium rounded	2
432544.7	5831982	VC 401/2-04	0.00	0.68	Loose to medium dense light brown grey slightly silty gravelly to very gravelly fine to medium sand. Gravel is fine to medium sub-angular	8
442958	5817711	VC 401/2-05C	0.00	1.30	Loose to medium dense light brown slightly gravelly fine to coarse sand. Gravel is fine to medium sub-angular and sub rounded	8
442958	5817711	VC 401/2-05C	1.30	4.20	Medium dense to dense dark grey silty (sometimes very silty) fine sand	4
442574.8	5816409	VC 401/2-06A	0.00	1.10	Medium dense to dense light brown very gravelly fine to coarse sand. Gravel is fine to coarse sub rounded and sub-angular	3b
442574.8	5816409	VC 401/2-06A	1.10	3.20	Dense light brown slightly gravelly fine to coarse sand. Gravel is fine	3b
441730.8	5816831	VC 401/2-07	0.00	0.60	Medium dense to dense brown very gravelly fine to coarse sand. Gravel is fine to coarse sub-angular to angular	3b
441730.8	5816831	VC 401/2-07	0.60	1.05	Dense brown sub rounded gravelly fine to coarse sand	3b
441730.8	5816831	VC 401/2-07	1.05	2.50	Dense to very dense sand gravel grading into gravelly sand. Gravel is fine to coarse sub-angular to angular	3b
441730.8	5816831	VC 401/2-07	2.50	3.16	Dense to very dense grey fine to medium sand	2
439904.2	5817023	VC 401/2-08	0.00	3.70	Medium dense to dense greyish brown gravelly to very gravelly fine to coarse sand. Gravel is fine to medium sub-rounded to sub-angular	3b
439904.2	5817023	VC 401/2-08	3.70	5.30	Dense grey slightly silty fine to medium sand	2
439968.4	5818249	VC 401/2-09	0.00	0.30	Loose very sandy gravel. Gravel is to coarse sub-angular to sub rounded	8
439968.4	5818249	VC 401/2-09	0.30	0.90	Medium dense light brown very gravelly fine to coarse sand. Gravel is fine to coarse sub-angular to sub-rounded	3b
439968.4	5818249	VC 401/2-09	0.90	5.90	Medium dense to dense greyish brown slightly fine to coarse sand	2

Easting (m)	Northing (m)	id	Depth from (m)	Depth to (m)	Description	Unit
432752.7	5831157	VC 401/2-10	0.00	0.64	Medium dense to dense light brown very gravelly sand. Gravel is fine to coarse sub-rounded to sub-angular	8
432752.7	5831157	VC 401/2-10	0.64	2.20	Dense yellowish brown slight gravelly fine to medium sand. Gravel is fine sub-rounded	3b
443151.9	5823186	VC 401/2-11A	0.00	1.74	Loose light brown grey slightly gravelly fine to medium sand. Gravel is fine to medium	8
443151.9	5823186	VC 401/2-11A	1.74	3.86	Dense grey to dark grey very gravelly find to medium sand to very sandy gravel. Gravel is fine to coarse sub rounded to sub-angular	3b
443151.9	5823186	VC 401/2-11A	3.86	5.83	Dense light grey slightly silty fine to medium sand	2
442781.9	5822250	VC 401/2-12	0.00	0.90	Medium dense light brown slightly silty slightly gravelly fine to medium sand. Gravel is fine sub-rounded to sub-angular	8
442781.9	5822250	VC 401/2-12	0.90	2.00	Dense brown very gravelly sand. Gravel is fine to coarse, sub-rounded to sub-angular	3b
442781.9	5822250	VC 401/2-12	2.00	4.00	Dense light brown gravelly fine to medium sand. Gravel is to coarse sub-rounded to sub-angular	3b
442781.9	5822250	VC 401/2-12	4.00	4.80	Dense brown very gravelly fine to coarse sand. Gravel is fine to coarse, sub-rounded to sub-angular	3b
443366.8	5821848	VC 401/2-13	0.00	1.03	Medium dense brown slightly silty gravelly fine to coarse sand. Gravel is fine to medium, sub-rounded to sub-angular	8
443366.8	5821848	VC 401/2-13	1.03	1.66	Very dense brown becoming grey silty gravelly fine to medium sand	2
442948.6	5821413	VC 401/2-14	0.00	0.50	Loose to medium dense greyish brown gravelly to very gravelly medium to coarse sand	8
442948.6	5821413	VC 401/2-14	0.50	4.64	Dense grey to greyish brown slightly silty fine to medium sand	2



Licence Areas 212, 240, 242/361 and 401/2

Other Licence Areas

0 10 km

Drawing projection: UTM WGS84 z31N.

Date:	01/09/2020	Revision Number:	0
Scale:	1:200,000 @A3	Illustrator:	KJF
Path:	W:\Projects\220701\Graphics_Office\Rep figs\Geoarch\2020_10_09		

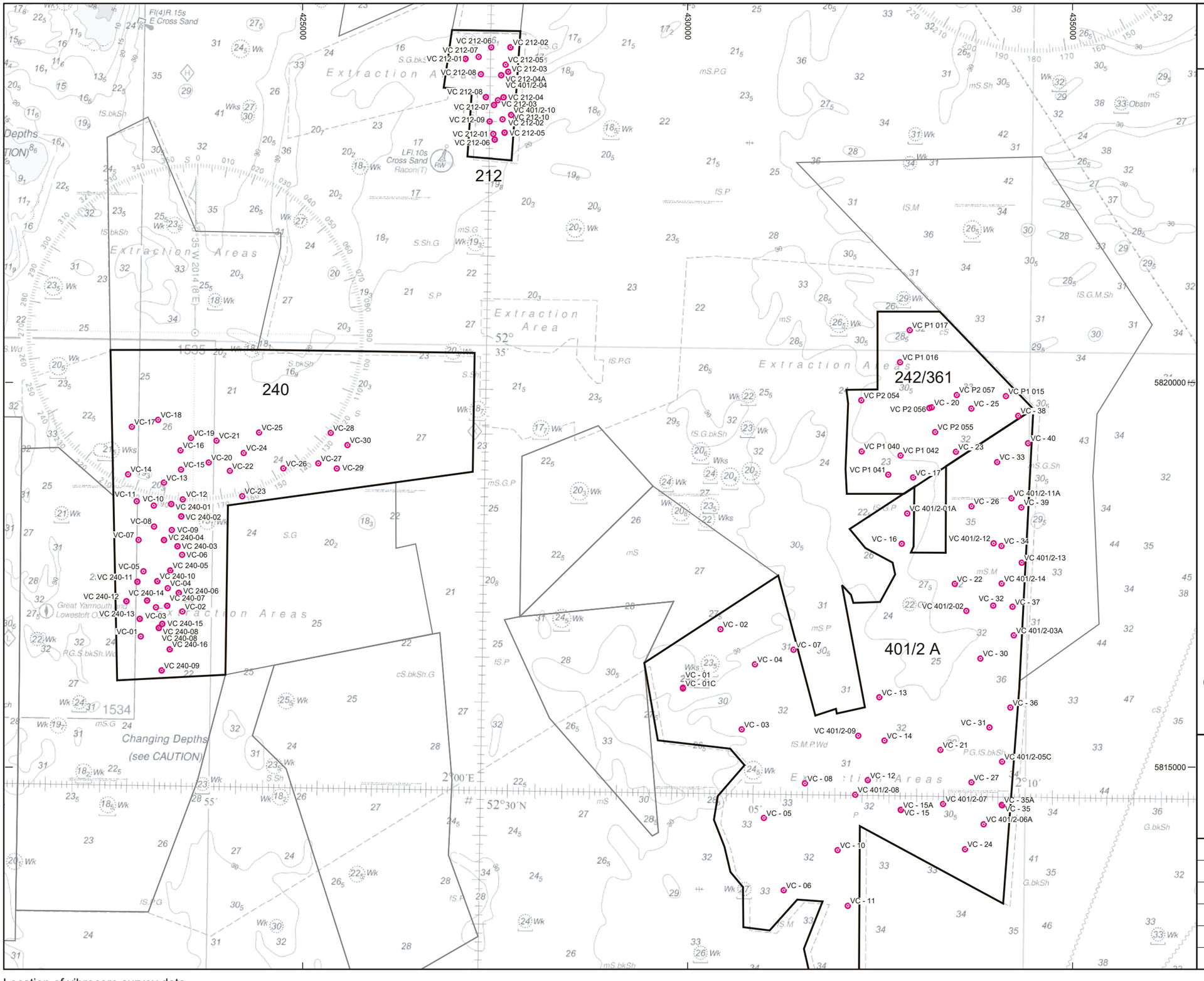
Location of Hanson Marine Aggregate Licence Areas

Figure 1

Revision Number:	0
Illustrator:	KJF
Date:	01/09/2020
Scale:	1:125,000 @A3
Path:	W:\Projects\220701\
Graphics_Office\Rep figs\Geoarch\2020_10_09	

Palaeo-Yare Catchment Assessment

Figure 2



Drawing projection: UTM WGS84 z31N.

