Wessex Archaeology

Round 3 Hornsea Offshore Windfarm Subzone 1 and Export Cable Route

Stage 1 and 2 Geoarchaeological Assessment



April 2013



ROUND 3 HORNSEA OFFSHORE WINDFARM SUBZONE 1 AND EXPORT CABLE ROUTE

Stage 1 and 2 Geoarchaeological Assessment

Prepared for: RPS Energy (London) 14 Cornhill London EC3V 3ND

On behalf of:

Smart Wind Limited 11th Floor 140 London Wall London EC2Y 5ND

Prepared by:

Wessex Archaeology Portway House Old Sarum Park Salisbury WILTSHIRE SP4 6EB

www.wessexarch.co.uk

April 2013

Report Ref: 87151.03

Quality Assurance

Project Code	87151	Accession Code	Client Ref.	
Planning Application Ref.		Ordnance Survey (OS) national grid reference (NGR)		

Version	Status*	Prepared by	Checked and Approved By	Approver's Signature	Date
v01	E	Jack Russell	Paul Baggaley	P. kog	11/02/2013
File:	87151_H	lornseaOWF_Geoar	ch_v1.doc		
v02	E	Jack Russell	Paul Baggaley	P. Logo	08/03/2013
File:	87151_F	lornseaOWF_Geoar	ch_v2.doc		
v03	F	Jack Russell	Paul Baggaley	P. kog	08/04/2013
File:	87151_H	lornseaOWF_Geoar	ch_v3.doc	·	
File:					
File:					

* I = Internal Draft; E = External Draft; F = Final

DATA LICENSES

This product has been derived in part from material obtained from the UK Hydrographic Office with the permission of the UK Hydrographic Office and Her Majesty's Stationery Office.

© Crown Copyright, 2013. Wessex Archaeology Ref. HA294/007/316-01.

The following notice applies:

NOT TO BE USED FOR NAVIGATION

WARNING: The UK Hydrographic Office has not verified the information within this product and does not accept liability for the accuracy of reproduction or any modifications made thereafter.

Wreck and obstruction data were supplied by SeaZone Solutions Ltd. © British Crown SeaZone Solutions Ltd. All rights reserved. Product Licence no. 012012.002.

This product has been derived in part from material obtained from the UK Hydrographic Office with the permission of the Controller of Her Majesty's Stationery Office and UK Hydrographic Office

(www.ukho.gov.uk).

NOT TO BE USED FOR NAVIGATION

Contains Ordnance Survey data © Crown copyright and database rights 2013

DISCLAIMER

THE MATERIAL CONTAINED IN THIS REPORT WAS DESIGNED AS AN INTEGRAL PART OF A REPORT TO AN INDIVIDUAL CLIENT AND WAS PREPARED SOLELY FOR THE BENEFIT OF THAT CLIENT. THE MATERIAL CONTAINED IN THIS REPORT DOES NOT NECESSARILY STAND ON ITS OWN AND IS NOT INTENDED TO NOR SHOULD IT BE RELIED UPON BY ANY THIRD PARTY. TO THE FULLEST EXTENT PERMITTED BY LAW WESSEX ARCHAEOLOGY WILL NOT BE LIABLE BY REASON OF BREACH OF CONTRACT NEGLIGENCE OR OTHERWISE FOR ANY LOSS OR DAMAGE (WHETHER DIRECT INDIRECT OR CONSEQUENTIAL) OCCASIONED TO ANY PERSON ACTING OR OMITTING TO ACT OR REFRAINING FROM ACTING IN RELIANCE UPON THE MATERIAL CONTAINED IN THIS REPORT ARISING FROM OR CONNECTED WITH ANY ERROR OR OMISSION IN THE MATERIAL CONTAINED IN THE REPORT. LOSS OR DAMAGE AS REFERRED TO ABOVE SHALL BE DEEMED TO INCLUDE, BUT IS NOT LIMITED TO, ANY LOSS OF PROFITS OR ANTICIPATED PROFITS DAMAGE TO REPUTATION OR GOODWILL LOSS OF BUSINESS OR ANTICIPATED BUSINESS DAMAGES COSTS EXPENSES INCURRED OR PAYABLE TO ANY THIRD PARTY (IN ALL CASES WHETHER DIRECT INDIRECT OR CONSEQUENTIAL) OR ANY OTHER DIRECT INDIRECT OR CONSEQUENTIAL LOSS OR DAMAGE.

DISCLAIMER

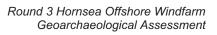
THE MATERIAL CONTAINED IN THIS REPORT WAS DESIGNED AS AN INTEGRAL PART OF A REPORT TO AN INDIVIDUAL CLIENT AND WAS PREPARED SOLELY FOR THE BENEFIT OF THAT CLIENT. THE MATERIAL CONTAINED IN THIS REPORT DOES NOT NECESSARILY STAND ON ITS OWN AND IS NOT INTENDED TO NOR SHOULD IT BE RELIED UPON BY ANY THIRD PARTY. TO THE FULLEST EXTENT PERMITTED BY LAW WESSEX ARCHAEOLOGY WILL NOT BE LIABLE BY REASON OF BREACH OF CONTRACT NEGLIGENCE OR OTHERWISE FOR ANY LOSS OR DAMAGE (WHETHER DIRECT INDIRECT OR CONSEQUENTIAL) OCCASIONED TO ANY PERSON ACTING OR OMITTING TO ACT OR REFRAINING FROM ACTING IN RELIANCE UPON THE MATERIAL CONTAINED IN THIS REPORT ARISING FROM OR CONNECTED WITH ANY ERROR OR OMISSION IN THE MATERIAL CONTAINED IN THE REPORT. LOSS OR DAMAGE AS REFERRED TO ABOVE SHALL BE DEEMED TO INCLUDE, BUT IS NOT LIMITED TO, ANY LOSS OF PROFITS OR ANTICIPATED PROFITS DAMAGE TO REPUTATION OR GOODWILL LOSS OF BUSINESS OR ANTICIPATED BUSINESS DAMAGES COSTS EXPENSES INCURRED OR PAYABLE TO ANY THIRD PARTY (IN ALL CASES WHETHER DIRECT INDIRECT OR CONSEQUENTIAL) OR ANY OTHER DIRECT INDIRECT OR CONSEQUENTIAL LOSS OR DAMAGE.

HORNSEA ROUND 3 ZONE SUBZONE 1 AND EXPORT CABLE ROUTE

Stage 1 and 2 Geoarchaeological Assessment

Contents

Sumn	mary	iii
Ackno	owledgements	iv
1 1.1 1.2	INTRODUCTION Background Aims and objectives	5
2	METHODOLOGY	6
3 3.1 3.2	PROJECT BASELINE Development Background Geoarchaeological Background	6
4	RESULTS	9
5	DISCUSSION AND ARCHAEOLOGICAL POTENTIAL	12
6	POTENTIAL FURTHER WORK	15
7	REFERENCES	17
8	APPENDIX 1 GEOARCHAEOLOGICAL FRAMEWORK	20
9	APPENDIX 2 OFFSHORE ARCHAEOLOGISTS ROLE FLOWCHART	22
10	APPENDIX 3 OFFSHORE BORHOLE RECORDING	23
11	APPENDIX 4 BOREHOLE SAMPLES TAKEN FOR STAGE 2 AND 3 WORK	42
12	APPENDIX 5 STAGE 2 ONSHORE VIBROCORE RECORDING	45
13	APPENDIX 6 VIBROCORE SAMPLES RETAINED FOR STAGE 3 WORK	55
14	APPENDIX 7 PRELIMINARY BOREHOLE LOGS	56





Figures

Figures	
Figure 1:	Borehole, vibrocore and site location
Figure 2:	Subzone 1 boreholes related to Botney Cut and Swarte Bank formations
Figure 3:	Borehole fence diagrams
Figure 4:	Borehole locations AC1a-CS, AC1b-CS and DC1-CS related to Sub-bottom profiler
data	
Figure 5:	Borehole locations NJ101-CS, NJ106-CS and AC2-CS related to Sub-bottom
profiler data	
Figure 6:	Borehole locations NJ105_CS and NJ103-CS related to Sub-bottom profiler data
Figure 7:	Borehole locations AC3-CS, NJ102-CS and NJ104-CS related to Sub-bottom
profiler data	
Figure 8:	Vibrocore locations VC05, VC06 and VC08 related to Sub-bottom profiler data
Figure 9	Vibrocore locations VC31, VC32 and VC34 related to Sub-bottom profiler data
Figure 10:	Borehole and vibrocore locations RS-CS, VC85A and VC86 related to Sub-bottom
profiler data	
Figure 11:	Vibrocore fence diagrams
Figure 12:	Vibrocore locations VC90 and VC92 related to Sub-bottom profiler data
Figure 13:	Vibrocore location VC116 related to Sub-bottom profiler data
Figure 14:	Vibrocores related to Palaeolandscape features of Archaeological Potential (Wessex
•	
Archaeology	
Archaeology	2013)
Archaeology Plate 1a:	2013) AC2-CS at 61.4m below SB
Archaeology Plate 1a: Plate 1b:	2013) AC2-CS at 61.4m below SB DC1-CS at 57.4m below SB
Archaeology Plate 1a: Plate 1b: Plate 2a:	2013) AC2-CS at 61.4m below SB DC1-CS at 57.4m below SB NJ101-CS at 47.75m below SB
Archaeology Plate 1a: Plate 1b: Plate 2a: Plate 2b:	2013) AC2-CS at 61.4m below SB DC1-CS at 57.4m below SB NJ101-CS at 47.75m below SB DC1-CS at 20.10m below SB
Archaeology Plate 1a: Plate 1b: Plate 2a:	2013) AC2-CS at 61.4m below SB DC1-CS at 57.4m below SB NJ101-CS at 47.75m below SB
Archaeology Plate 1a: Plate 1b: Plate 2a: Plate 2b: Plate 3a:	2013) AC2-CS at 61.4m below SB DC1-CS at 57.4m below SB NJ101-CS at 47.75m below SB DC1-CS at 20.10m below SB AC2-CS at 2.50m below SB
Archaeology Plate 1a: Plate 1b: Plate 2a: Plate 2b: Plate 3a: Plate 3b:	2013) AC2-CS at 61.4m below SB DC1-CS at 57.4m below SB NJ101-CS at 47.75m below SB DC1-CS at 20.10m below SB AC2-CS at 2.50m below SB NJ103-CS at at 1.95m below SB
Archaeology Plate 1a: Plate 1b: Plate 2a: Plate 2a: Plate 2b: Plate 3a: Plate 3b: Plate 4a:	2013) AC2-CS at 61.4m below SB DC1-CS at 57.4m below SB NJ101-CS at 47.75m below SB DC1-CS at 20.10m below SB AC2-CS at 2.50m below SB NJ103-CS at at 1.95m below SB NJ103-CS at 0.1m below SB
Archaeology Plate 1a: Plate 1b: Plate 2a: Plate 2a: Plate 2b: Plate 3a: Plate 3b: Plate 4a: Plate 4b:	2013) AC2-CS at 61.4m below SB DC1-CS at 57.4m below SB NJ101-CS at 47.75m below SB DC1-CS at 20.10m below SB AC2-CS at 2.50m below SB NJ103-CS at at 1.95m below SB NJ103-CS at 0.1m below SB AC2-CS at 0.00m below SB
Archaeology Plate 1a: Plate 1b: Plate 2a: Plate 2b: Plate 2b: Plate 3a: Plate 3b: Plate 4a: Plate 4b: Plate 5a:	2013) AC2-CS at 61.4m below SB DC1-CS at 57.4m below SB NJ101-CS at 47.75m below SB DC1-CS at 20.10m below SB AC2-CS at 2.50m below SB NJ103-CS at at 1.95m below SB NJ103-CS at 0.1m below SB AC2-CS at 0.00m below SB VC84A 0 to 2.92m below SB
Archaeology Plate 1a: Plate 1b: Plate 2a: Plate 2b: Plate 2b: Plate 3a: Plate 3b: Plate 3b: Plate 4a: Plate 4b: Plate 5a: Plate 5b:	2013) AC2-CS at 61.4m below SB DC1-CS at 57.4m below SB NJ101-CS at 47.75m below SB DC1-CS at 20.10m below SB AC2-CS at 2.50m below SB NJ103-CS at at 1.95m below SB NJ103-CS at 0.1m below SB AC2-CS at 0.00m below SB VC84A 0 to 2.92m below SB VC32A 0 to 1.49m below SB
Archaeology Plate 1a: Plate 1b: Plate 2a: Plate 2b: Plate 3a: Plate 3b: Plate 3b: Plate 4b: Plate 4b: Plate 5a: Plate 5b: Plate 6a:	2013) AC2-CS at 61.4m below SB DC1-CS at 57.4m below SB NJ101-CS at 47.75m below SB DC1-CS at 20.10m below SB AC2-CS at 2.50m below SB NJ103-CS at at 1.95m below SB NJ103-CS at 0.1m below SB AC2-CS at 0.00m below SB VC84A 0 to 2.92m below SB VC32A 0 to 1.49m below SB VC32A 0 to 1.92m below SB VC90 0 to 1.75m below SB VC85A 0 to 3.02m below SB
Archaeology Plate 1a: Plate 1b: Plate 2a: Plate 2b: Plate 2b: Plate 3a: Plate 3b: Plate 3b: Plate 4a: Plate 4b: Plate 5a: Plate 5b: Plate 6a: Plate 6b	2013) AC2-CS at 61.4m below SB DC1-CS at 57.4m below SB NJ101-CS at 47.75m below SB DC1-CS at 20.10m below SB AC2-CS at 2.50m below SB NJ103-CS at at 1.95m below SB NJ103-CS at 0.1m below SB AC2-CS at 0.00m below SB VC84A 0 to 2.92m below SB VC32A 0 to 1.49m below SB VC78 0 to 1.92m below SB VC90 0 to 1.75m below SB
Archaeology Plate 1a: Plate 1b: Plate 2a: Plate 2b: Plate 2b: Plate 3a: Plate 3b: Plate 3b: Plate 4a: Plate 4b: Plate 4b: Plate 5b: Plate 5b: Plate 6a: Plate 6b Plate 7a:	2013) AC2-CS at 61.4m below SB DC1-CS at 57.4m below SB NJ101-CS at 47.75m below SB DC1-CS at 20.10m below SB AC2-CS at 2.50m below SB NJ103-CS at at 1.95m below SB NJ103-CS at 0.1m below SB AC2-CS at 0.00m below SB VC84A 0 to 2.92m below SB VC32A 0 to 1.49m below SB VC32A 0 to 1.92m below SB VC90 0 to 1.75m below SB VC85A 0 to 3.02m below SB



ROUND 3 HORNSEA OFFSHORE WINDFARM SUBZONE 1 AND EXPORT CABLE ROUTE

Stage 1 and 2 Geoarchaeological Assessment

Summary

Geoarchaeological assessment has been undertaken of sediments retrieved during geotechnical investigations on the site of the Round 3 Hornsea Offshore Windfarm and Export Cable Route. This has comprised the offshore monitoring recording of sediments at 12 borehole locations and the assessment of vibrocore logs and onshore recording of 27 vibrocore samples from the Export Cable Route.

The following geological formations were interpreted within the boreholes and vibrocores.