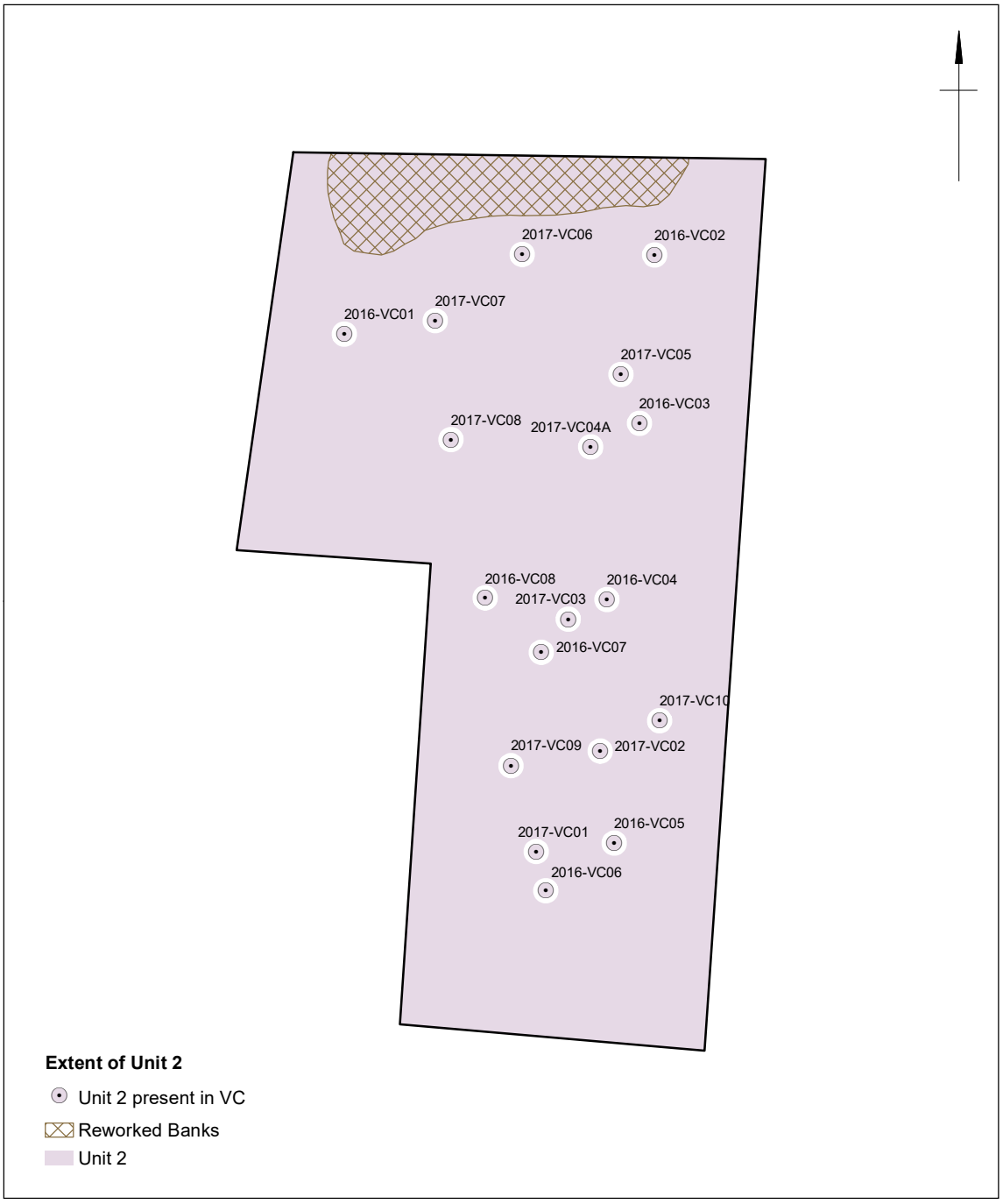
Date:	19/10/2020
Revision Number:	0
Scale:	1:80,000 @A3
Illustrator:	KJF
Path:	W:\Projects\220701\Graphics_Office\

Rep figs\Geoarch\2020_10_09

Location of vibrocore survey data

Figure 3

Area 212



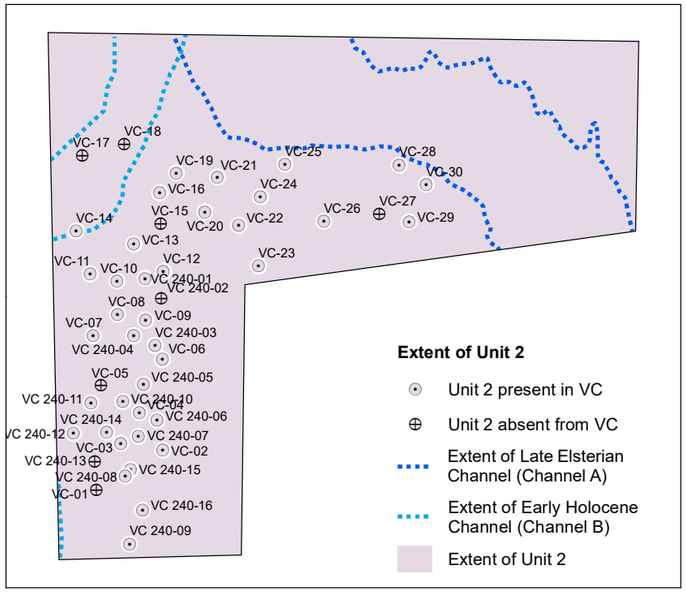
Drawing projection: UTM WGS84 z31N.

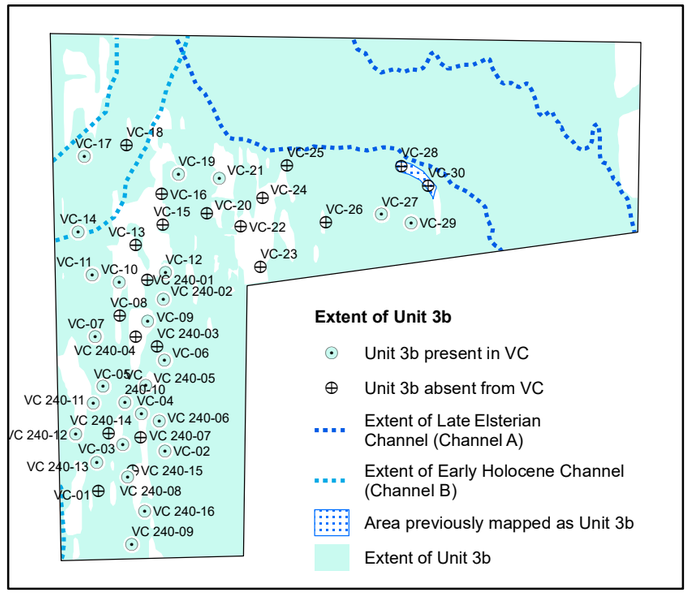
Date:	20/10/2020	Revision Number:	0
Scale:	1:20,000 at A4	Illustrator:	KJF
Path:	W:\Projects\220701\GIS\FigsMXD\Geoarch report		

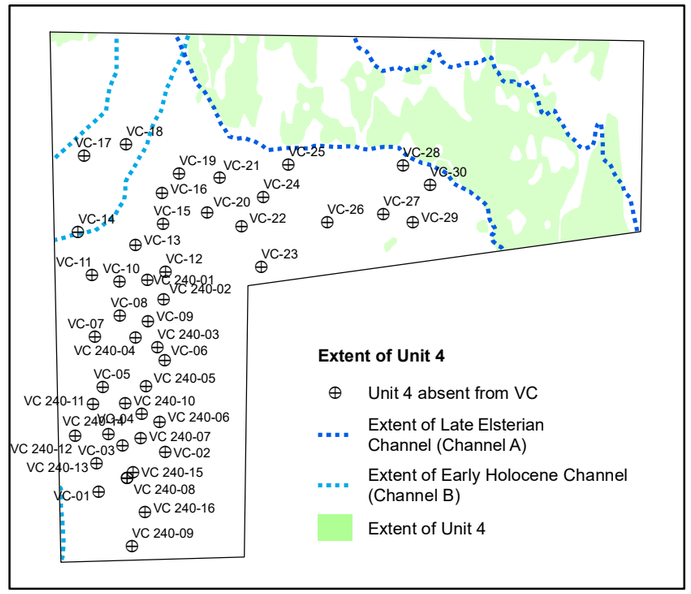
Area 212: Review of deposit extent based on review of vibrocore data