- Upper Cretaceous Chalk Bedrock
- Yarmouth Roads
- Swarte Bank
- Egmond Ground
- Bolders Bank and Lower Botney Cut
- Upper Botney Cut and Holocene Alluvium
- Seabed Sediment

Pleistocene sediments including the Yarmouth Roads, Swarte Bank and Egmond Ground contain glaciolacustrine, glacimarine, fluvial, estuarine and nearshore shallow marine deposits which are thought to have been deposited during the Lower and Middle Palaeolithic archaeological periods. The Bolders Bank and Lower Botney Cut formations comprise predominantly Glacial Till formed during the last Devensian glaciation a period of extreme cold and interpreted as a period of non occupation of this part of NW Europe. The Upper Botney Cut and Holocene alluvial sediments recorded are thought to relate to relate to glacial, lacustrine fluvial and estuarine environments spanning the Late Upper Palaeolithic and Mesolithic archaeological periods.

With regard to Stage 2/3 analysis of the samples from Subzone 1 and the cable route, further work would be of value in elucidating their palaeoenvironmental/geoarchaeological significance and precise dating. The extent of such analysis can be best assessed once a final design has been agreed and the extent of disturbance of the sediments sampled established.



Stage 1/2 Geoarchaeological Assessment

Acknowledgements

RPS Energy commissioned this report on behalf of SMart Wind Ltd. The borehole survey was undertaken by Fugro Ltd. aboard the SV Normand Mermaid. The vibrocore survey was undertaken by Fugro Ltd aboard the SV Fugro Commander. Wessex Archaeology would like to thank the staff of these organisations, particulalry Charles LeQuesne of RPS Energy for commissioning the work and his assistance during the project, and those aboard the vessels and onshore support staff for their assistance.

Jack Russell and Patrick Dresch carried out the onboard geoarchaeological monitoring of boreholes. Jack Russell undertook the Stage 2 vibrocore recording. The geoarchaeological assessment and compilation of this report was undertaken by Jack Russell. The illustrations were prepared by Kitty Brandon, Karen Nichols and Michael Grant. Paul Baggaley managed the project for Wessex Archaeology.



Stage 1 and 2 Geoarchaeological Assessment

1 INTRODUCTION

1.1 Background

- 1.1.1 Wessex Archaeology (WA) was commissioned by RPS Energy (RPS) on behalf of SMart Wind Limited (SW) to undertake geoarchaeological assessment of borehole and vibrocore samples undertaken as part of the Hornsea Offshore Windfarm Subzone 1 (SZ1) and Export Cable Route (ECR) geotechnical investigations. The collection of core samples from 12 borehole locations was archaeologically monitored offshore during October and November 2012. The preliminary vibrocores logs from 129 locations were assessed (Stage 1) and 27 vibrocores chosen for Stage 2 recording which was undertaken onshore during December 2012. The locations of the boreholes and vibrocores in relation to the proposed development can be seen on Figure 1. This report comprises a geoarchaeological assessment and summary of the results of the offshore monitoring and recording of borehole and vibrocore samples.
- 1.1.2 Previous archaeological work for the Hornsea Project has included a technical archaeological report (RPS 2013) and palaeoenvironmental assessment of core samples (Krawiec *et al.* 2011). The locations of the boreholes and vibrocores subject to earlier palaeoenvironmental assessment are shown on **Figures 1** and **2**.

1.2 Aims and objectives

- 1.2.1 The specific aims and objectives of this investigation as set out in the Method Statement (RPS and WA 2012) are as follows:
 - To inform the Environmental Impact Assessment;
 - To inform a better and more detailed understanding of the geomorphology and geoarchaeology of the development zone;
 - If possible, to inform an archaeological deposit model for the Hornsea Zone;
 - To log the deposition sequence of the sediments, and determine the environment in which this took place;
 - To evaluate the potential for past human use;
 - To determine the archaeological importance of the identified deposits;
 - To generate geoarchaeological data for archaeological assessment;
 - To identify sub-samples of sequences of archaeological interest that can be considered in decisions about palaeoenvironmental assessment, analysis and scientific dating.

2 METHODOLOGY

- 2.1.1 The specific method for onboard geoarchaeological monitoring of geotechnical boreholes is set out in the Method Statement (RPS and WA 2012). A flow chart (provided by Dong Energy) to demonstrate how the archaeological recording and sampling was undertaken within the geotechnical investigation is given in **Appendix 1**. As only one archaeologist was on board the vessel and operations were conducted 24 hours a day, the geotechnical engineers were informed of sediments of geoarchaeological interest and the need to keep these sediments for further archaeological work rather than destructively test them where practicable so that the staged approach to the use of geotechnical data set out in the Method Statement (RPS and WA 2012) and **Appendix 2** could be achieved.. The offshore work enabled the offshore recording of sediments (Stages 1/2) (**Appendix 3**), selection of samples for onshore recording (Stages 1/2) (**Appendix 4**) and potential palaeoenvironmental assessment (Stage 3) and analyses (Stage 4).
- 2.1.2 The method for the geoarchaeological assessment of the vibrocores also followed the five Stages set out in Appendix 2. As the final vibrocore logs were not available, the preliminary onboard vibrocore logs (Fugro Alluvial Offshore Ltd., 2012) were assessed in relation to the known palaeogeograpic features of interest identified by the British Geological Survey (Cook 1991, Brown 1986), the North Sea Palaeolandscapes Project (NSPP) (Gaffney et al. 2007, 2009) and the Humber Regional Environmental Characterisation (REC) (Tappin et al. 2011). 27 vibrocores (VC05, VC06, VC06C, VC08, VC31, VC32A, VC34, VC72, VC77, VC78, VC79, VC80, VC81, VC82, VC83, VC84A, VC85A, VC86, VC87A, VC88, VC90, VC91, VC92, VC93, VC96, VC104A and VC116A) were chosen for Stage 2 recording and it was agreed by a teleconference call during November 2012 (with SMW, Dong, RPS and Fugro) that these vibrocores be available for Stage 2 geoarchaeological recording at Fugro Ltd, Great Yarmouth. The Stage 2 geoarchaeological recording was undertaken over two days during December 2012. The results of the Stage 2 recording of vibrocores are given in Appendix 5. Samples were taken back to WA for potential Stage 3 dating and palaeoenvironmental assessment (Appendix 6). These samples are currently in storage at WA.
- 2.1.3 This staged approach (**Appendix 2**) to the geoarchaeological assessment of offshore geotechnical data conforms to archaeological standards which are set out in English Heritage guidelines regarding environmental archaeology (English Heritage 2002), geoarchaeology (English Heritage 2007) and management of archaeological projects (English Heritage 2006). More specifically this approach has formed the basis of the COWRIE (Collaborative Offshore Wind Research into the Environment) guidance document on the archaeological use of geotechnical data, (Gribble and Leather for EMU 2011). The stages also conform to the Crown Estate guidelines for Written Schemes of Investigation for offshore renewables projects (Wessex Archaeology 2010a).

3 PROJECT BASELINE

3.1 Development Background

- 3.1.1 The Hornsea Zone proposed development is located 31 and 190km off the Yorkshire coast within water depths predominantly between 30 and 40m with maximum depths of up to 70m (**Figure 1**).
- 3.1.2 SZ1 is the first development zone within the Hornsea Round 3 Zone to be assessed in detail and is an irregular area approximately 407km² in size located approximately 120km



East of Hornsea in East Yorkshire. The proposed ECR extends approximately 140km from the southern edge of SZ1 to landfall at Horseshoe Point on the North Lincolnshire Coast (**Figure 1**).

3.1.3 A phased development programme including the creation of Subzones is being undertaken in order to deliver the project. The geotechnical survey undertaken as part of this project comprised 11 boreholes within the SZ1 area (Figure 1) and also included one borehole at the Reactive Station site (RS-CS) which is situated along the route of the ECR. A vibrocores survey of 129 locations along the ECR was also undertaken (Figure 1).

3.2 Geoarchaeological Background

- 3.2.1 The following background summarises the geological formations known to exist at the SZ1 and ECR geotechnical survey areas. The age estimates are given related to the established British and Northwest European stage names. Within the Pleistocene epoch these are also supplemented, where known, with the now more prevalent and comparable Marine Isotope Stages (MIS), where odd numbers indicate an interglacial period and even numbers a glacial period. Ages in years within the Pleistocene epoch are expressed in millions of years ago (MA), thousands of years ago (ka) and within the Holocene epoch as years before present (BP).
- 3.2.2 The British Geological Survey have mapped and described the geological formations in the area (Cook 1991, Brown 1986) and it is with reference to this framework that the sedimentary sequence is discussed. The bedrock geology beneath the area is predominantly Upper Cretaceous Chalk Bedrock. This is overlain by Pleistocene and Holocene deposits which have been interpreted predominantly from seismic surveys undertaken between 1968 and 1981. The formations have been cored in some areas of the North Sea where microfossil analyses and stratigraphic relationships have been used to determine the ages of the formations (Hopson *et al.* 1991).
- 3.2.3 Overlying Chalk bedrock are two formations which are shown in profile *c*.15km to the south of the SZ1 area (Cook 1991, Brown 1986). These are the Ijmuiden Ground and the Winterton Shoal formations although are too deep to have been penetrated by this geotechnical survey. The Ijmuiden Ground is thought to be pre-delta deposits of sands silts and clays up to 45m in thickness and though to be of Early Pleistocene age (Late Praetiglian to Tiglian; c. 2MA to 1.5MA). Overlying this, the Winterton Shoal formation comprises delta front and nearshore deposits of sands, silts and clays up to 50m in thickness and is also of Early Pleistocene age (Eburonian to Waalian *c*.1.5 to1.4MA).
- 3.2.4 Overlying these formations the British Geological Survey have interpreted the Yarmouth Roads formation which reaches a maximum thickness of 120m although notably thins in a westerly direction (along the ECR). The formation contains recognisable infilled channel features and comprises fine and medium grained sands with interbedded silts and clays and intercalated shelly sands and reworked peat. The formation ranges in age from Early to Middle Pleistocene (Baventian to Cromerian *c*. 2.3MA to 480ka). The upper part of the Yarmouth Roads formation is thought comprise deltaic sediments and to be the offshore equivalent of the Cromer Forest-bed formation.
- 3.2.5 The Swarte Bank formation has also been described by the British Geological survey overlying the Yarmouth Roads formation in the SZ1 area. The Swarte Bank formation comprises the infill of sub glacial valley systems originally cut during the Anglian glaciation and infilled during the early part of the Wolstonian period (MIS 10 to 9; *c*.350 to 280ka).

The valleys are up to 100m deep and 4km in width and form an anastomosing complex delineated predominantly from NNE to SSW. The basal sediments comprise gravels, sands and stiff grey diamictons overlain by glaciolacustrine and glaciomarine sands and muds. (**Figure 2**). Organic sediments, probably from the from the Swarte Bank formation were assessed for their pollen content (Krawiec *et al.* 2012) from previous borehole investigations (Fugro Geoconsulting Ltd. 2012a, 2012b) from borehole locations (**HW25A**, **HW34a**, **HW36a**, **HW61**, **HW73** and **NJ5b**) within the SZ1 area. These predominantly contained pine dominated pollen floras.

- 3.2.6 To the west of SZ1, along the ECR and at the **RS-CS** location, overlying the Chalk Bedrock, the British Geological Survey have interpreted the Egmond Ground Formation (Cook 1991). This formation is up to 16m in thickness and comprises sands and gravels thought to be marine in origin. The formation is thought to be Wolstonian age (MIS 8; *c*. 280 to 250Ka).
- 3.2.7 Across most of the SZ1 and ECR areas the Bolders Bank formation has been mapped (Cook 1991, Brown 1986). This blanket of glacial till is extensive, overlying earlier Pleistocene formations and outcropping near the seabed surface. The formation comprises stiff red brown gravelly, sandy clays containing erratics including chalk, red-brown sandstone, grey mudstone and other metamorphic and igneous rocks. The formation is similar to the Hunstanton till of East Anglia and the tills of Holderness north of Spurn point. The formation is thought to be of late Devensian age (MIS 2; *c.* 18ka).
- 3.2.8 Incised into the Bolders Bank formation are scaphiform glacial valleys which are in places infilled with the Botney Cut formation. These valleys are up to 60m in depth and 4km in width. The basal fill of the Botney Cut formation comprises red brown gravelly, sandy clays which are lithologically indistinct from the Bolders Bank formation (Cameron *et al.* 1992). The upper part of the Botney Cut formation comprises laminated sands and clays thought to have formed in glaciolacustrine and occasionally glaciomarine environments. The formation is thought to be of Devensian to possibly Early Holocene age (*c.* 18 to 12ka).
- 3.2.9 A radiocarbon date obtained from organic sediment within a vibrocore, from **CR12** (at 3.78m) at the western end of the ECR returned a date of 14700±60BP (16490-15650 cal. BC; 18000 to 17760 cal. BP) (Krawiec *et al.* 2012). Pollen was absent from the sediment and it is somewhat enigmatic as the area is thought to have been ice covered at this time (Clark *et al.* 2012).
- 3.2.10 The Holocene terrestrial (fluvial, estuarine, lacustrine and coastal) environments and the probability that the areas have been inhabited have been inferred from the relatively shallow bathymetry and the finds made by fishermen of terrestrial sediments such as peat, terrestrial mammal bones and prehistoric archaeological finds across the Southern North Sea (e.g. Reid 1913, Godwin and Godwin 1933 and Coles 1998). Many reconstructions of this former "land bridge" have been made largely focussing on postulated former river courses. With the advent of ¹⁴C dating combined with geophysical and geological surveys more accurate wide scale reconstructions of Holocene palaeoenvironments have been made (e.g. Jelgersma 1979). The British Geological Survey (Cook 1991, Brown 1986) have mapped a number of the larger features such as the Silver Pit and Sole Pit thought to have formed major features during the early Holocene. Some of these scaphiform valleys are infilled with the Botney Cut formation. More detailed mapping of these terrestrial features using oil industry geophysical data in the area has been undertaken as part of the (NSPP) (Gaffney *et al.* 2007, 2009).

- 3.2.11 As part of the Humber (REC) survey two vibrocores (suffixed "**REC_**" to avoid confusion) **REC_VC39** and **REC_VC40**) were recovered from a large channel feature (identified in the NSPP) in the west of SZ1 (**Figures 1** and **2**). OSL dating and microfossil analyses of a 1.48m sequence of grey silt within vibrocore suggest that the sediments were formed in estuarine conditions during the early Holocene (*c*.10,500BP to 8000BP) in the west of SZ1 (Tappin *et al.*, 2011). This date is equivalent to the early Mesolithic archaeological period.
- 3.2.12 Radiocarbon dating and pollen analyses (Krawiec *et al.* 2012) were undertaken on vibrocores **CR1A2** and **CR1A8**, located at the western end of the proposed ECR (**Figure 1**). Within vibrocore **CR1A2** some organic sediment from 5.03m below SB submitted for radiocarbon dating returned a date of 11030±50BP (11,140 to 10,800 cal.BC; 13,090 to 12,750 cal. BP). This date is equivalent to the early Holocene geological epoch, MIS 1 and the late Upper Palaeolithic archaeological period. However, the date from this vibrocore is puzzling as the corresponding pollen analyses identified Elm (*Alnus*) which is noted not generally to appear in the British flora until after c.7000BP (Bennett and Birks 1990). Within vibrocore **CR1A8** some (unidentified) wood from 5.20m below SB submitted for radiocarbon dating returned a date of 7360±40BP (6350 to 6100cal.BC; 8300 to 8050 cal. BP). This date is equivalent to the Holocene geological epoch, MIS 1 and the Mesolithic archaeological period and fits well with the corresponding hazel (*Corylus avellana*) dominated pollen flora thought to be prevalent at during this period (Bennett 1983, 1986).
- 3.2.13 Whilst the exact geomorphology of the areas in the early Holocene, particularly the location and elevation of areas higher ground (which may have been subject to subsequent marine erosion) is unknown, it is possible to guess, based on current bathymetry and with reference to known sea level curves (Shennan *et al.* 2000, 2002; Ward *et al.* 2006) when the area would have become submerged for the last time. It is likely that the SZ1 area would have become submerged for the last time by *c.*9000BP and the ECR with a more varied bathymetry, is likely to have been submerged between *c.*11,000 to 7000 BP.
- 3.2.14 Recent seabed sediments are known across the SZ1 and ECR areas. These comprise sands and gravels and which are generally less that 2m in thickness where they are associated with the Bolders Bank formation (Cook 1991, Brown 1986).

4 RESULTS

- 4.1.1 The following results section summarises the sediments noted and recorded within the 12 boreholes which were subject to offshore monitoring and the 27 Stage 2 recorded vibrocores. Depths are given in metres below Lowest Astronomical Tide (m below LAT).
- 4.1.2 The full results of the onboard geoarchaeological monitoring of boreholes are given in Appendix 3. It is noted that the contractor's *Final Laboratory and In-Situ Report* for the SZ1 area has not been supplied neither has the onshore Stage 2 geoarchaeological recording been undertaken at this stage. The preliminary report (Fugro Geoconsulting Ltd 2012c) and preliminary field plots (Appendix 7) have however been supplied and integrated with the onboard geoarchaeological monitoring and recording (Appendix 2) in order to produce these preliminary results summarised below.
- 4.1.3 The Stage 2 vibrocore recording of 27 vibrocores (**Appendix 5**) has also been integrated with these results. It is noted that the results of the geotechnical logging and photographing of the vibrocores is ongoing and therefore the *Final Laboratory and In-Situ Report* for the vibrocores from the ECR area is also awaited.



- 4.1.4 On the basis of the onboard geoarchaeological monitoring and the Stage 2 vibrocore recording the following geological formations were identified:
 - Chalk
 - Yarmouth Roads
 - Swarte Bank
 - Egmond Ground
 - Bolders Bank and Lower Botney Cut
 - Upper Botney Cut and Holocene Alluvium
 - Seabed Sediment
- 4.1.5 A deposit model of SZ1 showing these formations (and the boreholes locations at which they occur) is shown as Rockworks fence diagrams on Figures 3a and 3b. Borehole and vibrocore locations related to Sub-bottom profiler data are shown on Figures 4 to 13. Where the Stage 2 recorded vibrocores are clustered (around the Silver Pit), selected vibrocores are shown as Rockworks fence diagrams (Figures 11a and 11b).
- 4.1.6 It is noted that at a number of the 12 borehole locations several attempts at coring were made. These various attempts have not been referred to individually below as the collated sedimentary sequence at each location is largely the same. The borehole locations (not various attempts) are referred to in the main body of this report. The exact number of attempts and locations of the various attempts at each location are given in **Appendix 7**.

Chalk (29.15 to 105.9m below LAT)

4.1.7 This formation was recorded within vibrocores (VC79, VC80, VC81, VC82, VC83, VC84A and VC87A) along the ECR and also at the RS-CS borehole location (Figures 10 and 11). It was not fully penetrated at any location although a thickness of 63.6m of the formation was drilled at the RS-CS location. It comprised white chalk, the upper surface of which appeared to have been burrowed in many cases by bivalve molluscs. It is likely that this is part of the Upper Cretaceous Chalk bedrock formation previously recorded within the area (Cameron *et al.* 1992).

Yarmouth Roads: (62.5 to 114.3m below LAT)

4.1.8 This formation was interpreted within the SZ1 area only at borehole locations AC1a-CS, AC1b-CS, AC2-CS, DC1-CS and NJ105-CS (Figures 3, 4, 5 and 6). The formation ranged in thickness from 17.3 (at location AC1a-CS) to 44m (at location DC1-CS) although was not fully penetrated at any location. The formation comprised grey silty, sands and contained frequent molluscs (especially AC2-CS) reworked organic material and wood (AC1a-CS and AC2-CS; Plate 1a). The sediments were which are occasionally laminated and interbedded (AC1a-CS and DC1-CS; Plate 1b). The formation is interpreted as being deposited in comprising, fluvial, estuarine and shallow marine environments.

Swarte Bank (43.3m to 109.5m below LAT)

4.1.9 This formation was interpreted at all of the SZ1 borehole locations (Figures 3, 4, 5, 6 and 7). The formation comprised predominantly estuarine and shallow marine green and grey silts and sands. These contained molluscan and organic inclusions including wood (AC1a-CS, AC2-CS, NJ101-CS; Plate 2a). Within predominantly finer grained glacial sediments some horizontal and varve like (probably seasonally induced) bedding was also noted within predominantly finer grained sediments (AC1b-CS, AC3-CS and DC1-CS; Plate 2b). Some minor slickenside structures were also noted within these finer grained glacial sediments indicative of post depositional dessication. The formation is interpreted as



being deposited in a wide range of environments including glacial (glaciolacustrine and glaciomarine) and nearshore, estuarine and shallow marine environments.

Egmond Ground (36m to 42.3m below LAT)

4.1.10 This formation was recorded at one location only, **RS-CS** (**Figure 10a**). The formation comprised yellowish brown slightly silty fine to coarse grained sand and was 6.3m in thickness Horizontally bedded laminar sediments and organic material including wood were recovered towards the base of the formation (**Appendix 3**).

Bolders Bank and Lower Botney Cut (19.94 to 53.8m below LAT)

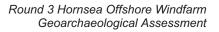
4.1.11 This formation was recovered at all of the borehole locations and within 11 of the Export Cable Route vibrocores (VC05, VC06, VC06C, VC08, VC32A, VC72, VC77, VC78, VC86, and VC92; Figures 3 to 13). It was fully penetrated within the boreholes only where it ranged in thickness from 11m (RS-CS and AC1a-CS) to 19.05m (DC1-CS) in thickness. The formation comprised predominantly stiff reddish brown sandy, gravelly clay. Frequent poorly sorted inclusions of chalk, flint, red sandstone, shale, coal, mudstone and various metamorphic and igneous rocks were recorded (Plates 3a, 3b). Some laminated bedding and structure was noted at the base of the unit which may be indicative of ice marginal deposition prior to the deposition of the overlying unstratified lodgement till. Other variation within the unit included thick and degraded shale content within vibrocore VC32A (Plate 5b) and a very high chalk content was noted within the formation within vibrocore VC78 (Plate 6a). The formation is interpreted as glacial sediments, predominantly late Devensian glacial till. The surface of the formation was noted to be disturbed and in many cases burrowed by molluscs (Plate 4a, Appendix 3 and Appendix 5).

Upper Botney Cut and Holocene Alluvium (42.97 to 52.31m below LAT)

4.1.12 This formation was recorded within the ECR vibrocores VC85A, VC91, VC92, VC93 and VC104A. It was not recorded within any of the SZ1 boreholes. The deposit was not fully penetrated in any of the vibrocores although a 2.52m thickness of the deposit was recorded within vibrocore VC85A (Figures 10a and 12; Plates 7a and 7b). The formation comprised generally grey sandy, silty clays with horizontal interbedding, probably indicative of tidally induced deposition (VC85A, and VC91). Molluscs, organic inclusions and some mottling indicative of water table fluctuations and sub-aerial exposure were also noted within the sediments. The formation is interpreted as belonging to the Upper Botney Cut (Cameron *et al.* 1992) and Holocene alluvial sediments.

Seabed Sediment (19.9m to 61.25m below LAT)

4.1.13 This formation was recorded overlying the Bolders Bank and Botney Cut Formation within SZ1 and also directly overlying Chalk bedrock and the Upper Botney Cut and Holocene Alluvium formations within the ECR vibrocores (Figures 3 to 13). It comprised silty, gravelly sand with frequent marine molluscs and ranged from 0.04m (VC116A) to 5.90m (VC96) in thickness. Occasional large cobbles were encountered. At location AC2-CS a large limestone boulder was cored which had some soft coral (dead man's fingers) adhering to its upper surface (Plate 4b). The unit was variable across the SZ1and ECR areas and was recorded at the top of every borehole and vibrocore (Plates 4 to 5).



5 DISCUSSION AND ARCHAEOLOGICAL POTENTIAL

- 5.1.1 Based on the onboard monitoring and recording of sediments summarised above the following comments relating specifically to the archaeological and geoarchaeological potential of the formations can be described as follows:
- 5.1.2 The Chalk bedrock encountered along the ECR is too old to be of archaeological interest. Its surface however marks the extent of palaeogeographic features such as the Silver and Sole Pits which would have formed significant landscape features during the late Upper Palaeolithic and Mesolithic archaeological periods, prior to their submergence. It is also possible that terrestrial sediments such as soils and/or artefactual evidence relating these periods may be present at its surface. No soil formation or artefacts were however noted on the Chalk surface within the Stage 2 recorded ECR vibrocores or at the **RS-CS** location where in general the surface is noted to have been burrowed by marine molluscs.
- 5.1.3 The Yarmouth Roads formation encountered within the SZ1 boreholes is known to comprise a complex delta-top sequence forming part of the so-called Ur-Frisia delta plain, consisting of sands with pebbles (including chalk), abundant plant debris and peat clasts (Cameron *et al.* 1992). The Yarmouth Roads formation was deposited between 2.3 MA and 480 ka. Although the earliest deposits are of no archaeological interest, the later deposits equate, in part, to the Cromer Forest-bed formation. Palaeolithic archaeological material has been recovered and identified from the Cromer Forest-bed formation for over 100 years (Reid Moir 1927). This early work was largely dismissed until more recent discoveries within the Cromer Forest-bed formation on the North Sea coast at Happisburgh, Norfolk and Pakefiled, Suffolk coupled with scientific dating techniques have proven this earlier than previously believed hominid occupation in NWEurope (Parfitt *et al.* 2005, 2010).
- 5.1.4 At Happisburgh, on the north Norfolk coast a series of alluvial sediments and associated with a former course of the river Thames have been investigated along a *c*.1km stretch of coastline. The deposits are thought to be either MIS 25 (*c*. 970 ka) or MIS 21 (*c*. 850 ka). The archaeological excavations there have unearthed flint artefacts within gravel layers belonging to the so called Hill House Formation of the Cromer Forest-bed formation (Parfitt *et al.* 2010). On the Suffolk coast at Pakefield, worked flint has been recovered from within the Cromer Forest-bed formation from the former floodplain of the pre-Anglian Bytham river (Parfitt *et al.* 2005). The age of the site is thought to be MIS 17 (*c*. 680 ka) or MIS 19 (*c*. 740 ka). The SZ1 area, whilst containing sediments of similar type and date to the Cromer Forest-bed formation is located in a much more northerly (*c*.80 to 100km further north) location than these archaeological sites. The archaeological site at Waverley Wood in Warwickshire thought to date to *c*.500ka indicates occupation during the Lower Palaeolithic at similar latitudes to the SZ1 area (Keen *et al.* 2006).
- 5.1.5 The Swarte Bank formation is extensive across the SZ1 area. This formation has been interpreted from geophysical data as infilling an anastomosing complex of palaeochannels (see **Figure 2b**). The sediments within the Swarte Bank formation are varied and it is noted that it is difficult to distinguish some of the coarser sediments those of the Yarmouth Roads formation. The British Geological Survey indicate that the age of the Swarte Bank sediments (which infill valleys thought to have been cut during the Anglian glaciation, MIS12) date from the early part of the Wolstonian period MIS 10 (*c*. 350ka) including the Purfleet interglacial (MIS 9 *c*. 280ka) (Cameron *et al.* 1992). This period of deposition spans the Lower to Middle Palaeolithic archaeological transition and is also a known period of occupation of the British Isles. The Corbets Tey Gravel at Purfleet, Essex comprises fluviatile, shelly deposits of a former course of the river Thames which are known to contain Levallois type flint artefacts which are possibly demonstrative of the

earliest use of this technique in Britain (Bridgland 1999, Wymer 1999). There are a range of palaeoenvironments represented within the Swarte Bank formation recorded within the SZ1 boreholes from glaciolacustrine to fluvial, estuarine, shallow marine and coastal sediments. These types of environment, the probable date of the deposits and the well preserved organic remains noted within the formation indicate the potential for both palaeoenvironmental and potentially archaeological material to be preserved within the sediments.

- 5.1.6 The Egmond Ground formation, interpreted at the **RS-CS** location, is thought to have been deposited during the Wolstonian period (MIS 8; *c*. 280 to 250ka). A number of archaeological sites dated to MIS 8 and 7 and containing Early Middle Palaeolithic assemblages are located in Suffolk and along the present-day Thames River (White *et al.* 2006). Although no evidence is preserved for human settlement during the cold extremes of the MIS 8 glacial, sites such as Acton, West London (associated with the top of Lynch Hill/Corbets Tey Gravel) and at Northfleet, Kent and West Thurrock, Essex (associated with the base of the Mucking/Taplow Formations) indicate both early and later MIS 8 occupation (White *et al.* 2006). The sediments recorded at the **RS-CS** location contained well preserved organic material indicating the palaeoenvironmental potential of the sediments.
- 5.1.7 Around 100km to the south of the **RS-CS** location an aggregate extraction area known as Area 240 has yielded a large number of artefacts including 33 hand axes and 100 fragments of faunal remains including woolly mammoth, woolly rhino, bison, reindeer and horse. The handaxes are datable by typology to the Middle Palaeolithic archaeological period (*c*. 300 to 30ka) thus proving the potential for Middle Palaeolithic archaeological remains to occur within sediments of the Southern North Sea (WA 2010b).
- 5.1.8 Whilst the SZ1 and ECR area and **RS-CS** locations lie within the limits of the MIS 8 glaciation, Marine Isotope records indicate this was on the whole a relatively mild cold stage with sea levels as low as *c*.100m (Pettit and White 2012).
- 5.1.9 Whilst no geological formations have been mapped/interpreted in the area spanning the period between the deposition of the Egmond Ground (MIS 8 280 to 250ka and the Bolders Bank MIS2 *c*.18ka formations the possibility that discrete outliers and currently unmapped sediments and associated archaeological remains of this date exist in the SZ1 and ECR area is noted.
- 5.1.10 The Bolders Bank and Lower Botney Cut have been grouped at this stage as they are sedimentologically indistinct. It is noted that within the SZ1 area there are channels interpreted by EMU in 2011 (RPS 2013) as being related to the Botney Cut formation (**Figure 2a**) although these are not apparent within the borehole data and therefore do not show on the borehole fence diagrams (**Figures 3a** and **3b**). These sediments of the Bolders Bank and Lower Botney Cut predominantly comprise glacial till which has been deposited during the last glacial period, the Devensian (MIS2 *c*.18ka) Archaeological material may be found reworked within these sediments however this is a period of absence from Britain and Northwestern Europe at these latitudes. It is noted that some of the undated palaeolandcape features within SZ1 and the ECR (**Figures 1, 2a** and **14**) identified in the within the REC project (Tappin *et al.* 2011), the NSPP project (Gaffney *et al.* 2007, 2009) and more recently by EMU (RPS 2013) and in the ECR area by Wessex Archaeology (2013) may be part of the Lower Botney Cut formation as described although not mapped in detail by the BGS (Cook 1991, Brown 1986).
- 5.1.11 The earliest human reoccupation of Britain is thought to have occurred subsequent to this during lowered sea levels by 14,700BP as exemplified by dated human remains in

Gough's Cave, Cheddar, Somerset (Jacobi and Higham 2009). The late Glacial (radiocarbon dated to 11,740+150BP) harpoon point recovered by fishermen from within a lump of trawled peat from the from the Leman and Owers Bank (Godwin and Godwin 1933) *c*.70km south of the SZ1 area indicates pioneer occupation of the Southern North Sea during this period.