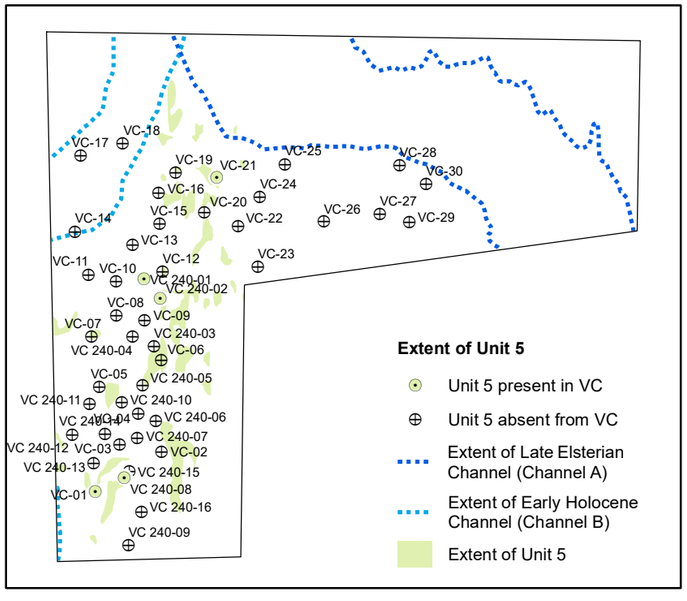
Figure 4

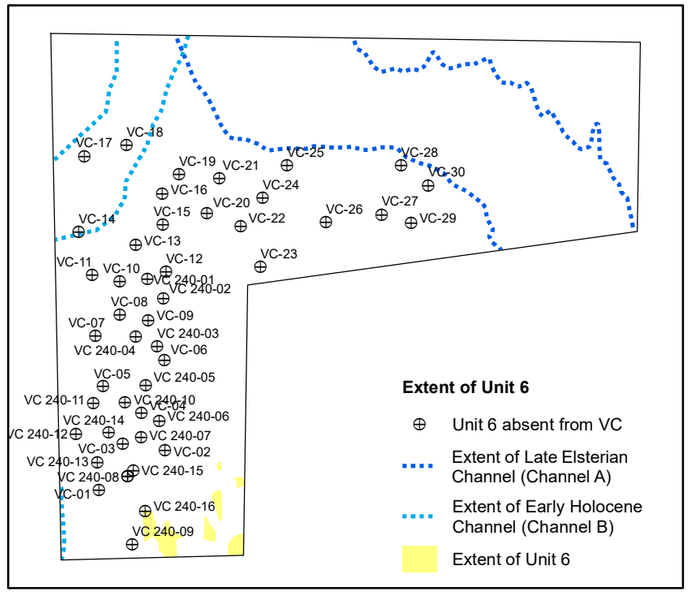
Area 240

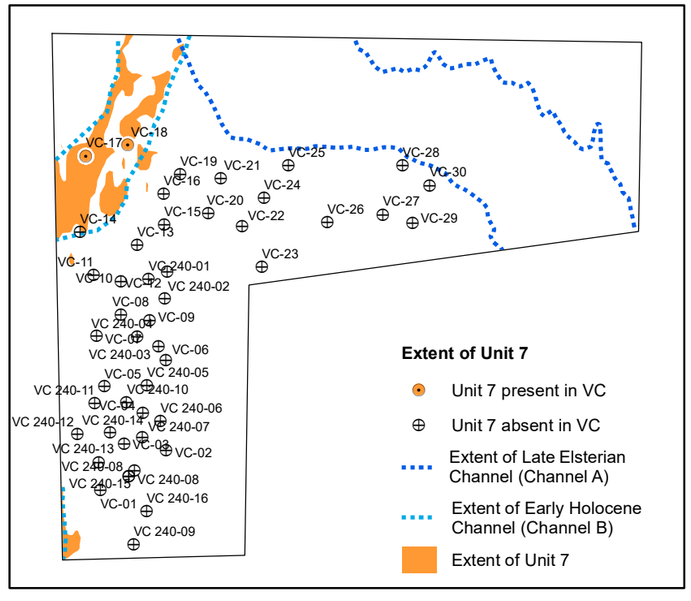












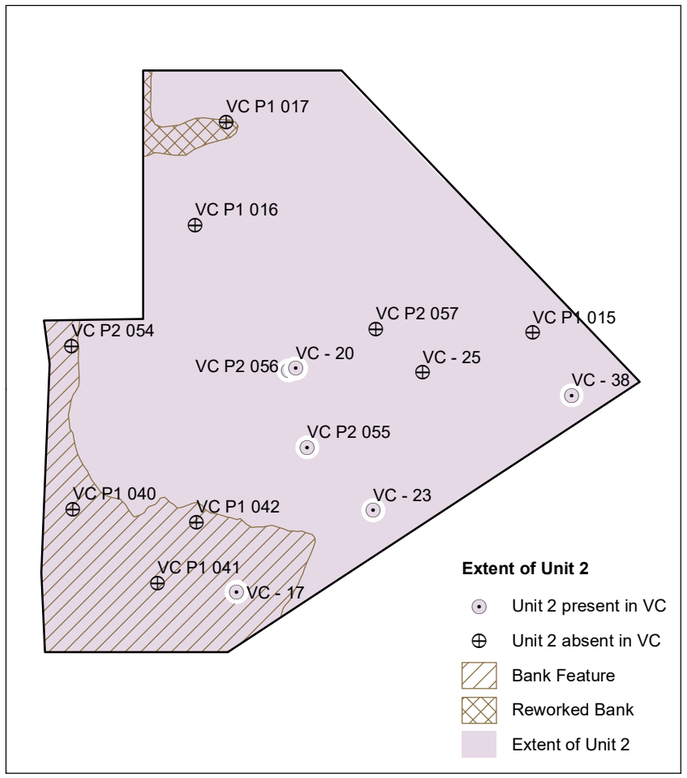
0 2.5 km

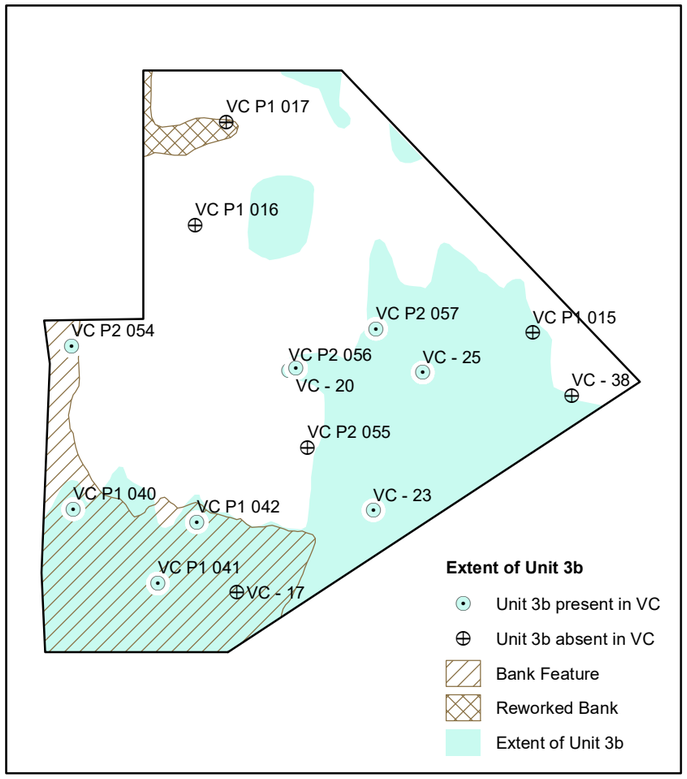
Date:	20/10/2020	Revision Number:	0
Scale:	1:80,000 at A3	Illustrator:	KJF
Path:	W:\Projects\220701\GIS\FigsMXD\Geoarch report		

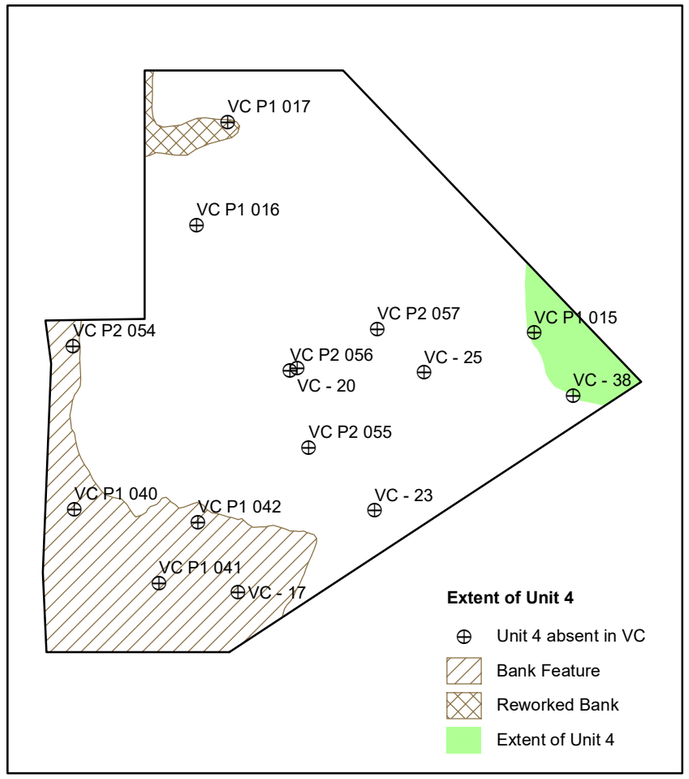
Area 240: Review of deposit extent based on review of vibrocore data

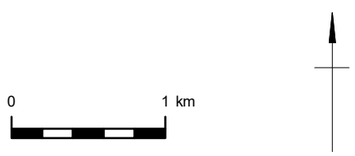
Figure 5

Area 242/361







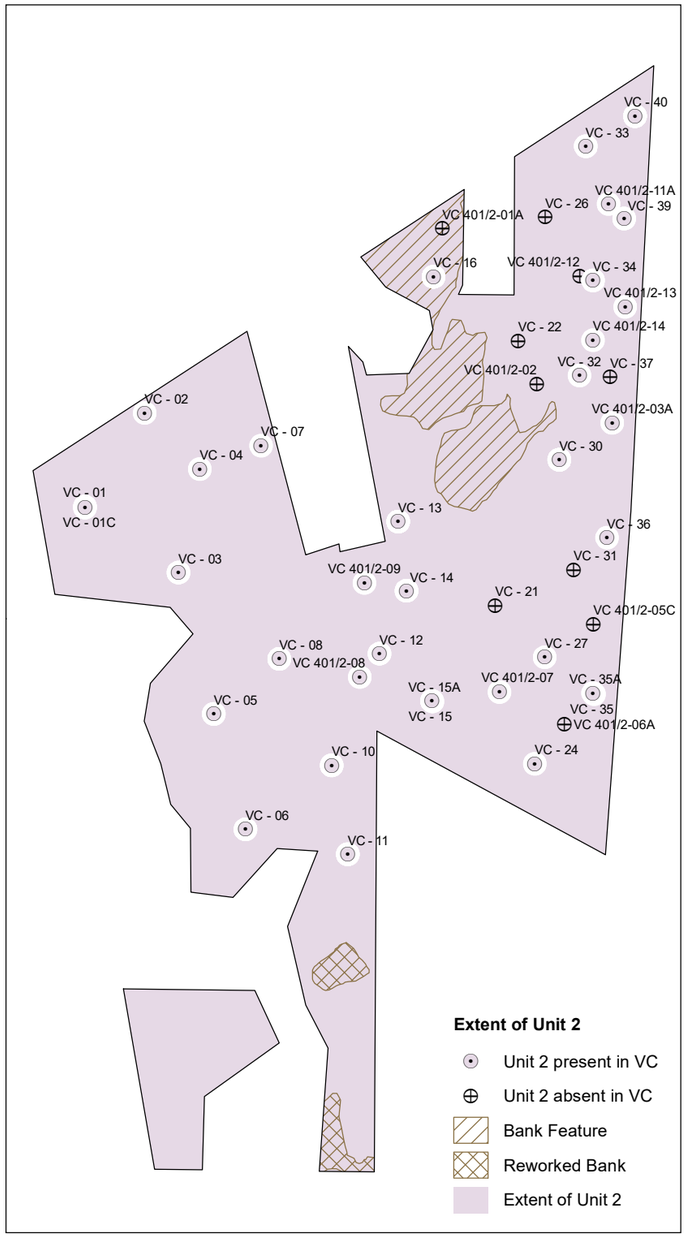


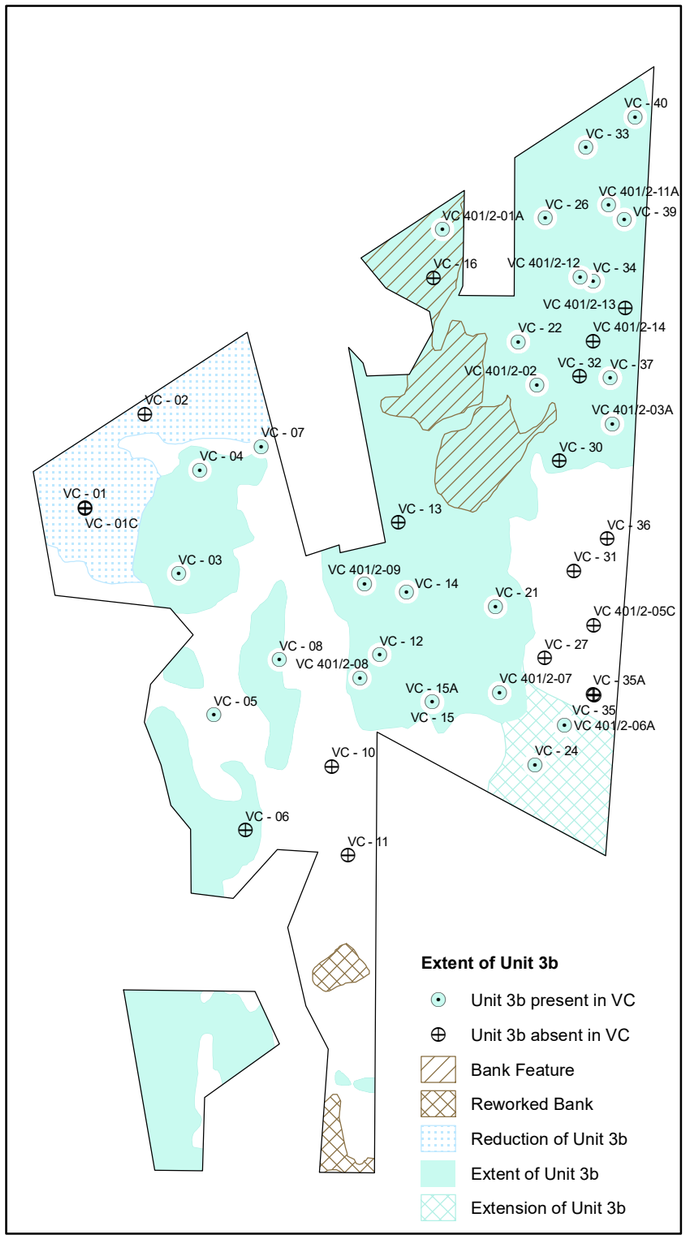
Date:	20/10/2020	Revision Number:	0
Scale:	1:40,000 at A3	Illustrator:	KJF
Path:	W:\Projects\220701\GIS\FigsMXD\Geoarch report		

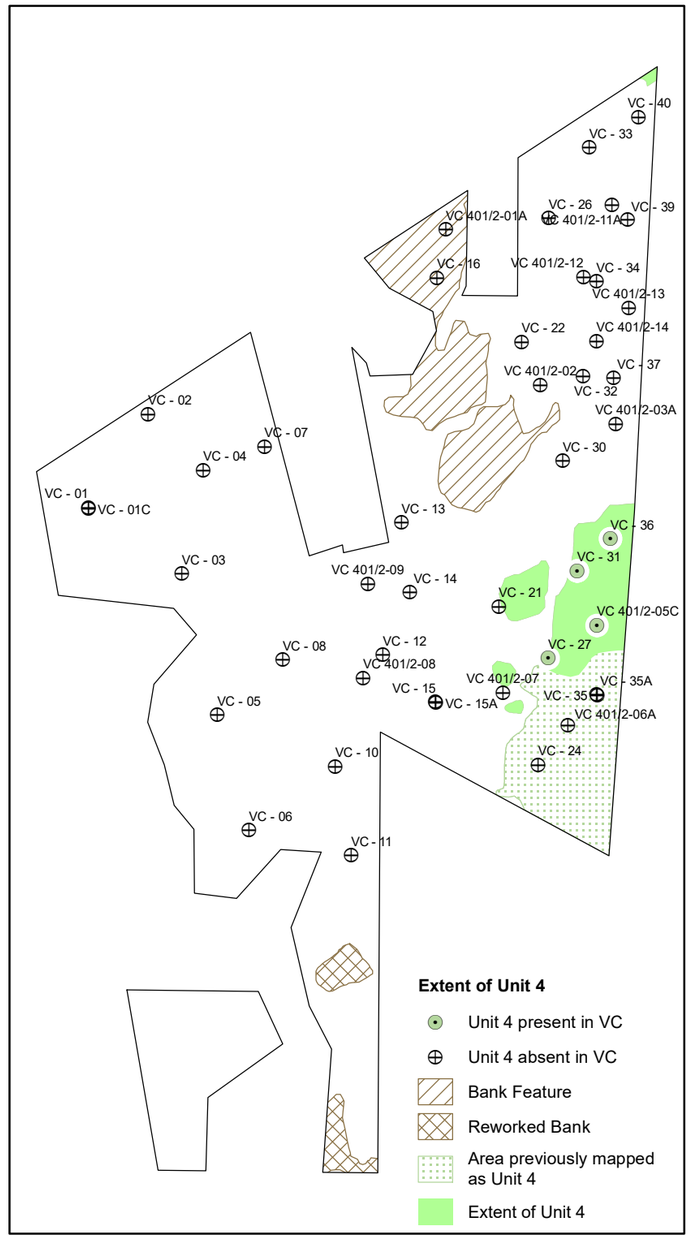
Area 242/361: Review of deposit extent based on review of vibrocore data

Figure 6

Area 401/2







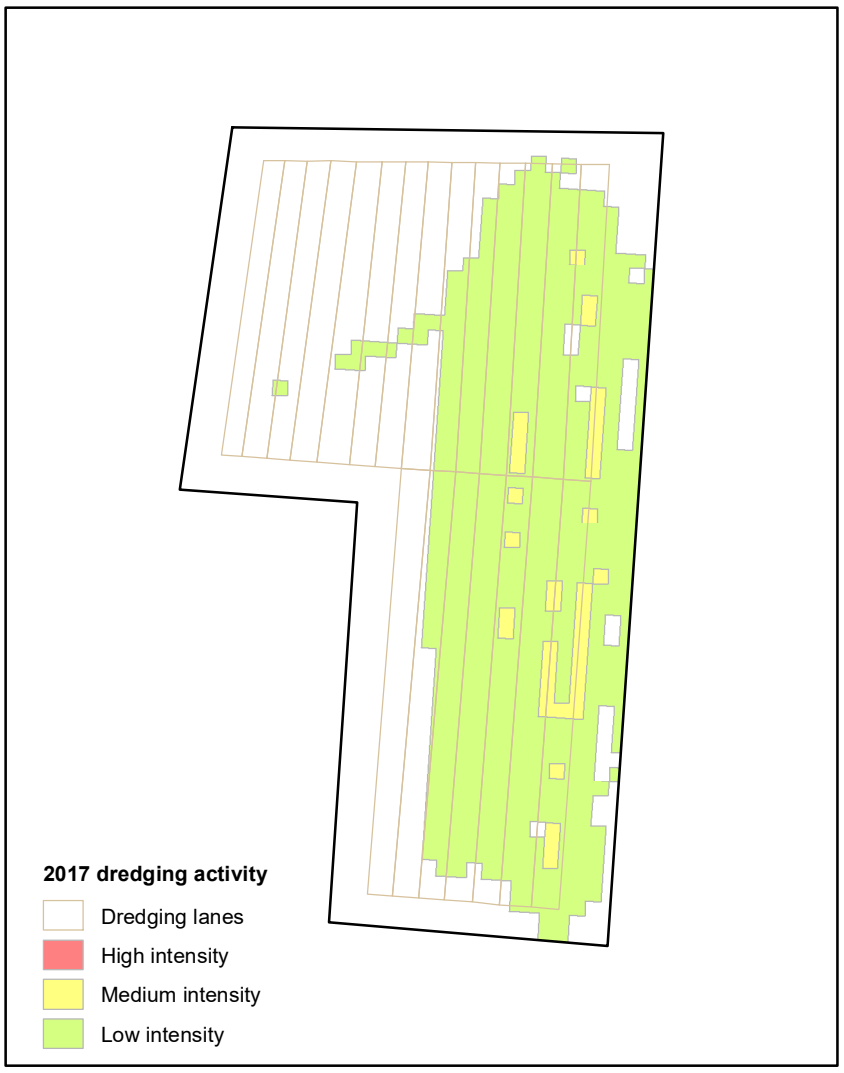
0 2.5 km

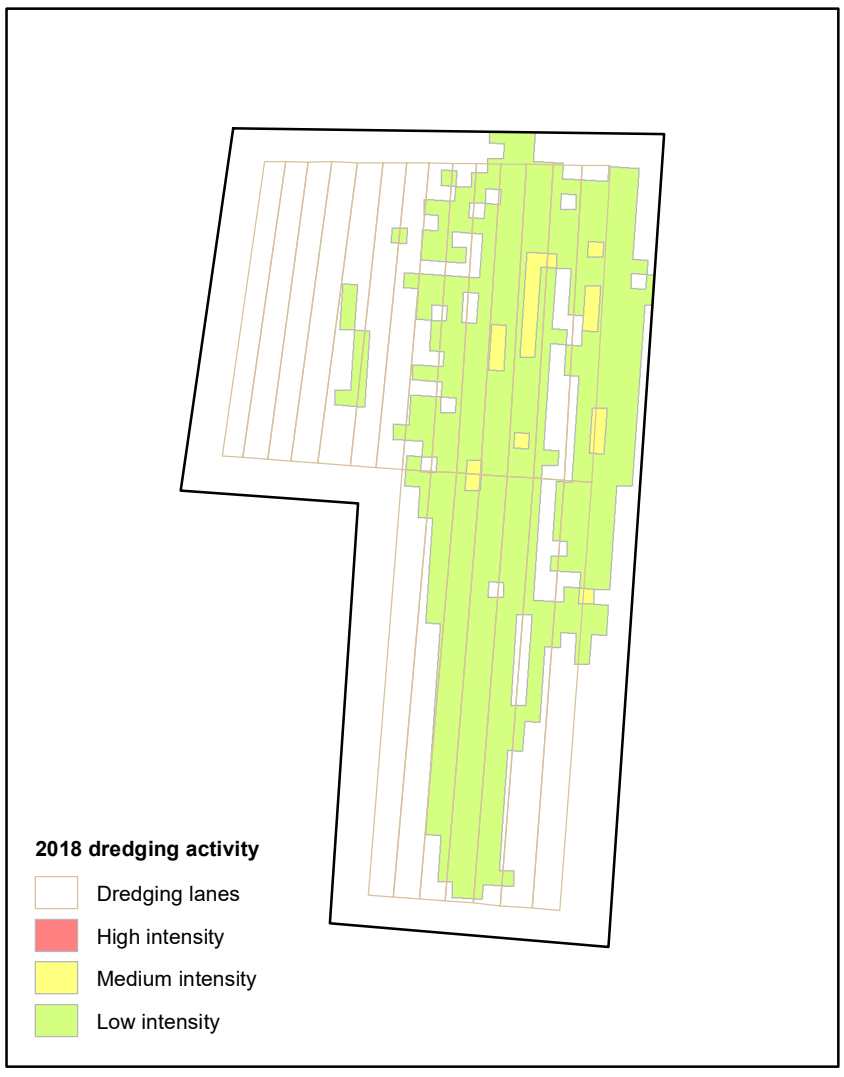
Date:	20/10/2020	Revision Number:	0
Scale:	1:80,000 at A3	Illustrator:	KJF
Path:	W:\Projects\220701\GIS\FigsMXD\Geoarch report		