- 5.1.12 Channel features mapped by the NSPP (Gaffney *et al.* 2007, 2009) and dated as part of the Humber REC (Tappin *et al.*, 2011) indicate that sediments relating to terrestrial features from the late Upper Palaeolithic and Mesolithic archaeological periods are extant within the SZ1 and ECR areas (**Figure 1**).
- 5.1.13 No sediments relating to these Holocene features were recorded within any of the boreholes during this investigation in the SZ1 area although two of the borehole locations (AC3-CS and NJ105) are close to or within features identified within the NSPP data as Holocene fluvial features. Borehole location AC3-CS is located close to an east to west delineated fluvial feature identified within the NSPP data (Figure 1) and a similarly delineated Botney Cut channel identified by EMU (Figure 2a, Figure 7a). Borehole location NJ103-CS appears to be within the middle of a north to south delineated fluvial feature identified within the MSPP project (Figure 1) although interpretation by EMU places the location adjacent to an east to west delineated Botney Cut channel (Figure 2a) which can also be seen on the Sub–bottom profiler data (Figure 6b).
- Along the ECR, vibrocores containing fluvial and estuarine sediments potentially dating to 5.1.14 the Holocene period were Stage 2 recorded (VC85A, VC91, VC92, VC93 and VC104A). Some of these correlated with features recorded in the NSPP data (Gaffney et al. 2007, 2009) especially adjacent to and on the edge of the Silver Pit (Figures 1, 10b and 11). More recent interpretation of Sub-bottom profiler data in the ECR area (Wessex Archaeology 2013) shows the location of palaeolandscape features of archaeological potential identified from geophysical data. These were grouped into Late Devensian to Early Holocene, Early Holocene and Holocene periods (Figure 14). An interesting dendritic patten of channels (no.s 75028, 75029, 75027, 75032 and 75033) was interpreted in the northeast of the ECR which notably adjoin the Botney Cut channels interpreted by Emu 2011 (Figure 2a) within the SZ1 area (Wessex Archaeology 2013). Unfortunately the majority of these palaeolandscape features of potential interest other than the larger Silver Pit (Figures 1, 10, 11 and 14) and Sole Pit (Figures 1, 9 and 14.) features were not covered by the vibrocore survey. The exceptions are vibrocores VC28. VC56 and VC74 where relatively small early Holocene channel features (nos. 75026, 75021 and 75014) were interpreted (Figure 14) and vibrocore VC116 which was interpreted as within a late Devensian (Botney Cut) channel feature (no. 75005; Figures 13 and 14). Vibrocores CR1A2 and CR1A8 previously obtained from the area of the large feature, possibly part of an offshore extension of the river Humber (no.75005), at the western end of the ECR (Figure 14) was radiocarbon dated to the Holocene period (Krawiec et al. 2011).
- 5.1.15 A large amount of literature regarding the possibility of Mesolithic occupation in the North Sea has been produced (e.g. Reid 1913, Coles 1998, Flemming 2004 and Waddington 2007). Whilst no finds of this date have been recovered from within the SZ1 and ECR areas the terrestrial environments and features including those grouped as the Upper Botney Cut and Holocene Alluvium formation identified during this study and within the geophysical data (Wessex Archaeology 2013) could contain Mesolithic archaeological remains. The final submergence of SZ1 at c.9000BP and for the shallower areas of the ECR by c.7000BP indicate that no terrestrial archaeological remains would be expected in the areas after the Late Mesolithic Archaeological period.

5.1.16 The seabed sediments interpreted across the SZ1 and ECR areas do not offer any potential for palaeoenvironmental work relating to prehistoric archaeological deposits. It is noted however that the large mammal remains and many of the finds that have been retrieved by fishermen from the North Sea will have derived from similar deposits. Robust archaeological material such as bone, flint and in a submerged context, wood can survive within these types of sediments and whilst may they may not be *in situ*, these types of finds are of interest due to their rarity. Within and on top of these seabed sediments is the likely location of more recent maritime archaeological remains, which are not the subject of this report.

6 POTENTIAL FURTHER WORK

- 6.1.1 The proposals for further analysis set out below are based on the five-stage assessment process set out in Appendix I. The need for any further work needs to be balanced against the degree to which these sediments will be disturbed by the wind farm proposals. For this reason it may be appropriate to wait until a final design has been decided before agreeing the precise scope of additional analysis.
- 6.1.2 Glacial, fluvial, estuarine and coastal sediments relating to former potentially inhabited landscapes have been identified. Based on current knowledge, these sediments are thought likely to span the last c. 1 million years encompassing the Lower Palaeolithic to Mesolithic archaeological periods. In order to understand the archaeological significance of these sediments more fully, a more robust chronological and palaeoenvironmental framework will be needed.
- 6.1.3 This focussed chronological and palaeoenvironmental work should however be integrated with the final results and reports of these geotechnical investigations and any further geotechnical and geophysical investigations in the area.

Boreholes

- 6.1.4 The onshore Stage 2 recording of the requested core samples (**Appendix 4**) would be required to further understand the sequence of deposits within SZ1 and at the **RS-CS** location. On the basis of the work undertaken so far it is considered that selected samples are suitable proceed to Stage 3 palaeoenvironmental assessment and scientific dating, particularly from the Yarmouth Roads, Swarte Bank and Egmond Ground
- 6.1.5 The sediments are also considered suitable for Stage 3 archaeological works. Given the potential age of some the sediments (c. 250 to 900Kya) and what has been recorded within them so far it is recommended that the Amino Acid Racemisation (AAR) and Optically Stimulated Luminescence (OSL) dating are suitable techniques in order to place the sediments within a more robust chronological framework. The samples listed from locations AC1b (AC1b-CS and AC1b-CSa) and RS-CS (RS-CS and RS-CSa) in Appendix 4 are considered most important required in order to complete this phase of work
- 6.1.6 A report should be submitted based on the Stage 2 and 3 results. This will state whether any Stage 4 analysis is warranted.
- 6.1.7 The borehole samples are currently held at Fugro Wallingford where it is recommended they are stored.



Vibrocores

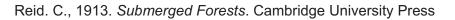
- 6.1.8 Stage 3 palaeoenvironmental assessment and scientific dating of the vibrocores samples from the cable route will provide important additional information relating to the Upper Botney Cut and Holocene alluvial sediments.
- 6.1.9 The Stage 3 assessment should comprise in the first instance scientific, radiocarbon (¹⁴C) dating of the sediments to better understand their chronology. Microfossil (pollen, diatoms, foraminfera and ostracods) and macrofossil (plants, molluscs, charcoal and insects) assessments are also recommended to gain a better understanding of the palaeoenvironmental and archaeological potential of the sediments.
- 6.1.10 A report should be submitted based on the results of the Stage 3 assessment. This report will state whether any further work is warranted.

L

7 **REFERENCES**

- Bennett, K.D. 1983. Postglacial population expansion of forest trees in Norfolk, UK. Nature 303, 164-67.
- Bennett, K.D. 1986. The rate of spread and population increase of forest trees during the postglacial. Philosophical Transactions of the Royal Society of London, Series B 314, 523-31.
- Bennett, K.D., Birks, H.J,B. 1990. Post-glacial history of alder (Alnus glutinosa) in the british isles. Journal of Quaternary Science, 5, 123-133
- Bridgland, D. 1999 "The Pleistocene of north-east England" In: D. Bridgland, B. Horton, and J. Innes (Eds) *The Quaternary of North-East England: a field guide* 1-9. Quaternary Research Association London
- Brown, M., 1986. Indefatigable Sheet *53°N 02°E* British Geological Survey, 1:250,000 Series, Quaternary Geology, Offshore Geology
- Cameron, T.D.J., Crosby, A., Balson, P.S., Jeffery, D.H., Lott, G.K., Bulat, J. and Harrison, D.J., 1992, *The geology of the Southern North Sea*. British Geological Survey, United Kingdom Offshore Report 7, London: HMSO.
- Clark, C.D., Hughes, A.L.C., Greenwood, S.L., Jordan, C. and Serjup, H.P. Pattern and Timing of retreat of the last British-Irish Ice Sheet. *Quaternary Science Reviews*. 44. p.112 -146
- Coles, B., 1998, Doggerland: a speculative survey, *Proceedings of the Prehistoric Society* 64: 45-81 Boomer, I., Waddington, C., Stevenson, T., and Hamilton, D. 2007
 "Holocene coastal change and geoarchaeology at Howick, Northumberland, UK" *The Holocene* 17, 89-104
- Cook, J. 1991, *Spurn Sheet* 53°*N* 00°*E*, British Geological Survey, 1:250,000 Series, Quaternary Geology, Offshore Geology
- English Heritage, 2002. Environmental Archaeology. A guide to the Theory Practice and Methods, from sampling and recovery to post-excavation.
- English Heritage, 2006. Management of Research Projects in the Historic Environment
- English Heritage, 2007. Geoarchaeology. Using Earth Sciences to understand the archaeological record.
- Flemming, N.C., 2004. Submarine Prehistoric Archaeology of the North Sea: Research Priorities and Collaboration with Industry. CBA Research.
- Fugro Geoconsulting Ltd. 2012a Factual Report. Laboratory and *in situ* data. Hornsea and Njord Wind Geotechnical Site Investigation. UK Sector North Sea. Report ref: J11082-3
- Fugro Geoconsulting Ltd. 2012b Factual Report. Laboratory and *in situ* data. Heron Wind Geotechnical Site Investigation. UK Sector. North Sea. Report ref: J11082-4

- Fugro Geoconsulting Ltd. 2012c. Interim factual report. Hornsea Offshore Windfarm. UK Sector. North Sea. Report ref.: J11155-2
- Fugro Alluvial Offshore Ltd. 2012. Hornsea Offshore Windfarm. Field Data. Cable Route Survey. Geotechnical Investigation
- Gribble, J. and Leather, S. for EMU Ltd. 2011. Offshore Geotechnical Investigations and Historic Environment Analysis: Guidance for the Renewable Energy Sector. Commissioned by COWRIE (project reference GEOARCH-09)
- Gaffney, V., Thomson, K. and Fitch, S. (eds), 2007, *Mapping Doggerland: The Mesolithic Landscapes of the Southern North Sea*, Archaeopress, Oxford
- Gaffney, V. Fitch, S. Smith, D, 2009, *Europe's Lost World. The rediscovery of Doggerland*. Research Report No 160. Council for British Archaeology
- Godwin, H. and Godwin, M.E., 1933. British Maglemose Harpoon sites. *Antinquity*,7: 36-48
- Hopson, P.M., Harrison, D.J., and Zalasiewicz, J.A., 1991. East Anglia. Sheet 52°N N-00°. Quaternary Geology. 1:250 000 map series. British Geological Survey/ Rijks Geoogische Dienst
- Jacobi, R.M., and Higham, T.F.G., 2009, 'The early Late glacial re-colonisation of Britain: new radiocarbon evidence from Gough's Cave, southwest England.' *Quaternary Science Reviews*. p1-19
- Jelgersma, S., 1979, 'Sea-level changes in the North Sea Basin' In Oele, E., Schüttenhelm, R.T.E. and Wiggers, A.J. (eds.). *The Quaternary History of the North Sea.* Acta Universitatis Upsaliensis: Symposium Universitatis Upsaliensis Annum Quingentesimum Celebrantis 2
- Keen, D.H., Hardaker, T., Lang, A.T.O., 2006. A Lower Palaeolithic industry from the Cromerian (MIS 13) Baginton Formation of Waverley Wood and Wood Farm Pits, Bubbenhall, Warwickshire, UK. *Journal of Quaternary Science* 21, 457-4
- Krawiec, K., Hopla, E.and Gearey, B.R., 2011. Palaeoenvironmental Assessment of near shore and offshore cores from the Hornsea Zone. Birmingham ArchaeoEnvironmental
- Parfitt, S. a, Ashton, N.M., Lewis, S.G., Abel, R.L., Coope, G.R., Field, M.H., Gale, R., Hoare, P.G., Larkin, N.R., Lewis, M.D., Karloukovski, V., Maher, B. a, Peglar, S.M., Preece, R.C., Whittaker, J.E., and Stringer, C.B., 2010. Early Pleistocene human occupation at the edge of the boreal zone in northwest Europe. *Nature*, 466 (7303), 229–33.
- 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.C, 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
- Pettitt, P. and White, M.J., 2012. *The British Palaeolithic: Human socieities at the edge of the Pleistocene world*. Abingdon: Routledge



Reid Moir, J. 1927. The Antiquity od Man in East Anglia. Cambridge University Press.

- RPS and Wessex Archaeology 2012. Hornsea R3 Offshore Windfarm Project 2. Archaeology Method Statement for monitoring offshore Coollection of Geotechnical cores. Prepared by RPS, 21/8/2012
- RPS 2013. Hornsea Round 3, Subzone 1: Archaeological Technical Report. Reference Number: 31047
- Shennan I., Richard Peltier, W., Drummond, R., and Horton, B. 2002. 'Global to local scale parameters determining relative sea-level changes and the post-glacial isostatic adjustment of Great Britain'. *Quaternary Science Reviews*. 21. 397-408
- Shennan, I., Lambeck, K., Flather, R., Horton, B. P., McArthur, J. J., Innes, J. B., Lloyd, J. M., Rutherford, M. M., and Wingfield, R. 2000 "Modelling western North Sea palaeogeographies and tidal changes during the Holocene" In: I. Shennan, and J. Andrews, (Eds) *Holocene land-ocean interaction and environmental change around the North Sea*, 299-319, Geological Society, Special Publications, 166, London
- Tappin, D R, Pearce, B, Fitch, S, Dove, D, Geary, B, Hill, J M, Chambers, C, Bates, R, Pinnion, J, Diaz Doce, D, Green, M, Gallyot, J, Georgiou, L, Brutto, D, Marzialetti, S, Hopla, E, Ramsay, E, and Fielding, H., 2011, '*The Humber Regional Environmental Characterisation*'. British Geological Survey Open Report OR/10/54. 357pp
- Waddington, Clive (ed.) 2007 Mesolithic Settlement in the North Sea Basin. A case study from Howick, North East England, Oxbow Books
- Ward, I., Larcombe, P. and Lillie, M., 2006. The dating of Doggerland post-glacial geochronology of the southern North Sea. *Environmental Archaeology*, 11, 2, 207-218
- Wessex Archaeology, 2010a. Model Clauses for Archaeological Written Schemes of Investigation. Offshore Renewables Projects. Prepared for the Crown Estate. Wessex Archaeology report reference:73340.05
- Wessex Archaeology, 2010b. Seabed Prehistory: Site Evaluation Techniques (Area 240): Seabed Sampling. Ref 70752.02
- Wessex Archaeology 2013. Hornsea Round 3 Zone. Subzone 1 and Export Cable Route. Archaeological Assessment of Geophysical data. Report ref.: 87152.02
- White, M.J., Scott, B., and Ashton, N.M., 2006. The Early Middle Palaeolithic in Britain: archaeology, settlement history and human behaviour. *Journal of Quaternary Science*, 21 (5), 525–541
- Wymer, J.J., 1999. *The Lower Palaeolithic Occupation of Britain*. Wessex Archaeology and English Heritage.

8 APPENDIX 1 GEOARCHAEOLOGICAL FRAMEWORK

To help frame geoarchaeological investigations of this nature, Wessex Archaeology has developed a five stage approach, encompassing different levels of investigation appropriate to the results obtained, accompanied by formal reporting of the results at the level achieved. The stages are summarised below:

Stage 1: Planning	Archaeological assessment of cores and logs generated by geotechnical contractors. This assessment will establish the presence and location of sediment units with likely archaeological, palaeo- environmental and/or dating potential, as a basis for deciding what Stage 2 archaeological recording is required. The Stage 1 report will state the scale of Stage 2 work proposed. Should no further works be required a brief Stage 1 report outlining the results of the assessment will be prepared.
Stage 2: Core Recording	Each core containing sediment units identified as having archaeological, palaeo-environmental or dating potential in Stage 1 will be split, with half of each core being cleaned and recorded. The stratigraphy of each core will be recorded, a basic sediment description for each of the units will be made and those units of particular archaeological/palaeo-environmental interest will be highlighted. The Stage 2 report will state the nature and scope of any Stage 3 analyses required to characterise and interpret the sediment units in order to build an outline Quaternary deposit model and thus identify areas of potential archaeological significance.
Stage 3: Sub- sampling and Assessment	Sub-sampling and assessment of any units of archaeological and/or palaeo-environmental interest. Sub-samples for the assessment of microfossil environmental indicators (pollen, diatoms, ostracods and/or foraminifera) will be taken from one core-half, with the other core-half retained intact should further sub-sampling be required. Assessment will comprise analysis (identification and quality of preservation) of a series of sub-samples to enable the value of the palaeo-environmental material surviving within the cores to be identified. Sub-samples will also be taken and retained at this stage in case radiocarbon dating is required during Stage 4. Scientific dating may be undertaken at this stage if warranted. The Stage 3 report will set out the results of each laboratory assessment together with an outline of the archaeological implications of the combined results, and will indicate whether and Stage 4 work is warranted.
Stage 4: Analysis and Dating	Full analysis of pollen, diatoms, ostracods and/or foraminifera assessed during Stage 3. Typically, Stage 4 will be supported by scientific dating of suitable sub-samples. Should Stage 3 assessment indicate that there is no further analytical work required on the microfossil assemblages, consideration will still be given for a programme of radiocarbon analyses to provide a chronological framework for the deposits encountered unless no suitable samples could be procured. The Stage 4 report will provide an account of the palaeo- environment(s) at each relevant coring location within a chronological framework (absolute or relative) and an outline of the archaeological implications of the analysis.

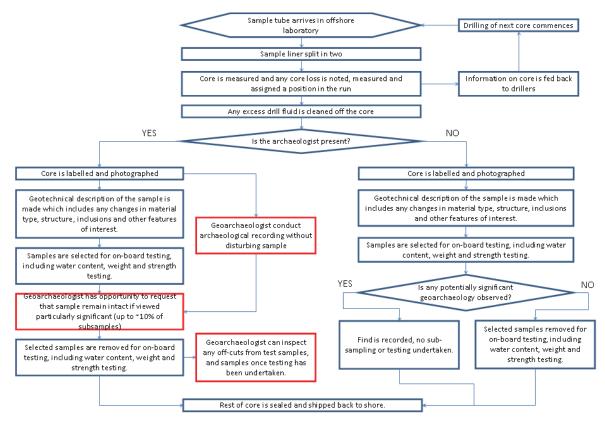
Final Reporting	If the archaeological results are sufficiently significant, a final report will be compiled covering all aspects of the palaeo-topography and prehistory of the area affected by the development, incorporating the results of each stage.
	If the archaeological results are not significant then the relevant Stage Report(s) will constitute the final documents for the investigation.
	If required, the Final Report will include relevant data generated by the baseline assessment and geophysical (sub-bottom) review, in order to place the results of the core recording and analysis within the context of the broad pattern of deposits within the area. The report will comprise as detailed a Quaternary deposit model for the area as possible, and address the implications of that model in terms of archaeological potential.

8.1.1

Т

9 APPENDIX 2 OFFSHORE ARCHAEOLOGISTS ROLE FLOWCHART

OFFSHORE SAMPLE HANDLING - WITH ONE ARCHAEOLOGISTS ONBOARD



10 APPENDIX 3 OFFSHORE BORHOLE RECORDING

AC1a_CS

Т

Depth mbSB	Core sample	Sediment description	BGS Unit
0 to 15.8		Sediments not records a classically recorded on board	
15.8 to 16.1	RC12	Sediments not geoarchaeologically recorded onboard Mid brownish grey silty SAND. Possible collapse/downhole disturbance. Occasional shells and small black organic inclusions from 15.8 to 15.9m	SBK
18.3 to 18.8	RC14	Mid greenish grey SAND. Loose, wet. Horizontal laminar bedding of light grey silty sand and dark grey organic layers.	SBK
19.3 to 19.8	RC15	Mid greenish grey slightly silty SAND. Loose. Horizontally bedded layer of high molluscan and organic content at 19.5 to 19.6m below seabed. Frequent molluscs from 19.7 to 19.8m	SBK
23.3 to 23.9	RC19	Mid greenish grey silty SAND. Horizontal interbedded structure of of silty sand, silty clay and darker organic laminae.	SBK
25.2 to 26.3	RC21	Loose mid greenish grey slightly silty SAND. Occasional broken molluscs and darker organic laminae from 25.2 to 25.35m	SBK
28.7 to 29.3	RC24	Wood fragments recovered.	
32.2 to 32.45	RC28	Mid grey silty SAND. Frequent molluscan inclusions and occaional sub angular flint from 20 to 30mm diameter. Fining upwards	SBK
34.7 to 35.2	RC30	Mid greenish grey slightly silty SAND. Includes horizontally bedded layers of molluscan rich sediment and occasional subangular flint. Coarsening upwards.	SBK
36.4 to 37.3	RC32	Mid greenish grey slightly silty SAND. From 36.4 to 36.5, frequent shell inclusions and occasional flint. Coarsening upwards.	SBK
41.4 to 42.05	RC36	Mid greenish grey slightly silt SAND. Wood fragment at 41.6m.	SBK
43.4 to 44.4	RC38	Mid greenish grey slightly silty SAND. Horizontally bedded laminae of grey silty sand and darker organic material	SBK
45.9 to 47.7	RC40	Mid greenish grey slightly clayey silty SAND. Interbedded horizontal laminae of grey silty clay and darker organic matter. Layer of wood, molluscs and organic material from 46.6 to 46.9	SBK
47.4 to 48.65	RC41	Mid greenish grey slightly silty SAND.	SBK

AC1b-CS

Depth mbSB	Core sample	Sediment description	BGS
0 to 0.57	RC01	Dark reddish brown silty SAND. Compact. Frequent pebbles, subrounded to angular of mixed lithologies up to 50mm diameter. Poorly sorted. Abrupt, erosive boundary.	SS
0.57 to 1.5	RC01	Dark reddish brown sandy silty CLAY. Occasional pebbles of mixed litholgy with some horizontal bedding and foliated/platy structure noted.	BB/IBCT
1.5 to 2.35	RC02	Dark reddish brown sandy silty CLAY. Occasional pebbles of mixed lithology with some horizontal bedding and foliated/platy structure noted.	BB/IBCT
2.3 to 3.8	RC03	Dark brownish grey slightly sandy CLAY. Very occasional small pebbles and occasional molluscan fragments. Poorly sorted.	BB/IBCT
3.8 to 5.3	RC04	Dark brownish grey slightly sandy CLAY, as above. Sample disturbed at both ends. Some organic material noted at 4.5 to 4.8m.	BB/IBCT
5.5 to 8.3		Not geoarchaeologically recorded	
8.3 to 9.8	RC08	Dark grey sandy CLAY. Occasional small poorly sorted subangular pebbles comprising predominantly chalk and flint with one belemnite fossil also recorded. Thick laminae of reddish brown clay and sand.	BB/IBCT
		Not geoarchaeologically recorded	
11.3 to 12.65	RC10	Dark grey sandy CLAY. Stiff. Occasional to moderate small (up to 30mm diameter) pebbles comprising predominantly poorly sorted subangular chalk and flint. A band of loose grey silty fine SAND present from 11.85 to 12.3m. Laminae of sand and clay some of which have oxidised at 12.3 to 12.5m.	BB/IBCT
12.65 to 15.8		Not geoarchaeologically recorded	
15.8 to 16.25	RC13	Dark grey silty SAND. Sand is fine grained. Some regularly and tightly spaced <i>c</i> . 2mm thick darker and lighter "varve like" bedding especially from 16 to 16.15m.	SBK
16.25 to 81.4		Not geoarchaeologically recorded onboard	

AC2-CS

Depth mbSB	Core sample	Sediment description	BGS Unit
0 to 0.1m	RC01	A 0.1m thick grey limestone boulder was encountered and cored at the seabed surface. Dead mans fingers adhering to it's upper surface. Disturbed sample.	SS
0.1 to 0.15m	RC01	Reddish brown clayey sand adhering to the lower surface of the boulder described above.	BB/IBCT
0.95 to 1.75	RC02	Reddish brown gravelly sandy CLAY. Occasional small pebbles up to 5mm diameter comprising rounded to angular chalk, red sandstone, flint, coal and shale.	BB/IBCT
1.75 to 43.75		Not geoarchaeologically recorded	
43.75 to 45.10	RC31	Grey SAND. Sand is fine to medium grained. Sorted. Fining upwards. Occasional molluscan remains. Disturbed 10mm boundary	SBK
45.1 to 45.15	RC31	Grey CLAY. Bounded by 25mm thick beds of black organic sand.	SBK
45.15 to 45.25	RC31	Grey SAND. Sand is fine grained. Sorted.	SBK
45.25 to 46.75	RC32	Greenish grey SAND. Bands of organic darker material including lignite/wood up to 50mm diameter.	SBK/YM
46.75 to 48.25	RC33	Dark greeish grey SAND. Occasional thin beds of molluscan remains.	YM
48.25 to 49.55	RC34	Dark greenish grey fine SAND. Frequent molluscan remains.	YM
49.75 to 51.25	RC35	Dark greenish grey fine SAND. Frequent molluscan remains including <i>Cerastoderma edule</i> and Scrobicularia/Tellina type. Horizontal clayey sand beds from 51m to 51.25 indicative of tidal deposition.	YM
51.25 to 52.75	RC36	Grey SAND. Frequent horizontally interbedded sands/soft grey silty clays and shelly beds including occasional <i>Mytilus edulis.</i>	YM
52.75 to 54.25	RC37	Greenish grey SAND. Occasional clay bed fro 52.75 to 53m. Occasional bivalve molluscs and wood (at 54.05m).	YM
54.25 to 55.75	RC38	Greenish grey SAND. Wet. Soft. Occasional hard grey clay horizontally bedded. Occasional broken bivalve molluscs.	YM
55.75 to 57.25	RC39	Greenish grey SAND. Occasional whole bivalve mollusc.	YM
57.25 to 60.25		Not geoarchaeologically recorded	YM
60.25 to 61.65	RC42	Grey SAND. Sorted. From 61.18 to 61.22 horizontally interbedded silty clay. From 61.22 to 61.40 very frequent molluscan remains and moderate wood. From 61.40 to 61.65m very frequent bivalve molluscs.	YM

61.75 to 62.95	RC43	Grey SAND. From 62.05 to 62.25, very frequent (occasionally whole) bivalve molluscs, moderate organic remains and occasional bone (fish vertebra). From 62.45 to 62.85 darker horizontally bedded layers of organic rich sand and clay.	YM
63.25 to 64.75	RC44	Grey sandy CLAY. Sand is fine grained. Horizontally interbedded fine sand layers (possible varves) and pockets of sand up to 5mm diameter. Stiff. From 63.4 to 63.6m some evidence of post depositional frost heave as indicated by a slightly blocky/pellety structure.	ΥM
64.75 to 80.4m		Not geoarchaeologically recorded.	

AC3-CS

Depth mbSB	Core sample	Sediment description	BGS Unit
0 to 15.8m		Sediments not geoarchaeologically recorded onboard	
15.8 to 16.1	RC12	Mid brownish grey silty SAND. Possible collapse/downhole disturbance. Occasional shells and small black organic inclusions from 15.8 to 15.9m	SBK
18.3 to 18.8	RC14	Mid greenish grey SAND. Loose, wet. Horizontal laminar bedding of light grey silty sand and dark grey organic layers	SBK
19.3 to 19.8	RC15	Mid greenish grey slightly silty SAND. Loose. Horizontally bedded layer of high molluscan and organic content at 19.5 to 19.6m below seabed. Frequent molluscs from 19.7 to 19.8m	SBK
23.3 to 23.9	RC19	Mid greenish grey silty SAND . Horizontal Interbedded structure of silty sand, silty clay and darker organic laminae.	SBK
25.2 to 26.3	RC21	Loose mid greenish grey slightly silty SAND. Occasional broken molluscs and darker organic laminae from 25.2 to 25.35m	SBK
28.7 to 29.3	RC24	Wood fragments recovered.	
32.2 to 32.45	RC28	Mid grey silty SAND. Frequent molluscan inclusions and occasional sub angular flint from 20 to 30mm diameter. Fining upwards	SBK
34.7 to 35.2	RC30	Mid greenish grey slightly silty SAND. Includes horizontally bedded layers of molluscan rich sediment and occasional subangular flint. Coarsening upwards.	SBK
36.4 to 37.3	RC32	Mid greenish grey slightly silty SAND. From 36.4 to 36.5, frequent shell inclusions and occasional flint. Coarsening upwards.	SBK
41.4 to 42.05	RC36	Mid greenish grey slightly silt SAND. Wood fragment at 41.6m.	SBK
43.4 to 44.4	RC38	Mid greenish grey slightly silty SAND. Horizontally bedded laminae of grey silty sand and darker organic material	SBK
45.9 to 47.7	RC40	Mid greenish grey slightly clayey silty SAND. Interbedded horizontal laminae of grey silty clay and darker organic matter. Layer of wood, molluscs and organic material from 46.6 to 46.9	SBK
47.4 to 48.65	RC41	Mid greenish grey slightly silty SAND.	SBK
36.1 to 37.05	RC26	Greyish brown slightly silty sandy CLAY. Horizontal regularly interbedded structure. Rhythmitic possibly tidal deposition.	SBK

37.6 to 39.1	RC27	Grey SAND. Sand is medium grained. Occasional wood up to 40mm diameter. Wet. Frequent broken molluscs up to 3mm diameter, more frequent and larger from 38.6 to 39.1m. Some feintly visible horizontal bedding especially from 37.6 to 37.8m where there are some siltier and darker organic beds/patches. Fining upwards.	SBK
39.1 to 40.25	RC28	Grey SAND. Sand is medium grained. Wet. Frequent broken and whole bivalve molluscs. Some feintly visible horizontal bedding.	SBK
40.60 to 41.5	RC29	Grey SAND. Sand is medium grained. Wet. Very frequent broken and whole bivalve molluscs. Occasional wood/lignite, up to 45mm diameter.	SBK
41.5 to 45.1		Poor sample recovery	SBK
45.1 to 45.85		Grey clayey SAND. Some subvertical bedding with black organic sand, brown clay and grey sand beds. Possible evidence of post depositional slumping convoluted/push morraine complex bedding.	SBK
45.85 to 46.80	RC33	Grey clayey SAND. Mixed horizontal and diagonal bedding as above. Vertically delineated bivalve (<i>Scrobicularia</i> type).	SBK
46.8 to 48.3	RC34	Very dark grey CLAY. Occasional pockets of sand.	SBK
48.3 to 49.3	RC35	Grey CLAY. Stiff. Feint horizontal bedding. Occasional fine sand beds up to 5mm in thickness. 50mm diameter brown sandy CLAY at edge of sample. Occasinal very small shell fragments. Some evidence of diagonal bedding at 49m.	SBK
49.8 to 51.3	RC36	Grey sandy CLAY. Stiff. Moderate bivalve molluscs, occasionally whole. Some black possibly organic spots. Becomes slightly browner with more black spots up to 7mm in diameter from 52.5 to 52.8	SBK
51.3 to 52.80	RC37	Grey sandy CLAY. Stiff . Occasional minor slickenside structures from 51.3 to 51.4m. Occasional broken and whole bivalve molluscs.	SBK
52.8 to 54.3	RC38	Grey sandy CLAY. Stiff. Occasinal whole bivalves with both valves still attached and infilled with darker, organic sediment.	SBK
54.3 to 80.4		Not geoarchaeologically monitored	