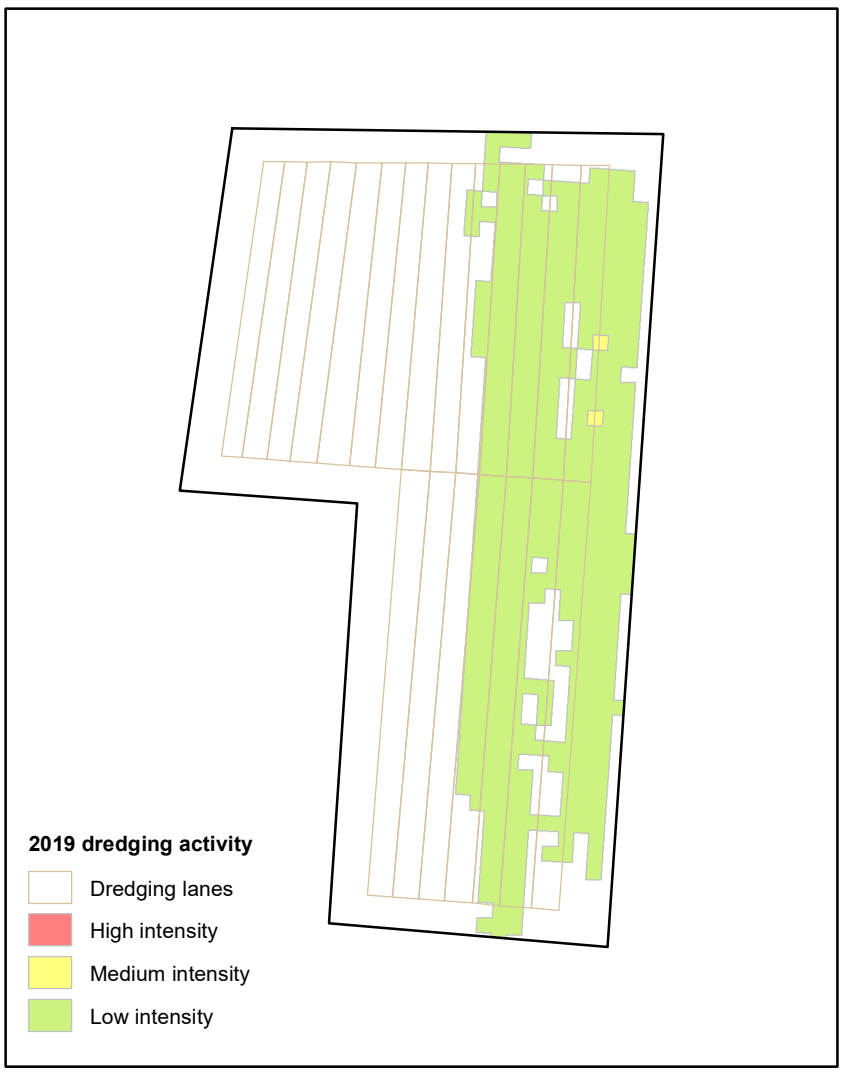
Area 401/2: Review of deposit extent based on review of vibrocore data

Figure 7

Area 212







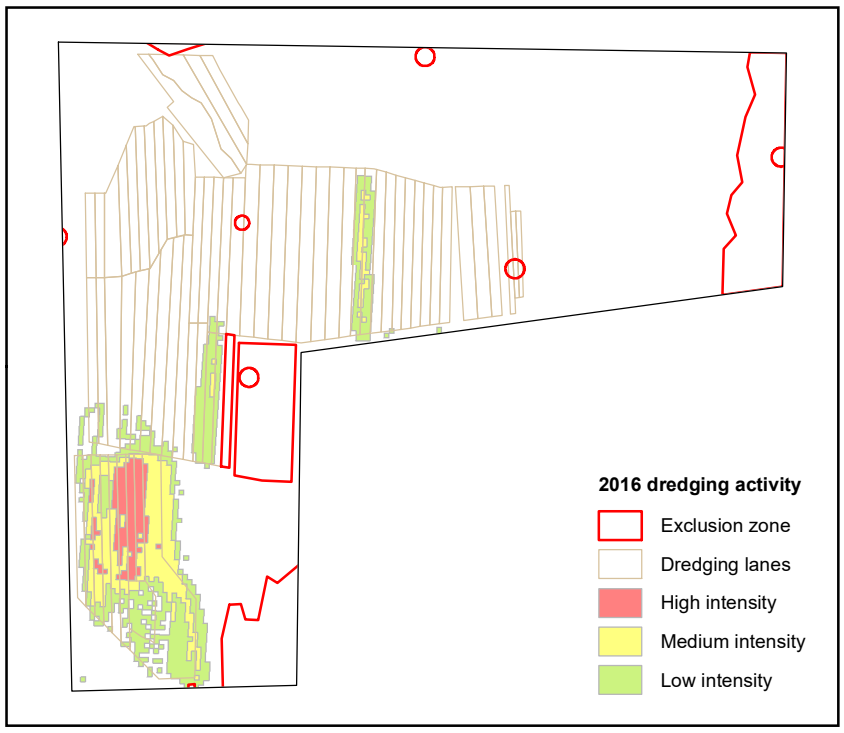
0 1 km

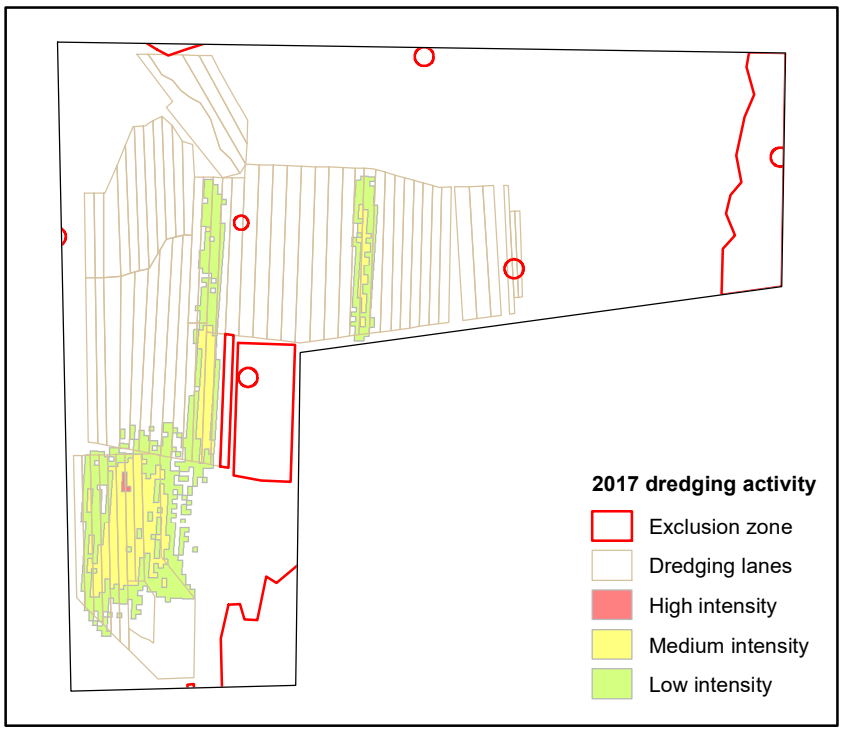
Date:	21/10/2020	Revision Number:	0
Scale:	1:25,000 at A3	Illustrator:	KJF
Path:	W:\Projects\220701\GIS\FigsMXD\Geoarch report		