DC1-CS

Depth mbSB	Core sample	Sediment description	BGS Unit
0.00 to 0.85	RC01	Grey silty clayey SAND. Core loss between 0 and 0.4m Sand is fine, medium, predominantly coarse grained and poorly sorted. Occasional pebbles up to 4mm diameter. 100mm disturbed/burrowed boundary.	SS
0.85 to 1.50	RC01	Reddish brown sandy gravelly CLAY. Stiff. Contains sand pockets which are likelt to be molluscan burrows infilled with the overlying sediment. Gravel is poorly sorted subangular to subrounded chalk, red sandstone and grey sandstone. Feint horizontally bedded structure visible within the sandy clay.	IBCT/BB
1.50 to 3.00	RC02	Reddish brown sandy gravelly CLAY. Stiff. Sand is fine to medium grained within small pockets and bands. One horizontally bedded band of sand at 2.7m. Very sandy from 2.7 to 2.9m. Gravel is subrounded to subangular chalk, sandstone and occasional quartz and shale up to 10mm diameter. From 2.3 to 2.5m a feint laminar/foliated horizontal bedding structure noted - especially towards the core edges.	IBCT/BB
3.00 to 4.50	RC03	Reddish brown sandy gravelly CLAY. Stiff. Sand is fine to medium grained within small pockets and bands. One horizontally bedded band of sand from 3.00 to 3.10m. Gravel is poorly sorted subrounded to subangular chalk, flint, sandstone and occasional quartz and shale up to 24mm diameter. From 3.00 to 3.10m a feint laminar/foliated horizontal bedding structure noted - especially towards the core edges	IBCT/BB
4.50 to 6.00	RC04	Reddish brown sandy gravelly CLAY. Stiff. Sand is fine to medium grained within small pockets and bands. Gravel is poorly sorted subrounded to subangular chalk, flint, sandstone quartz and shale.	IBCT/BB
6.00 to 7.00	RC05	Reddish brown sandy gravelly CLAY. Stiff. Sand is fine to medium grained within small pockets and bands. Gravel is poorly sorted subrounded to subangular chalk, flint, sandstone, quartz and shale	IBCT/BB
7.00 to 8.50	RC06	Reddish brown sandy gravelly CLAY. Stiff. Sand is fine, medium and predominantly coarse grained within small pockets and bands. Gravelly sand bed at 7.50m .Gravel is poorly sorted subrounded to subangular chalk, flint, sandstone, quartz and shale	IBCT/BB
8.50 to 9.40	RC07	Reddish brown sandy gravelly CLAY. Stiff. Sand is fine, medium and coarse grained within small pockets and bands. Gravel is poorly sorted subrounded to subangular chalk with flint, sandstone, quartz and shale also noted.	IBCT/BB

1	I	1	1
9.40 to 10.9	RC08	Reddish brown sandy gravelly CLAY. Stiff. Sand is fine, medium and coarse grained within small pockets and bands. Gravel is poorly sorted subrounded to subangular chalk with flint, sandstone, quartz and shale also noted. One large quartz veined mudstone cobble.	IBCT/BB
10.90 to 12.40	RC09	Grey silty, gravelly sandy CLAY. Becomes sandier with depth. One 70mm diameter igneous cobble. Some horizontal laminar bedding from 11.55 to 12.4m with sandy layers containg organic remains.	IBCT/BB
12.40 to 13.90	RC10	Reddish brown sandy gravelly CLAY. Stiff. Sand is fine, medium and coarse grained within small pockets and bands of sand.Gravel is poorly sorted subrounded to subangular chalk with flint, sandstone, quartz and shale.	IBCT/BB
13.9 to 15.40	RC11	Not geoarchaeologically recorded onboard	
15.40 to 16.90	RC12	Reddish brown CLAY. Interbedded sand layers. Minor slickenside stuctures and frost shattered sediments at 15.75m. No inclusions.	IBCT/BB
16.9 to 18.4	RC13	Brownish grey sandy CLAY. No inclusions. Horizontally interbedded with sand and minor slickenside structures.	IBCT/BB
18.4 to 19.9	RC14	Brown/grey SAND and CLAY. Horizontally interbedded varve like structures. At 19.55 some small slickenside structures visible.	SWB
19.9 to 21.4	RC15	Brown/grey SAND and CLAY. Horizontally interbedded varve like structure.	SWB
21.4 to 49.00		Not geoarchaeologically recorded onboard	
49.00 to 51.4	RC35	Green SAND. Sand is fine to predominantly medium grained. Very frequent molluscs including Scrobicularia/Tellina type. Hard clay bed at 51m with a valve of <i>Cerastoderma edule</i> . Feint laminar silty clay beds. Some darker black organic sand from 51.25 to 51.4m	YM
51.4 to 52.9	RC36	Green SAND. Horizontally bedded organic peaty, molluscs rich sandy layer at 52.8m	YM
52.9 to 54.4	RC37	Green SAND. Occasional organic remains including black wood/twigs up to 50mm in length in beds delineated by a higher organic content at 53.85 and 54.35m. Frequent molluscan remains.	YM
54.4 to 55.9	RC38	Green SAND. Frequent beds of bivalve molluscs and horizontal beds of organic material (2mm thickness). Some rounded peat balls up to 20mm diameter.	YM
55.9 to 57.4	RC39	Greenish grey SAND. Wet. Sand is fine to medium grained. Small horizontal beds, up to 8mm in thickness of organic remains at 56.25 and 57m.	YM
57.4 to 58.9	RC40	Green SAND. Sand is fine to medium grained. Wet. Frequent organic bands from 57.6 to 58.1m.	YM
58.9 to 60.4	RC41	Green SAND. Sand is fine to medium grained. Wet. Frequent organic bands from 57.6 to 58.1m.	YM
60.4 to 61.9	RC42	Green SAND. Sand is fine to medium grained. Wet. Frequent organic bands at 59m.	YM

П

61.9 to 63.4	RC43	Green SAND. Sand is fine to medium grained. Occasional small grey clay patches and mollusc burrows from 61.9 to 70.2. Organic bands at 63.2m.	YM
63.4 to 64.9	RC44	Green SAND. Sand is fine to medium grained. Frequent molluscs in layers predominantly bivalves (Including Scrobicularia/Tellina type and <i>Cerastoderma edule</i>), with occasional gastropods. Organics bands at 64.15 and some cemented sand.	YM
64.9 to 66.4	RC45	Grey SAND with horizontally interbedded sandy clay laminations (possibly tidally induced), thinly spaced. Molluscs frequent from 64.9 to 65.4m.	YM
66.4 to 67.9	RC46	Grey SAND with horizontally interbedded sandy clay laminations (possibly tidally induced), thinly spaced, 2 to 4mm in thickness.	ΥM
67.9 to 69.4	RC47	Not geoarchaeologically recorded onboard	YM
69.4 to 70.90	RC48	Grey SAND with horizontally interbedded sandy clay laminations (possibly tidally induced), thinly spaced. Occasional bivalve molluscs and beds containing organic remains.	ΥM
70.9 to 72.4	RC49	Not geoarchaeologically recorded onboard	YM
72.4 to 73.4	RC50	Grey SAND. Sand is fine to medium grained. Occasional bivalve molluscs and grey clay patches up to 10mm diameter.	YM
73.9 to 74.5	RC51	Grey SAND. Well sorted. Intrusive clay smeared on edges of core. Occasional thin 4mm thick horizontally bedded organic layers.	YM
74.5 to 80.1	RC52	Not geoarchaeologically recorded onboard	

Т

NJ101-CS

Depth mbSB	Core sample	Sediment description	BGS Unit
0 to 0.95	RC01	Poor recovery. Some brown silty sand and small to medium sized pebbles including flint, limestone and basalt. One worn <i>Buccinum undatum</i> mollusc.	SS
0.95 to 1.50	RC02	No recovery	SS
1.50 to 1.75	RC02	Reddish brown sandy gravelly CLAY. Stiff. No structure. Gravel includes poorly sorted rounded to subangular chalk, red sandstone up to 45mm in diameter.	BB
1.75 to 7.75		Not geoarchaeologically recorded onboard.	
7.75 to 9.25	RC07	Reddish brown sandy gravelly CLAY. Stiff. No structure. Gravel includes poorly sorted rounded to subangular chalk, red sandstone up to 10mm in diameter.	BB
9.25 to 10.75	RC08	Reddish brown sandy gravelly CLAY. Stiff. No structure. Gravel includes poorly sorted subangular chalk and red sandstone up to 5mm in diameter.	BB
10.75 to 15.25		Not geoarchaeologically recorded onboard.	
15.25 to 16.75	RC13	Reddish brown sandy gravelly CLAY. Stiff. No structure. Gravel includes poorly sorted subangular chalk and red sandstone up to 5mm in diameter. At 16.05m some horizontally bedded clay and sand with occasional organics noted.	вв
16.75 to 18.25	RC14	Brown gravelly sandy CLAY. Gravel is chalk and sandstone. At 17.15m a 100mm thick bed of grey silt and feint horizontal laminar bedding. Sandy pocket at 17.75m. Silty fine sand at 18.25m	BB
18.25 to 19.75	RC15	Brown gravelly sandy CLAY. Gravel is chalk, flint and sandstone up to 5mm diameter. The tip of a belemnite was also noted. From 19.05 to 19.75 horizontally interbedded sand and clay layers up to 4mm in thickness. Bedding becomes wavy from 19.5 to 19.75m	BB
19.75 to 21.05	RC16	Beige SAND. Stiff. Interbedded with brown clay layers which are generally horizontal, occasionally diagonal, usually 2 to 10mm in thickness. The bedding is occasionally fractured with occasional small slickensides. From 20.45 to 21.05m brown stiff CLAY with finely bedded horizontal laminations and a slightly blocky structure around 21.00m Brown stiff slightly sandy CLAY. Occasional small chalk up	SWB
21.25 to 22.75	RC17	to 1mm diameter becoming more frequent from 22 to 22.75m	SWB
22.75 to 46.75		Not geoarchaeologically recorded onboard.	

46.75 to 48.25	RC34	Grey SAND with beds of frequent mollusc and gravelly sand at 46.85 to 46.95m and 47.10 to 47.20m. Occasional wood up to 80mm in length and gravel up to 40mm diameter. Some silty clay beds which are noteably wet from 47.5m onwards	SWB
48.25 to 49.75	RC35	Grey SAND with horizontally bedded layers of clay.	SWB
49.75 to 51.25	RC36	Grey SAND with occasional horizontally bedded layers of clay.	SWB

NJ102-CS

Depth mbSB	Core sample	Sediment description	BGS Unit
0 to 0.4m	RC01	Brown silty, gravelly SAND.	SS
0.4 to 1.5	RC01	Mid greyish brown sandy CLAY. Stiff. Gravel is subrounded to subangular chalk, flint and red sandstone. Poorly sorted	BB
1.5 to 15.7		Not geoarchaeologically recorded onboard.	
15.7 to 17.2	RC12	Brown silty SAND. Moderate broken molluscs and small subangular flint pebbles.	SBK
17.2 to 18.7	RC13	Brown silty SAND. Moderate broken molluscs and small subangular flint pebbles. Horizontally bedded grey silty bsand bands.	SBK
18.7 to 20.1	RC14	Mid greenish grey slightly silty CLAY. Feintly visible laminar horizontal bedding delineated by slightly darker possibly organic layers.	SBK
20.2 to 23.2		Not geoarchaeologically recorded onboard.	
23.2 to 24.7	RC17	Mid greenish grey slightly silty SAND. Horizontally bedded organic layers and occasional wood fragments from 23.8 to 24m.	SBK
24.7 to 26.2	RC18	Mid brownish grey very silty SAND. Moderate molluscan inclusions, frequent between 25.8 and 26.2m.	SBK
26.2 to 32.2		Not geoarchaeologically recorded onboard.	
32.2 to 33.55	RC23	Mid greenish grey silty CLAY	SBK
33.55 to 35.2		Not geoarchaeologically recorded onboard.	
35.2 to 36.7	RC25	Mid greenish grey silty CLAY. Some horizontally bedded laminations including beds of organic material at 36.1m	SBK
41.2 to 42.7	RC29	Mid greenish grey silty CLAY. Some horizontally bedded laminations including beds of molluscan and organic material	SBK

NJ103-CS

Depth mbSB	Core sample	Sediment description	BGS Unit
0 to 0.25	RC01	Brown SAND and CLAY. Disturbed	SS
0.25 to 0.9	RC01	Brown sandy gravelly CLAY. Gravel is small up to 5mm subrounded to subangular including chalk and red sandstone	BB
0.9 to 19.3		Not geoarchaeologically recorded onboard	
19.3 to 20.8	RC15	Mid brownish grey slightly silty SAND. Freqquent molluscan remains between 22.8 and 23.3m	SWB
20.8 to 25.3		Not geoarchaeologically recorded onboard	
25.3 to 26.8	RC19	Mid greenish grey slightly silty SAND. Horizontally bedded including darker organic layers at 25.65m	SWB
26.8 to 28.3	RC20	Mid greenish grey slightly silty SAND. Horizontally bedded including darker organic layers at 27.95 to 28.10m	SWB

NJ104-CS

Depth mbSB	Core sample	Sediment description	BGS Unit
0 to 1.5		Sample redrilled and disturbed	
1.5 to 2.1	RC02	Sample disturbed due to redrill with greyish brown gravelly sand overlying. Mid greyish brown gravelly sandy CLAY. Gravel is poorly sorted small subangular including chalk and red sandstone.	SS/BB
2.1 to 5.1		Not geoarchaeologically recorded onboard	
5.1 to 6.6	RC05	Brown silty CLAY. Horizontally bedded laminations of clay and silty sand from 5.75 to 6.2m	BB
6.6 to 9.6		Not geoarchaeologically recorded onboard	
9.6 to 11.1	RC08	Grey/red sandy CLAY. Stiff	BB
11.1 to 12.6	RC09	Sandy CLAY. Includes possible organic laminae at 12.25m	
12.6 to 17.1		Not geoarchaeologically recorded onboard	
17.1 to 18.0	RC13	Greenish grey silty CLAY. Horizontally bedded darker organic and grey silty clay laminae. Occasional molluscan inclusions.	SWB
18.6 to 18.95	RC14	Grey/Brown silty SAND. Horizontally interbedded laminar structure.	SWB
18.95 to 22.1		Not geoarchaeologically recorded onboard	SWB
22.1 to 22.4	RC17	Reddish brown sandy CLAY. Horizontally bedded darker organic laminae from 22.1 to 22.2m	SWB