Area 212: Dredging activity determined from Electronic Monitoring System data

Figure 8

Area 240





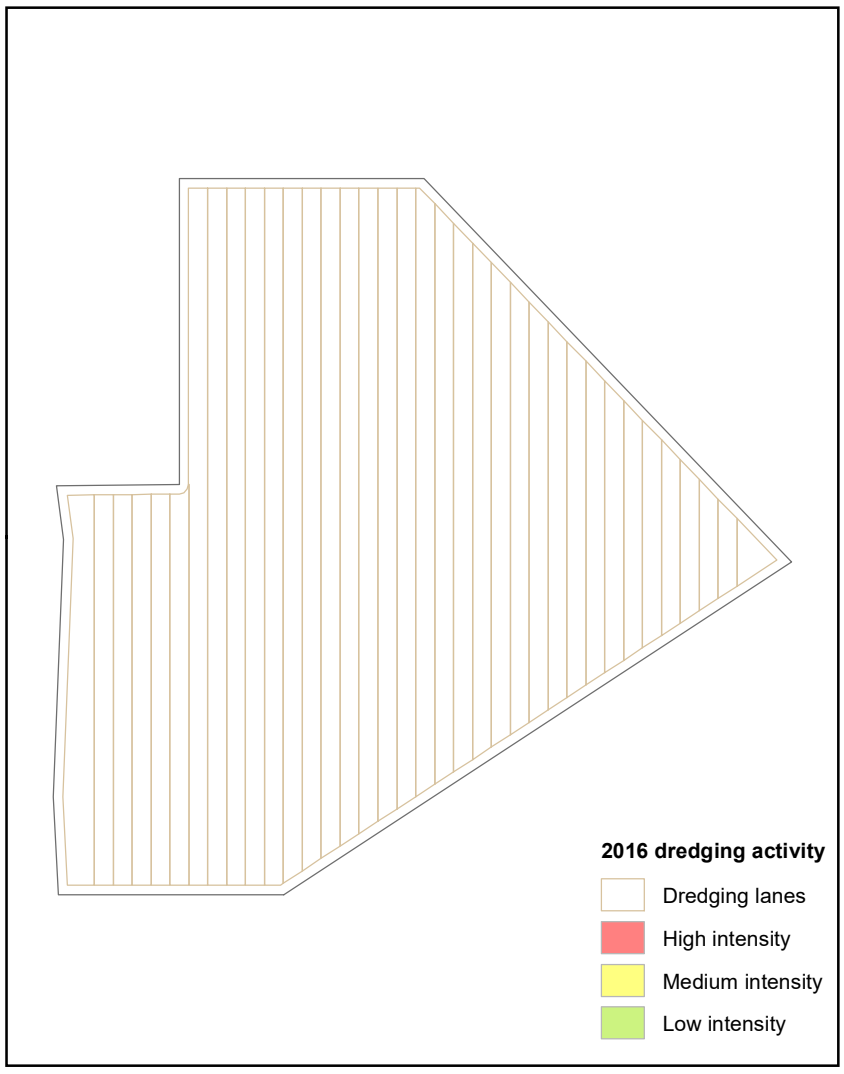
0 2.5 km

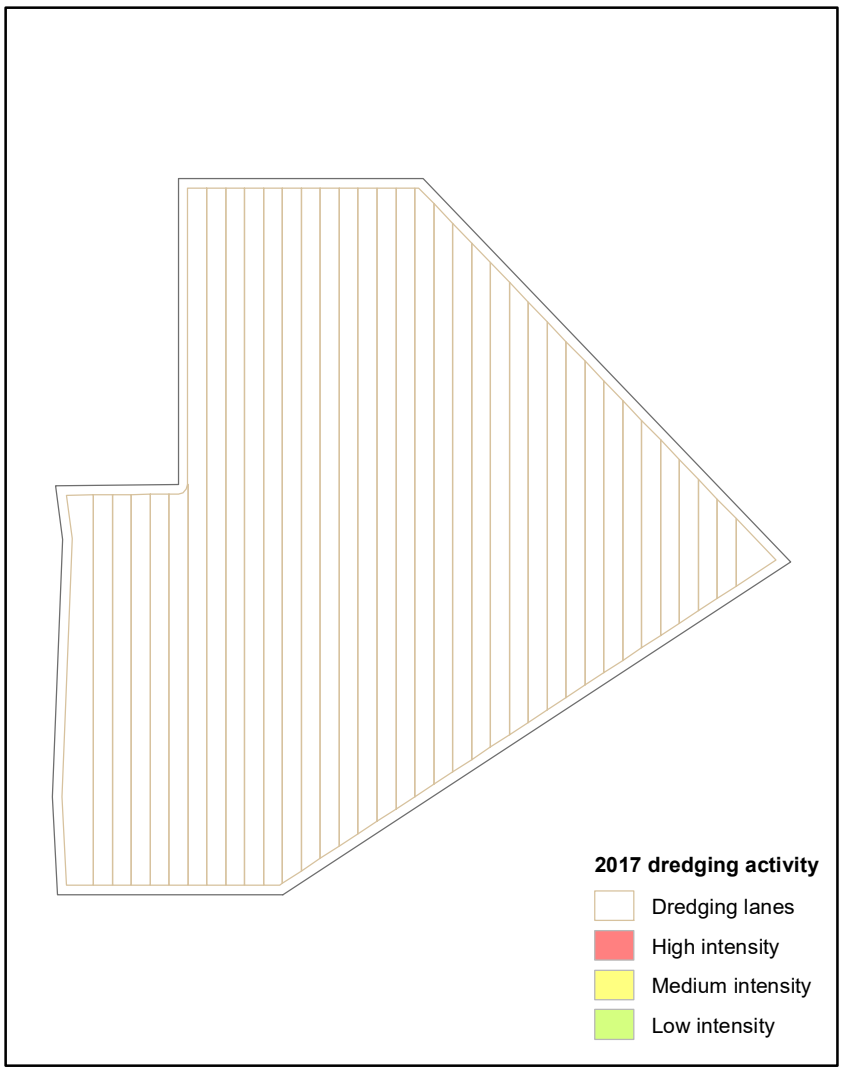
Date:	21/10/2020	Revision Number:	0
Scale:	1:80,000 at A3	Illustrator:	KJF
Path:	W:\Projects\220701\GIS\FigsMXD\Geoarch report		

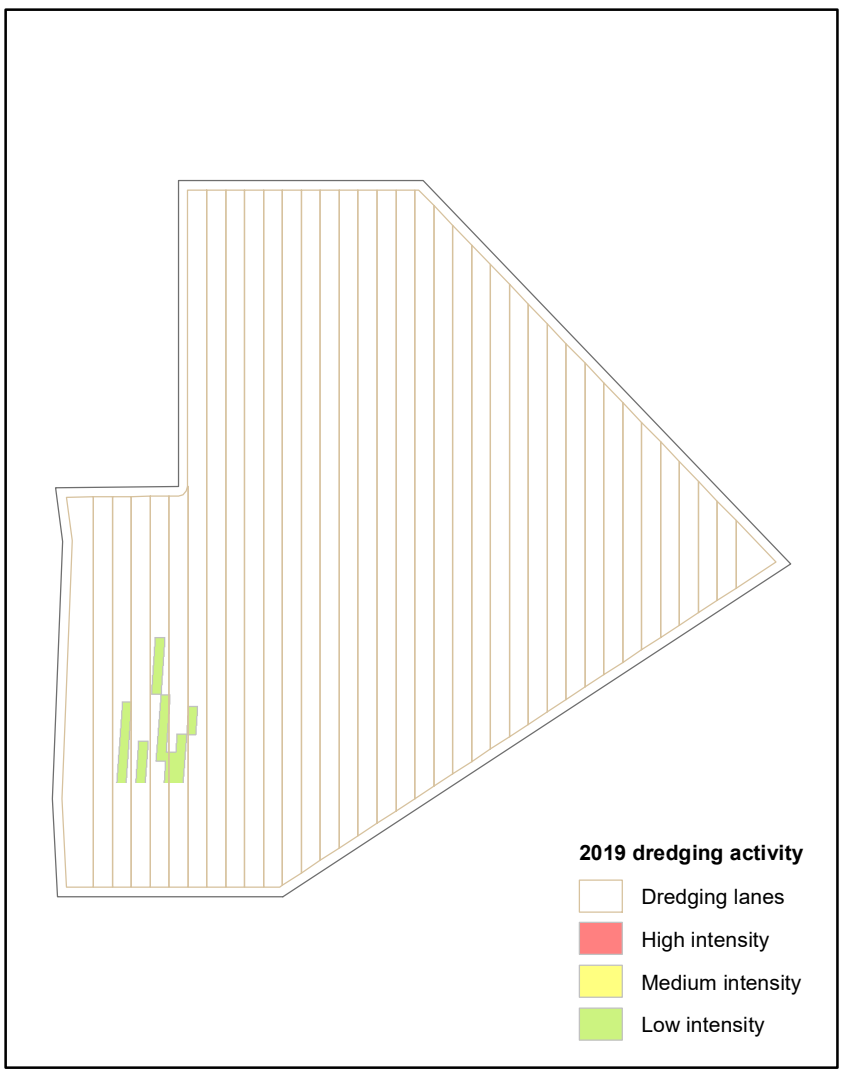
Area 240: Dredging activity determined from Electronic Monitoring System data