22.4 to 25.1		Poor sample recovery	SWB
25.1 to 25.45	RC20	Greenish grey silty SAND. Occasional wood fragments from 25.1 to 25.2m	SWB
26.1 to 26.9	RC21	Greenish grey silty SAND. Occasional molluscs. Horizontally bedded laminar structure from 26.45 to 26.55m	SWB
27.1 to 28.1	RC22	Greenish grey silty SAND. Occasional molluscs, more frequent at 27.1m.	SWB
28.1 to 29.1	RC23	Greenish grey silty SAND. Molluscs frequent between 28.25 and 28.35m.	SWB
29.1 to 30.6	RC24	Greenish grey silty SAND. Molluscs frequent between 30.45 and 30.6m.	SWB
		Not geoarchaeologically recorded onboard	
38.1 to 39.6	RC30	Greenish grey silty SAND. Horizontally bedded laminar structure with organic layers at 39.2m	SWB
39.6 to 41.1		Not geoarchaeologically recorded onboard	
41.1 to 42.6	RC32	Greenish grey silty SAND. Horizontally bedded laminar structure with organic layers at 42.45m	SWB

NJ105-CS

Depth mbSB	Core sample	Sediment description	BGS Unit
0 to 0.4	RC01	Brown gravelly SAND. Frequent broken and whole molluscs. Gravel includes small to medium (up to 35mm diameter) subrounded to subangular flint. Occasional black organic patches. Wet. Soft. 100mm burrowed/disturbed boundary.	SS
0.4 to 1.00	RC01	Reddish brown sandy gravelly CLAY. Contains large, 40mm diameter vertical molluscan burrows infilled with overlying sediment and molluscs from 0.4 to 0.6m. From 0.6m onwards some feint horizontal laminar bedding visible. Gravel is small poorly sorted rounded to angular including chalk, sandstone and metamorphic rocks.	IBCT/BB
1.5 to 2.15	RC02	Reddish brown slightly sandy gravelly CLAY. Wet. Stiff. Horizontal closely spaced foliated bedding. Gravel comprises small poorly sorted rounded to angular chalk, flint, metamorphic and igneous rocks. 10mm thick medium to coarse grained sand bed at 2.15m including small medium to coarse grained sand sized particles of chalk.	IBCT/BB
3.00 to 4.00	RC03	Reddish brown slightly sandy gravelly CLAY. Wet. Stiff. Horizontal foliated bedding visible. Gravel comprises small poorly sorted rounded to angular chalk, flint, metamorphic and igneous rocks up to 25mm diameter.	BB
4.5 to 6.00	RC04	Reddish brown slightly sandy gravelly CLAY. Wet. Stiff. Horizontal foliated bedding visible. Gravel comprises small poorly sorted rounded to angular chalk, flint, metamorphic and igneous rocks up to 25mm diameter.	IBCT/BB

-		

6.00 to 7.20	RC05	Reddish brown slightly sandy gravelly CLAY. Wet. Stiff Gravel comprises small poorly sorted rounded to angular chalk, flint, metamorphic and igneous rocks up to 25mm diameter.	IBCT/BB
7.5 to 9.00	RC06	Reddish brown slightly sandy gravelly CLAY. Wet. Stiff Gravel comprises small poorly sorted rounded to angular chalk, flint, metamorphic and igneous rocks up to 25mm diameter.	IBCT/BB
9.00 to	RC07	Reddish brown slightly sandy gravelly CLAY. Wet. Stiff. Gravel comprises small poorly sorted rounded to angular chalk, flint, metamorphic and igneous rocks up to 40mm diameter. Occasional 10mm thick beds of silty sand. From 10.2 to 10.4 sand increases with moderate broken molluscan remains. Darker grey/brown silty sand bed from 10.31 to 10.34m Fining upwards.	IBCT/BB

NJ105-CSa

Depth mbSB	Core sample	Sediment description	BGS Unit
14.5 to 15.4	RC01	Dark grey silty SAND. Sand is medium and predominantly fine grained. Sorted. Becomes sandier and contains thin laminae of organic matter from around 15.04 to 15.4m	BB/SWB
15.5 to 16.7	RC02	Dark grey silty SAND. Some yellowish brown patches. Sand is fine, medium and coarse grained. Frequent broken molluscs within an coarser sand bed from 16.3 to 16.7m.	SWB
16.7 to 18.05	RC03	Dark greenish brown silty SAND. Sand medium and predominantly fine grained. Sorted. Horizontally bedded laminae of organic material from 17.94 to 18.06m.Moderate molluscan inclusions	SWB
18.05 to 27.2		Not geoarchaeologically recorded onboard	
27.2 to 28.7	RC10	Dark grey silty SAND. Sand is medium and predominantly fine grained. Sorted. Horizontally bedded laminae of organic material and clay from 27.56 to 27.66	SWB
28.7 to 30.2	RC11	Dark grey silty sandy CLAY. Frequent organic material between 28.7 to 28.8m.	SWB
30.2 to 33.2		Not geoarchaeologically recorded onboard	
33.2 to 34.7	RC14	Grey SAND. Sand is predominantly fine grained. Well sorted. Pockets of organic material between 34.3 to 34.7m.	YM
34.7 to 40.7		Not geoarchaeologically recorded onboard	
40.7 to 42.2	RC19	Dark grey slightly silty SAND. Sand is predominantly fine grained. Well sorted	YM
42.2 to 46.7		Not geoarchaeologically recorded onboard	

46.7 to 48.2	RC23	Grey slightly silty SAND. Sand is predominantly fine grained. Well sorted. Occasional molluscan inclusions at 48.0m	YM
48.2 to 49.6	RC24	Dark grey slightly silty SAND. Sand is predominantly fine grained. Well sorted. Contains horizontally bedded silty laminations throughout	ΥM
49.7 to 50.2	RC25	Grey silty SAND. Sand is predominantly fine grained. Well sorted. Occasional horizontally bedded laminar structure and molluscan remains especially between 49.7 to 49.9m	YM

NJ106-CS

Depth mbSB	Core sample	Sediment description	BGS Unit
0.00 to 5.5		Poor sample recovery at these levels/not geoarchaeologically recorded	
5.5 to 7.0	RC05	Reddish brown slightly sandy gravelly CLAY. Gravel is poorly sorted and of mixed lithologies including chalk and flint	BB
7.0 to 19.0		Poor sample recovery/not geoarchaeologically recorded	
19.0 to 20.3	RC14	Yellowish grey SAND. Occasional small gravel including chalk and flint. Moderate molluscan inclusions, more frequent from 19.55 to 19.85m.	SWB
20.3 to 21.8		Not geoarchaeologically recorded	
21.8 to 23.3	RC16	Brownish/greenish grey silty CLAY. Horizontally interbedded with clay and silty clay laminations. Stiff.	SWB
23.3 to 24.8	RC17	Greenish grey CLAY. Horizontally interbedded with laminations of light grey silty CLAY.	SWB
24.8 to 36.7		Not geoarchaeologically recorded	
36.7 to 38.15	RC26	Dark greenish grey silty SAND. Sand is fine to medium and occasionally coarse grained. Sorted. Occasional molluscs and small organics possibly charcoal especially between 37.8 and 38m.	SWB
38.2 to 39.7	RC27	Greenish grey silty SAND. Occasional to moderate small gravel inclusions including broken molluscs. Sand is fine to medium and occasionally coarse grained. Sorted. Some flecks of black possibly organic material.	SWB
39.7 to 41.2	RC28	Dark grey silty SAND. Sand is fine to medium and occasionally coarse grained. Sorted. Occasional to moderate bivalve molluscs.	SWB
412 to 42.7	RC29	Greenish grey silty CLAY. Moderate bivalve molluscs. Horizontal bed of light grey sand 50mm in thickness at 41.3m.	SWB
42.7 to 44.55	RC30	Greenish grey silty SAND. Predominnatly horizontally bedded laminar and lenticular/ slightly wavy bedding including lighter grey sands thickness and from 43.4 to 43.6m and with organic peaty silt beds at 43.85 to 44.05m	SWB
44.2 to 45.7	RC31	Greenish grey silty SAND. Horizontally bedded laminations including organic/peaty layers especially from 45.4 to 45.55m	SWB

RS-CS

Depth mbSB	Core sample	Sediment description	BGS Unit
0.0 to 0.9	RC01	Poor sample recovery	
0.9 to 1.8	RC02	Reddish brown sandy gravelly CLAY. Stiff. Gravel is poorly sorted including subrounded to subangular red sandstone, grey mudstone and coal up to 5mm diameter.	BB
1.8 to 3.3	RC03	Reddish brown sandy gravelly CLAY. Stiff. Gravel is frequent poorly sorted including rounded to subangular chalk, red sandstone, grey mudstone and coal up to 15mm diameter.	BB
3.3 to 4.8	RC04	Reddish brown sandy gravelly CLAY. Stiff. Gravel is frequent poorly sorted including rounded to subangular chalk, red sandstone, grey mudstone, micrite and coal up to 20mm diameter. One subangular 100mm diameter grey conglomerate cobble.	BB
4.8 to 6.3	RC05	Reddish brown slightly silty sandy gravelly CLAY.Stiff. Gravel is frequent poorly sorted including rounded to subangular chalk, red sandstone, grey mudstone and coal up to 15mm diameter.	BB
6.3 to 12.3		Not geoarchaeologically recorded.	
12.3 to 18.45		Recorded predominantly from bagged sediments: Yellowish brown silty SAND with laminar beds of darker organic remains and silt beds (12.3 to 15.3, 18.3 to 18.45m). Wood remains at 17.45m.	EG

RS-CSa

Depth mbSB	Core sample	Sediment description	BGS Unit
0.00 to 0.4	RC01	Beige/brown gravelly SAND. Gravel is poorly sorted broken molluscs <i>Buccinum</i> sp., occasionally whole including and subrounded to subangular pebbles up to 60mm diameter. Sand is medium to very coarse grained comprising a high proportion of broken molluscs. Disturbed and burrowed boundary	SS
0.4 to 1.1	RC01	Reddish brown sandy gravelly CLAY. From 0.4 to 0.7m, heavily burrowed. Stiff. Gravel is poorly sorted including subrounded to subangular red sandtone, grey mudstone and coal up to 5mm diameter.	BB

Key to BGS units abbreviations:

Chalk (UCk) Yarmouth Roads (YR) Swarte Bank (SWB) Egmond Ground (EG) Bolders Bank and Lower Botney Cut (BB/IBCT) Upper Botney Cut and Holocene Alluvium (uBCT/HA) Seabed Sediment (SS)



11 APPENDIX 4 BOREHOLE SAMPLES TAKEN FOR STAGE 2 AND 3 WORK

Borehole Number	Sample	Depth from (m)	Sample Type	Sample Length (cm)
AC1a-CS	12BagA	15.80	Bag	10
AC1a-CS	14WaxA	18.30	Wax	5
AC1a-CS	14BagB	18.70	Bag	10
AC1a-CS	15BagB	19.50	Bag	10
AC1a-CS	15BagD	19.70	Bag	10
AC1a-CS	19WaxA	23.30	Wax	15
AC1a-CS	21BagA	25.20	Bag	15
AC1a-CS	24BagA	28.70	Bag	20
AC1a-CS	24WaxA	28.90	Wax	10
AC1a-CS	28BagB	32.30	Bag	5
AC1a-CS	28WaxA	32.35	Wax	10
AC1a-CS	30BagC	35.15	Bag	5
AC1a-CS	32BagA	36.40	Bag	10
AC1a-CS	36WaxA	41.50	Wax	25
AC1a-CS	38BagC	44.10	Bag	10
AC1a-CS	40WaxC	46.50	Wax	10
AC1a-CS	40BagB	46.60	Bag	30
AC1a-CS	41WaxB	48.35	Wax	15
AC1a-CS	45WaxA	53.50	Wax	20
AC1a-CS	63WaxA	76.55	Wax	20
AC1a-CS	65BagB	79.70	Bag	10
AC1b-CS	4WaxA	4.10	Wax	25
AC1b-CS	8WaxB	8.70	Wax	30
AC1b-CS	8BagC	9.40	Bag	20
AC1b-CS	10WaxB	12.30	Wax	20
AC1b-CS	13BagB	16.05	Bag	20
AC1b-CS	14BagC	17.90	Bag	10
AC1b-CS	15WaxA	18.55	Wax	15
AC1b-CS	17WaxA	20.93	Wax	4
AC1b-CSa	6BagC	26.65	Bag	5
AC1b-CSa	17BagC	39.25	Bag	25
AC1b-CSa	21BagA	44.30	Bag	10
AC1b-CSa	21BagC	44.65	Bag	5
AC1b-CSa	22BagD	46.65	Bag	10
AC1b-CSa	22WaxA	46.15	Wax	25
AC1b-CSa	23WaxA	47.45	Wax	20
AC1b-CSa	23BagB	47.65	Bag	30
AC1b-CSa	25WaxA	50.50	Wax	10
AC1b-CSa	25BagB	50.60	Bag	20
AC1b-CSa	34BagC	61.25	Bag	30
AC1b-CSa	35WaxA	62.25	Wax	25
AC1b-CSa	39BagB	66.90	Bag	15
AC1b-CSa	40BagB	67.85	Bag	8
AC1b-CSa	49WaxA	80.10	Wax	20
AC1b-CSa	49BagB	80.30	Bag	20
AC2-CS	17BagC	23.05	Bag	25

AC2-CS	31BagC	45.1	Bag	5
AC2-CS	32BagC	46.6	Bag	15
AC2-CS	36BagB	52.1	Bag	5
AC2-CS	36BagC	52.15	Bag	20
AC2-CS	42BagB	61.15	Bag	5
AC2-CS	42BagC	61.2	Bag	15
AC2-CS	43BagB	62.05	Bag	20
AC2-CS	43BagD	62.45	Bag	5
AC2-CS	43BagF	62.7	Bag	15
AC2-CS AC3-CS	14BagC	19	Bag	5
AC3-CS		19.95		5
AC3-CS	15BagC 15WaxA	20.1	Bag Wax	30
AC3-CS	16WaxA	20.1		25
AC3-CS AC3-CS		21.65	Wax	25
	18WaxA		Wax	
AC3-CS	20WaxA	27.1	Wax	30
AC3-CS	20BagA	27.7	Bag	10
AC3-CS	26WaxB	36.45	Wax	20
DC1_CS	9BagB	11.50	Bag	5
DC1_CS	14BagB	19.25	Wax	20
DC1_CS	22BagA	30.40	Bag	25
DC1_CS	28BagC	40.2	Bag	5
DC1_CS	35BagC	51.1	Bag	10
DC1_CS	36BagC	52.7	Bag	10
DC1_CS	37BagC	53.85	Bag	5
DC1_CS	37BagD	54.25	Bag	5
DC1_CS	40BagB	57.6	Bag	30
DC1_CS	44BagC	64.15	Bag	10
NJ101-CS	14BagB	17.15	Bag	5
NJ101-CS	34BagB	46.85	Bag	5
NJ101-CS	34BagC	47.15	Bag	5
NJ102-CS	1BagA	1.10	Bag	5
NJ102-CS	12BagE	17.15	Bag	5
NJ102-CS	13BagA	17.20	Bag	5
NJ102-CS	14WaxD	19.65	Wax	10
NJ102-CS	17BagC	23.80	Bag	20
NJ102-CS	18BagC	25.80	Bag	20
NJ102-CS	23BagC	33.20	Bag	20
NJ102-CS	25BagC	36.10	Bag	15
NJ102-CS	29BagA	41.20	Bag	55
NJ104-CS	2BagC	1.70	Bag	20
NJ104-CS	5BagD	5.75	Bag	25
NJ104-CS	5WaxB	6.00	Wax	20
NJ104-CS	8BagB	9.75	Bag	25
NJ104-CS	9BagD	12.25	Bag	25
NJ104-CS	12BagE	16.95	Bag	5
NJ104-CS	13BagA	17.10	Bag	10
NJ104-CS	14BagB	18.75	Bag	3
NJ104-CS	17BagA	22.10	Bag	30
NJ104-CS	20BagA	25.10	Bag	10
NJ104-CS	21WaxA	26.45	Wax	10
NJ104-CS	22BagA	27.10	Bag	30
NJ104-CS	23BagB	28.35	Bag	10