Figure 9

Area 242/361





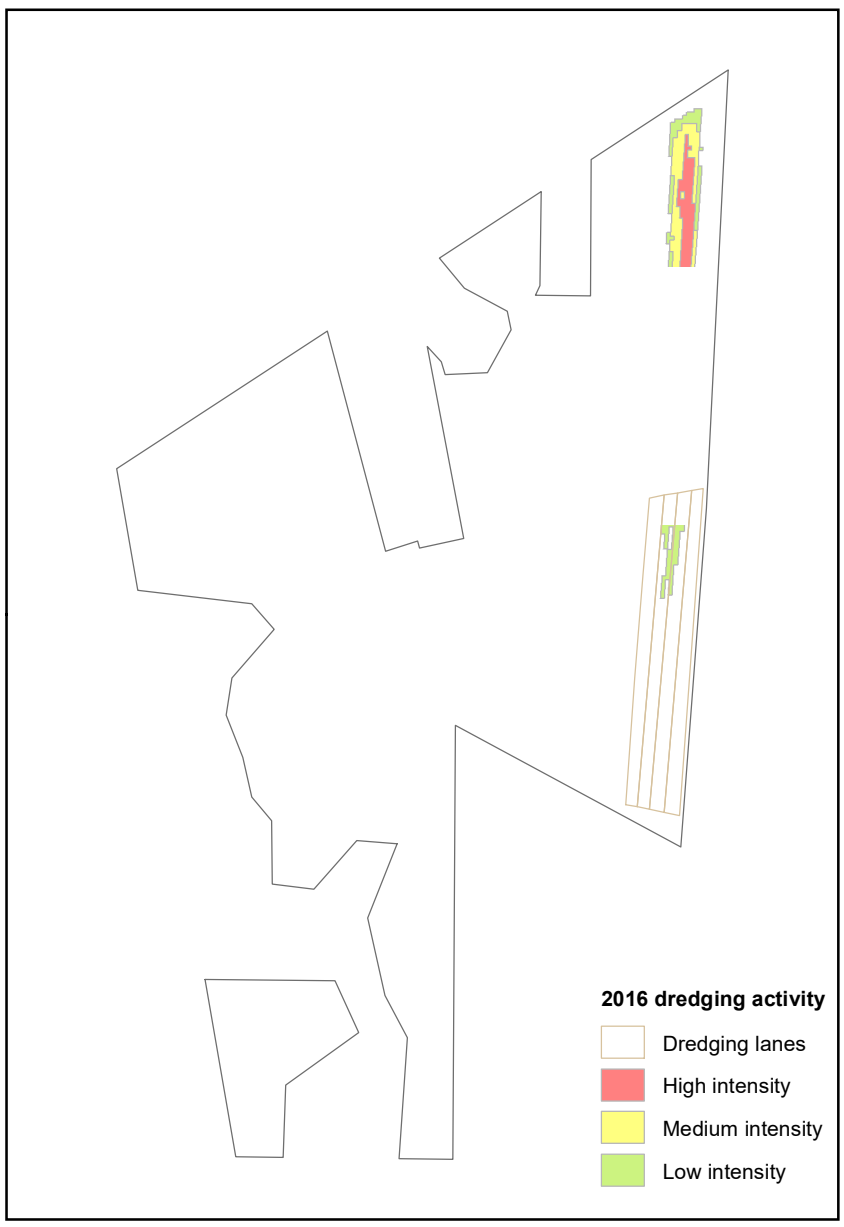


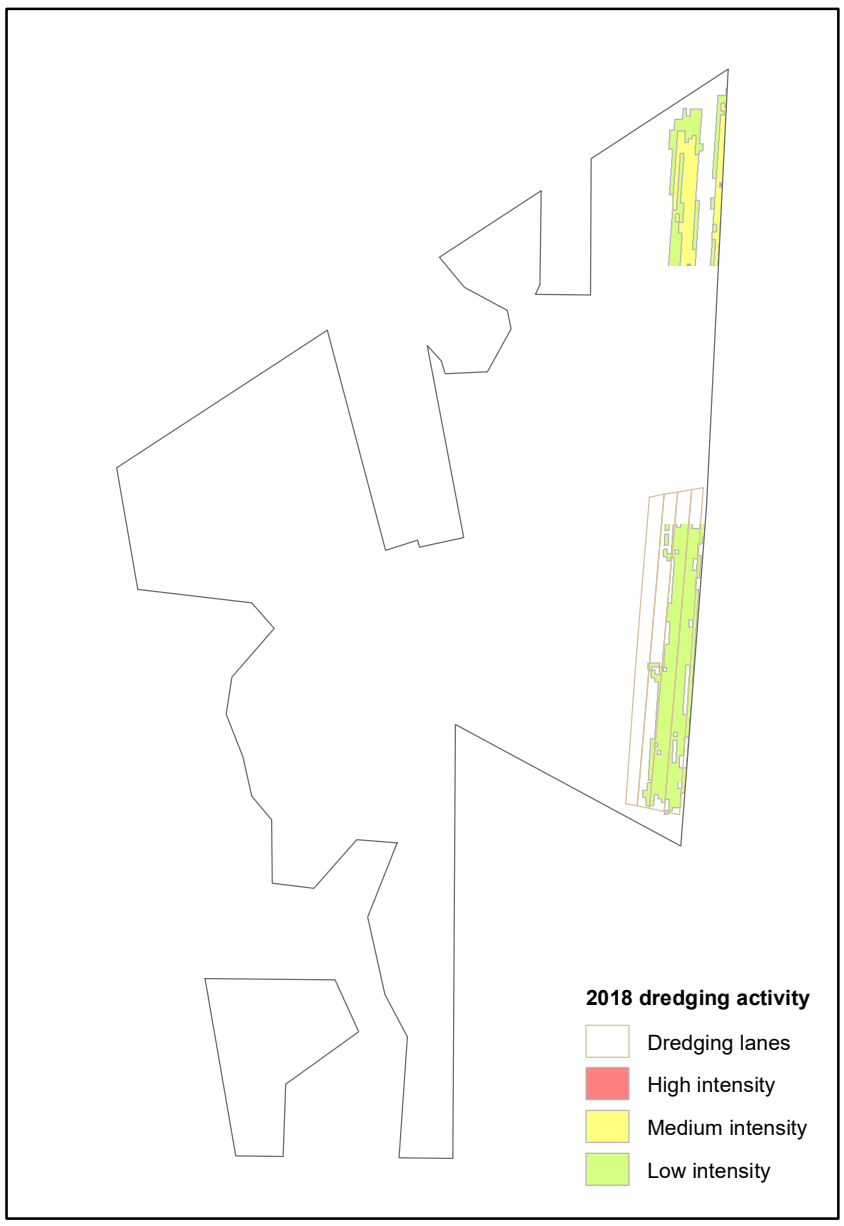
Date:	21/10/2020	Revision Number:	0
Scale:	1:40,000 at A3	Illustrator:	KJF
Path:	W:\Projects\220701\GIS\FigsMXD\Geoarch report		

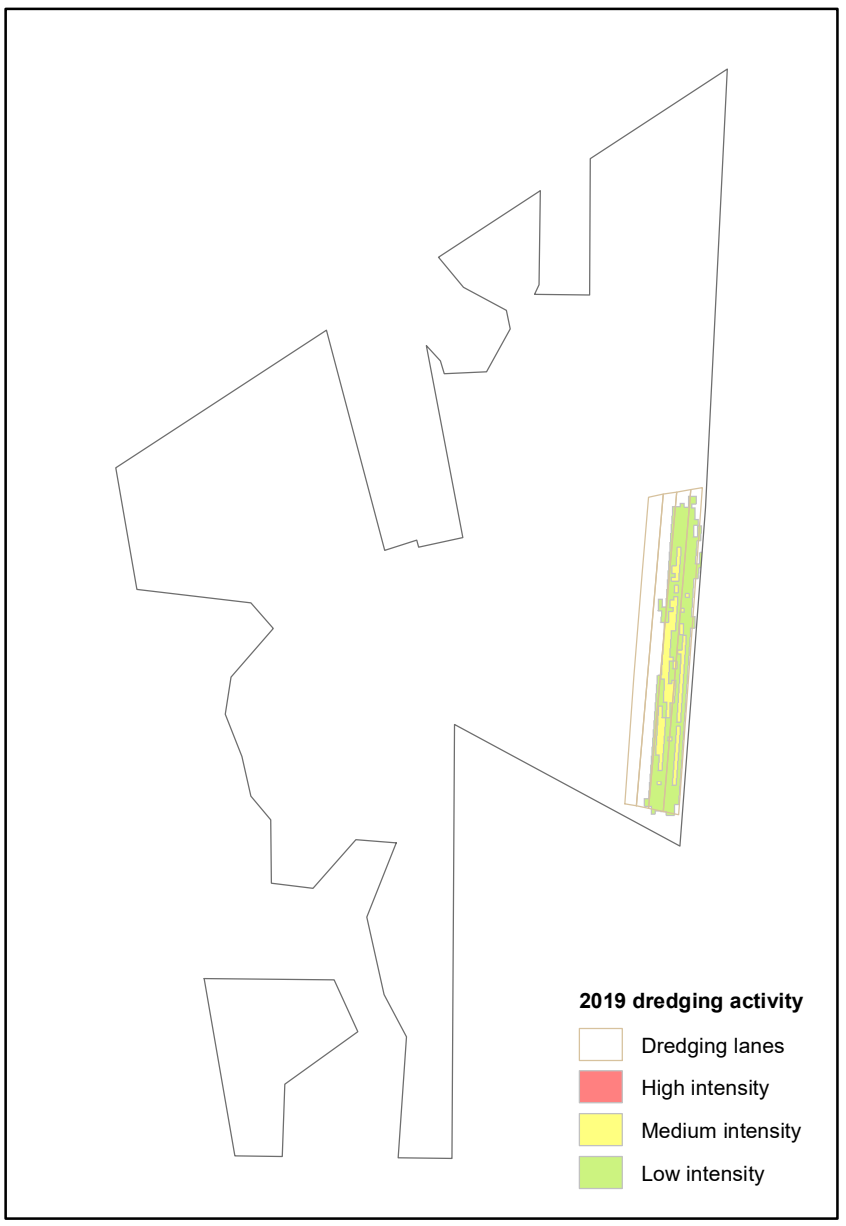
Area 242/361: Dredging activity determined from Electronic Monitoring System data

Figure 10

Area 401/2







0 2.5 km

Date:	21/10/2020	Revision Number:	0
Scale:	1:100,000 at A3	Illustrator:	KJF
Path:	W:\Projects\220701\GIS\FigsMXD\Geoarch report		

Area 401/2: Dredging activity determined from Electronic Monitoring System data

Figure 11

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.

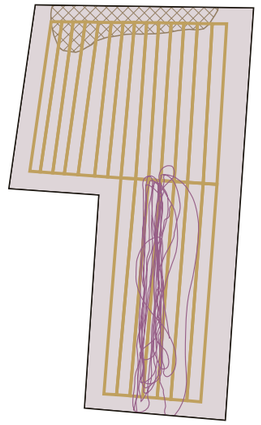
Operational sampling undertaken to date:

- 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.

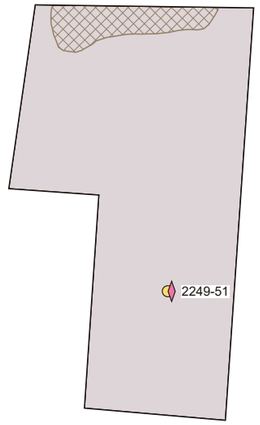
Sampling Operation Groups:

Group 1: Previously sampled dredge lanes targeting Unit 2.
Group 2: Unsampled 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). On two consecutive sample operations within a single dredge lane with no recovered finds, no further sampling will be required.	Testable	Maintain current rate of assessment (1 in 14 loads). On two consecutive sample operations within a single dredge lane with no recovered finds, no further sampling will be required.
	H1.2: Some of the Middle Palaeolithic material recovered from Unit 3b is *in situ*	Not testable		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 *in situ*	Not testable		Not testable		Not testable	
	H1.5: Some *in situ* Lower Palaeolithic material is recovered from units other than Unit 3b	Tested		Testable		Testable	
	H1.6: Artefactual material appears to be *in situ* in areas other than Unit 3b and the vicinity of Channel B	Tested		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	Not testable		Not 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	Not testable		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	

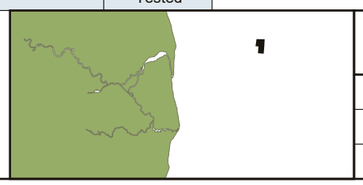
Licence Area (311 hectares)
Dredging Sub Areas
Operational Sampling tracks

Reworked bank

Units subcropping surficial sediment (Unit 8):
Unit 2 Lower Palaeolithic

Known archaeology:
Bone / faunal
Stone

0 1 2 km



Date:	19/10/2020	Revision Number:	0
Scale:	1:40,000 @A3	Illustrator:	KJF
Path:	W:\Projects\220701\Graphics_Office\Rep figs\Geoarch\2020_10_09		

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 Elsterian 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:

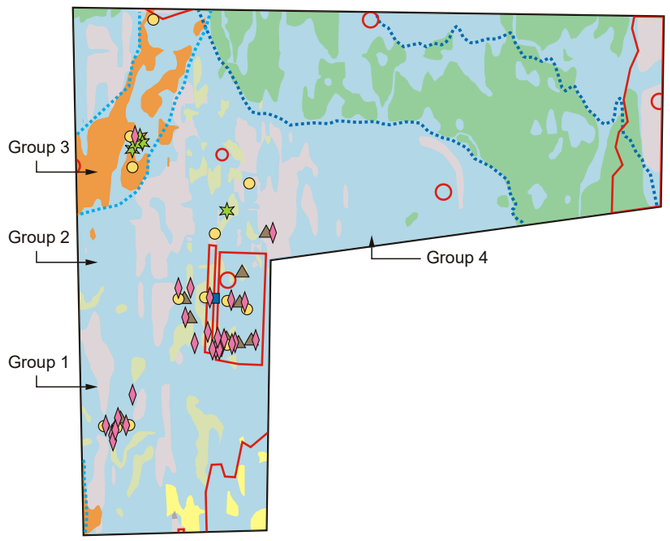
- Sixteen operational sampling events have been undertaken in Area 240 up to December 2019. All targeted the southwest dredge lanes, targeting predominantly Unit 3b sediments with localised areas of Unit 2 (due to dredging out of Unit 3b) and localised pockets of Unit 5/6.

Sampling Operation Groups:

Group 1: Southwest dredge lanes: Previously sampled dredge lanes targeting predominantly Unit 3b.
Group 2: Central dredge lanes: Partially unsampled 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 *in situ*	Tested		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		Not testable	
	H1.4: Some Late Upper Palaeolithic material from the vicinity of Channel B is *in situ*	Tested		Tested		Testable		Testable	
	H1.5: Some *in situ* Lower Palaeolithic material is recovered from units other than Unit 3b	Not testable		Not testable		Not testable		Not testable	
	H1.6: Artefactual material appears to be *in situ* in areas other than Unit 3b and the vicinity of Channel B	Not testable		Not testable		Not testable		Not testable	
	H1.7: Prehistoric material is recovered for periods later than the Later Upper Palaeolithic	Tested		Tested		Testable		Testable	
	H1.8: Faunal remains appear to be in primary contexts	Tested		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		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		Not testable	
	H2.3: Middle Palaeolithic material is clustered in relatively large quantities at discrete locations	Tested		Tested		Testable		Testable	
	H2.4: Middle Palaeolithic material is present in small quantities throughout Unit 3b deposits	Tested		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		Not testable		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		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		Testable	
	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		Testable	
Operational Sampling Methods	H5.1: Faunal and artefactual material is found at all wharves where Operational Sampling takes place	Tested		Tested		Testable		Testable	

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 5 km

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

Drawing projection: UTM WGS84 z31N.

Date:	21/10/2020	Revision Number:	0
Scale:	1:80,000 @A3	Illustrator:	KJF
Path:	W:\Projects\220701\GIS\FigsMXD\Geoarch report		

Area 242/361

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**)

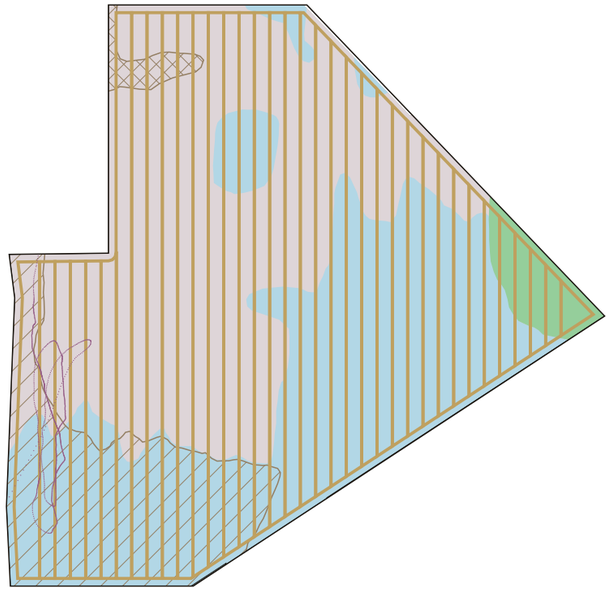
Operational sampling undertaken to date:

- 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.

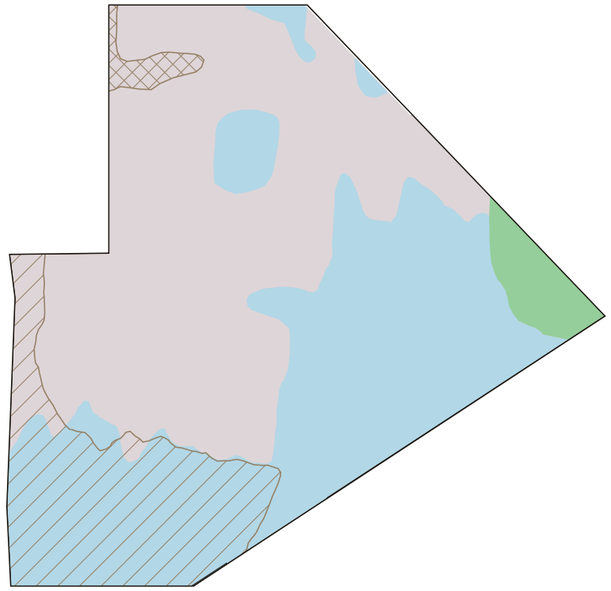
Sampling Operation Groups:

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.

A. Interpretation and Operational Sampling tracks



B. Interpretation and known archaeology

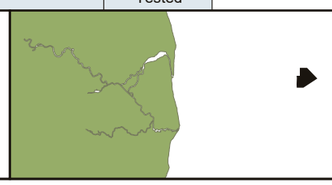


	Hypothesis	Target Group 1		Target Group 2	
		Hypothesis tested	Threshold	Hypothesis tested	Threshold
Inhabitation	H1.1: Middle Palaeolithic material is recovered from units other than Unit 3b	Tested	Sample at a rate of assessment (1 in 30 loads). If Unit 3b is encountered below reworked bank feature, 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 *in situ*	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 *in situ*	Not testable		Not testable	
	H1.5: Some *in situ* Lower Palaeolithic material is recovered from units other than Unit 3b	Tested		Testable	
	H1.6: Artefactual material appears to be *in situ* 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		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	Testable		Not testable	
Natural Processes	H3.1: Middle Palaeolithic material is recovered in areas where Unit 3b has been reworked by natural processes	Testable		Not testable	
	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		Not testable	
	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

0 1 2 km



Date:	22/10/2020	Revision Number:	0
Scale:	1:40,000 @A3	Illustrator:	KJF
Path:	W:\Projects\220701\Graphics_Office\Rep figs\Geoarch\2020_10_09		

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).

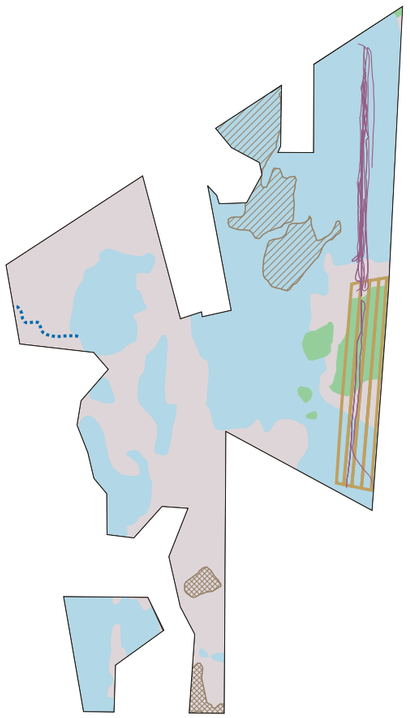
Operational sampling undertaken to date:

- 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.

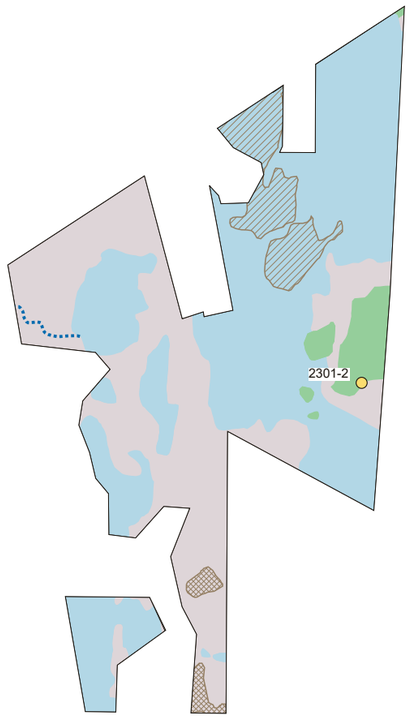
Sampling Operation Groups:

Group 1: Sampled northern dredge lanes targeting Unit 3b.
Group 2: Partially unsampled 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	For unsampled dredge lanes 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 *in situ*	Tested		Tested		Not testable	
	H1.3: Late Upper Palaeolithic material is recovered from other places in addition to the vicinity of Channel B	Tested		Tested		Testable	
	H1.4: Some Late Upper Palaeolithic material from the vicinity of Channel B is *in situ*	Not testable		Not testable		Not testable	
	H1.5: Some *in situ* Lower Palaeolithic material is recovered from units other than Unit 3b	Not testable		Not testable		Testable	
	H1.6: Artefactual material appears to be *in situ* 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		Tested		Testable	
	H1.8: Faunal remains appear to be in primary contexts	Tested		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		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		Not testable	
	H2.3: Middle Palaeolithic material is clustered in relatively large quantities at discrete locations	Tested		Tested		Testable	
	H2.4: Middle Palaeolithic material is present in small quantities throughout Unit 3b deposits	Tested		Tested		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		Tested		Testable	

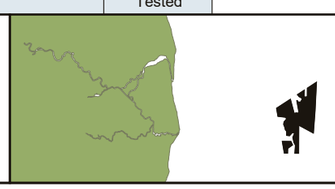
Licence Area (5112 hectares)
Dredging Sub Areas

Reworked bank
Bank feature (unknown age)
Extents of Late Elsterian channel (Channel A)

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

Known archaeology:
Bone / faunal

0 5 km



Date:	23/10/2020	Revision Number:	0
Scale:	1:125,000 @A3	Illustrator:	KJF
Path:	W:\Projects\220701\Graphics_Office\Rep figs\Geoarch\2020_10_09		

Wessex Archaeology Ltd registered office Portway House, Old Sarum Park, Salisbury, Wiltshire SP4 6EB
Tel: 01722 326867 Fax: 01722 337562 info@wessexarch.co.uk www. wessexarch.co.uk

FS 606559