NJ104-CS	24BagD	30.45	Bag	15
NJ104-CS	30BagC	39.20	Bag	40
NJ104-CS	32WaxE	42.45	Wax	10
NJ106-CS	14BagC	19.55	Bag	15
NJ106-CS	14BagE	19.95	Bag	15
NJ106-CS	16WaxD	22.90	Wax	30
NJ106-CS	23WaxA	32.80	Wax	30
NJ106-CS	25WaxB	35.80	Wax	30
NJ106-CS	26BagC	37.80	Bag	20
NJ106-CS	27WaxA	38.30	Wax	30
NJ106-CS	28BagA	39.70	Bag	10
NJ106-CS	29WaxA	41.20	Wax	20
NJ106-CS	30WaxC	43.40	Wax	20
NJ106-CS	30WaxE	43.85	Wax	20
NJ106-CS	31WaxB	44.60	Wax	25
NJ106-CS	31WaxD	45.40	Wax	15
NJ106-CS	33BagB	47.35	Bag	15
NJ106-CS	33WaxA	47.50	Wax	10
NJ106-CS	33WaxC	48.00	Wax	25
NJ106-CSb	2BagB	1.95	Bag	20
RS-CS	11WaxA	12.40	Wax	20
RS-CS	14WaxA	17.50	Wax	20
RS-CS	15BagA	18.30	Bag	5



12 APPENDIX 5 STAGE 2 ONSHORE VIBROCORE RECORDING

VC05

Depth mbSB	Sediment description	BGS Unit
0.00 to 0.17	10YR 4/3 Brown silty sandy GRAVEL. Poorly sorted. Wet. Frequent broken molluscs including <i>Pecten</i> sp. Gravel is predominantly flint up to 50mm diameter, subrounded to subangular. Angled, disturbed by coring boundary.	SS
0.17 to 0.35	7.5YR 4/3 Brown sandy CLAY and 10YR 4/2 Dark greyish brown silty gravelly SAND. Occasional broken molluscs. Wet. Erosive abrupt boundary	SS
0.35 to 1.81	7.5YR 4/3 Brown gravelly sandy CLAY. Stiff. Gravel is chalk, red sandstone and limestone.	IBCT/BB

VC06

Depth mbSB	Sediment description	BGS Unit
0 to 0.10	10YR 4/4 Dark yellowish brown sandy GRAVEL. Sand is fine to coarse (predominantly medium) grained. Gravel is predominantly subrounded to subangular flint up to 80mm diameter. Frequent broken bivalve molluscs. Disturbed boundary	SS
0.10 to 1.53	10YR 3/2 Very dark greyish brown sandy gravelly CLAY. Very stiff. Frequent subrounded to angular chalk up to 15mm diameter, occasional small red sandstone, coal, siltstone and limestone. Molluscan burrow at 0.35m	IBCT/BB

VC06C

Depth mbSB	Sediment description	BGS Unit
0.00 to 0.17	10YR 4/3 Brown sandy GRAVEL. Sand is fine to coarse (predominantly medium) grained. Gravel is predominantly subrounded to subangular flint up to 80mm diameter. Occasional broken bivalve molluscs. Abrupt boundary	SS
0.17 to 0.67	10YR 4/1 Dark grey gravelly sandy CLAY. Frequent subrounded to subangular chalk up to 15mm diameter, occasional small red sandstone, coal and broken molluscs.	IBCT/BB

Depth mbSB	Sediment description	BGS Unit
0.00 to 0.35	10YR 4/2 Dark greyish brown silty gravelly SAND. Gravel is predominantly subrounded to subangular flint up to 35mm diameter. Moderate broken molluscs and black organic spots up to 20mm diameter. Boundary is clear, 0mm and erosive.	SS
0.35 to 1.85	10YR 3/2 Very dark greyish brown gravelly sandy silty CLAY. Very stiff. Gravel is predominantly poorly sorted subrounded to subangular chalk up to 8mm diameter, occasional flint up to 35mm diameter and occasional red sandstone up to 5mm diameter. From 0.97 to 1.41m a large angled 45degrees band of degraded angular grey siltstone in a silt/clay matrix.	IBCT/BB

VC31

Depth mbSB	Sediment description	BGS Unit
0.00 to 5.15	2.5Y 5/4 Light brown olive SAND. Colour is variable due to core drying out and is a darker grey colour where still wet. Sand is fine to coarse grained. Sorted. Whole bivalves at 0.83 and 3.65m (?horse mussel). Very frequent broken molluscs throughout (c .10 to 20% of the sediment).	SS

VC32A

Depth mbSB	Sediment description	BGS Unit
0.00 to 0.58	2.5Y 4/4 Olive brown SAND. Occasional subangular brown sandstone up to 25mm diameter. Frequent broken molluscs up to 4mm diameter. Sand is fine to medium grained. Well sorted. Very diffuse boundary.	SS
0.58 to 1.21	2.5Y 4/3 Olive brown SAND. Drying has caused colour changes and where still wet the colour is darker grey/black. Sand is fine to medium grained. Frequent broken molluscs up to 3mm diameter. Becomes shellier/gravellier at 1.13 to 1.21m including an oxidised/onion weathered 55mm clay pebble. 1mm abrupt boundary	SS
1.21 to 1.49	5Y 4/1 Dark grey gravelly silty clayey SAND. Gravel is angular and bedded grey siltstone/claystone. Sand is fine grained	IBCT/BB

Depth mbSB	Sediment description	BGS Unit
0.00 to 0.56	2.5Y 6/3 Light yellowish brown SAND. Variable colour due to cores drying out. Where still waterlogged the sediment is a 2.5Y 4/1 grey colour. Sand is fine to medium grained and well sorted. No structure. Frequent sand sized (up to 1mm) broken molluscs, occasionally whole (at 0.20m).	SS

VC72

Depth mbSB	Sediment description	BGS Unit
0.00 to 0.70	2.5Y 7/3 Pale yellow SAND. Frequent broken molluscs up to 5mm diameter (up to 50% of sediment) Sand is medium grained. Clear boundary	SS
0.70 to 1.32	2.5Y 6/3 Light yellowish brown gravelly SAND. Gravel is predominantly subrounded to subangular flint up to 60mm diameter with occasional chalk, quartz, igneous and metamorphic rocks. Frequent broken molluscs including <i>Gibbula</i> sp. Boundary 100mm and burrowed	SS
1.32 to 2.82	10YR 3/3 Dark brown gravelly sand CLAY. Very Stiff. Small 8mm diameter molluscan burrow at 1.34m infilled with overlying sediment. At 1.70m 10mm diameter molluscan burrow. From 1.32 to 1.52m very frequent subrounded to subangular grey/black shale up to 8mm diameter. From 1.52m to 2.02m frequent subrounded to subangular shale (up to 10mm diameter), chalk (up to 12mm diameter and red sandstone (up to 6mm diameter)	IBCT/BB

Depth mbSB	Sediment description	BGS Unit
0.00 to 0.56	2.5Y 5/4 Light olive brown SAND. Frequent broken molluscs up to 3mm diameter. Disturbed/clayey from 0.50 to 0.56m. One large 80mm diameter subrounded ?granite cobble. Fining upwards. Well sorted from 0.00 to 0.48.	SS
0.56 to	10YR 3/2 Very dark greyish brown gravelly slightly sandy CLAY. Stiff. Gravel is predominantly subrounded to subangular chalk up to 25mm diameter and occasional small pieces of coal and broken molluscs. Molluscan burrows at 0.83m 25mm diameter and infilled with overlying	
1.46	sediment.	IBCT/BB

Т

Depth mbSB	Sediment description	BGS Unit
0.00 to 0.43	10YR 6/4 Light yellowish brown gravelly SAND. Very frequent broken bivalve molluscs. Gravel is predominantly subrounded to subangular flint with occasional chalk and granite. Occasional echinoid spines. 40mm boundary, disturbed	SS
0.43 to 1.83	5Y 4/1 Dark grey gravelly CLAY. Stiff. Gravel is very frequent subrounded to subangular chalk up to 60mm diameter comprising between 40 and 60% of the sediment. Frequent small subrounded to rounded grey shale and coal up to 4mm diameter.	IBCT/BB

VC79

Depth mbSB	Sediment description	BGS Unit
0.00 to 0.08	10 YR 5/3 Brown gravelly SAND. Very frequent broken molluscs up to 3mm diameter, occasionally whole bivalves. 10mm boundary.	SS
0.08 to 0.24m	White Chalk. 25mm diameter molluscan burrow from 0.08 to 0.24m infilled with the overlying sediment. Edges of the burrow are stained green and orange.	UCk

Depth mbSB	Sediment description	BGS Unit
0.00 to 0.15	2.5Y 5/4 Light olive brown SAND. Frequent gravel including subrounded to subangular flint and chalk up to 12mm diameter. Very frequent broken molluscs (up to 60% of the sediment). Sand is fine, medium and predominantly coarse grained. 10mm erosive boundary	SS
0.15 to 0.25	White Chalk. Hard. Blocky. Contains small 8mm diameter molluscan burrows infilled with the overlying sediment	UCk

Depth mbSB	Sediment description	BGS Unit
0.00 to 1.25	10YR 4/2 Dark greyish brown silty sandy GRAVEL. Very frequent whole and broken bivalve molluscs including <i>Mytilus edulis</i> , Pecten sp. and occasional serpulid worm tubes. Colour varies due to drying out of core. Frequent subrounded and subangular flint and occasional metamorphic rocks up to 75mm diameter. 3mm boundary, slightly burrowed.	SS
1.25 to 1.60	White Chalk. Soft "Putty Chalk" from 1.25 to 1.28. Wet.	UCk

VC82

Depth mbSB	Sediment description	BGS Unit
0.00 to 1.59	10YR 5/4 Yellowish brown gravelly SAND/ sandy GRAVEL. Gravel is predominantly subrounded to subangular flint up to 15mm diameter and occasional quartz. Very frequent broken and occasionally whole molluscs including <i>Gibbula</i> sp. from 0.95 to 1.45m. Bands of gravellier and shellier sediment. Slightly darker and a slightly silty content from 0.00 to 0.33m Sand is fine to very coarse grained. Boundary is disturbed, 100mm	SS
1.59 to 3.19	White Chalk. Slightly wet/soft at its upper surface	UCk

Depth mbSB	Sediment description	BGS Unit
0.00 to 0.11	10YR 4/3 Brown SAND. Sand is medium to coarse grained. Moderate rounded to subrounded flint up to 10mm diameter. Boundary has been burrowed.	SS
0.11 to 1.88	White Chalk. From 0.11 to 0.16m Soft "Putty Chalk" with a slightly greenish/yellow tinge. Burrow from 0.11 to 0.17m infilled with the overlying sediment.	UCk

VC84A

Depth mbSB	Sediment description	BGS Unit
0 to 0.05	2.5Y 4/4 Olive brown gravelly SAND. Loose. Poorly sorted. Occasional molluscs predominantly broken bivalves up to 10mm diameter. Gravel is rounded to subangular flint up to 55mm diameter. Disturbed 50mm boundary.	SS
0.05 to 2.92	White Chalk. Slightly discoloured yellow from 0.15 to 0.17m. Blocky.	UCk

VC85A

Depth mbSB	Sediment description	BGS Unit
0 to 0.75	Beige SAND. Sand is medium to coarse grained. Very frequent broken molluscs up to 3mm diameter. Well sorted. 5mm boundary	SS
0.75 to 2.50	Beige sandy GRAVEL. Sand is medium to coarse grained. Very frequent broken and occasionally whole (<i>Mytilus</i> <i>edulis</i> at 1.61m) molluscs. Sorted. Gravel is predominantly subrounded to angular flint and occasional quartz up to 5mm in diameter. Very diffuse 200mm boundary.	SS
2.50 to 3.02	2.5Y 4/2 Dark greyish brown sandy silty CLAY. Slightly oxidised brown/grey. Burrow at 2.75m 20mm diameter. Very diffuse 300mm boundary.	uBCT/HA
3.02 to 5.93	2.5Y 5/1 Grey sandy silty CLAY. Wet, soft. Horizontally interbedded. Sand is fine grained and occasionally in beds of up to 80mm in thickness. Frequent molluscs especially from 4.67 to 5.02m.	uBCT/HA

Depth mbSB	Sediment description	BGS Unit
0.00 to 1.56	10YR 4/3 Brown sandy GRAVEL. Sand is fine to coarse grained. Gravel is predominantly subrounded to subangular flint, quartz, sandstone up to 60mm diameter. Poorly sorted. Colour varies dependent on how dried out the core sample is. Very frequent broken and occasionally whole molluscs mostly bivalves including <i>Pecten sp.</i> . Boundary clear/erosive and angled.	SS
1.56 to 4.52	7.5YR 3/3 Dark brown gravelly sandy CLAY. Gravel is subrounded to subangular chalk, red sandstone and flint up to 12mm diameter. Stiff. Slightly dark greyish brown 10YR 3/2 from 1.56 to 1.81 probably due to drying out. Molluscan burrows from 1.56 to 1.70 up to 12mm diameter infilled with overlying sediment.	IBCT/BB

VC87A

Depth mbSB	Sediment description	BGS Unit
0.00 to 0.55	10 YR 4/3 Brown sandy GRAVEL. Frequent broken molluscs up to 10mm diameter. Gravel is predominantly subrounded to subangular flint up to 50mm diameter and occasional quartz. Sand is fine to coarse grained. Boundary 4mm but disturbed by coring	SS
0.55 to 2.19	10 YR 3/2 Very dark greyish brown gravelly sandy CLAY. Gravel is predominantly subrounded chalk up to 10mm diameter. Poorly sorted. Occasional to moderate small coal and shale up to 5mm diameter. One diagonal molluscan burrow infilled with the overlying sediment at 0.69m	IBCT/BB

VC88

Depth mbSB	Sediment description	BGS Unit
0 to 1.20	10YR 5/4 Yellowish Brown SAND. Sand is medium to coarse grained. Well sorted. Very frequent broken shell including <i>Pecten</i> sp. up to 50mm diameter comprising c.50% of the sediment. Diffuse 150mm boundary.	SS
1.20 to 3.52	10YR 6/3 pale brown sandy GRAVEL. Gravel is predominantly subrounded to subangular flint with quartz up to 35mm diameter. Occasional bryozoans noted on the surface of the flint. Very frequent molluscs including <i>Gibbula</i> sp. and Tellina/Scrobicularia type bivalves. Molluscs comprise c. 50% of the sediment.	SS

Depth mbSB	Sediment description	BGS Unit
0.00 to 0.10	0 0 0	
0.10 to 1.75	10YR 3/2 Very dark greyish brown gravelly sandy CLAY. Stiff. Gravel is predominantly subrounded to angular chalk (up to 6mm diameter) and siltstone (up to 12mm diameter)	IBCT/BB

Depth mbSB	Sediment description	BGS Unit		
0.00 to 0.10	2.5Y 3/2 Very dark greyish brown silty SAND. Sand is fine to medium grained. Large 100mm diameter subangular grey limestone cobble. Disturbed (by coring/cobble) boundary	SS		
0.1 to 0.70	2.5Y 4/1 Dark grey clayey silty SAND. Soft/Wet. Sand is fine grained. Frequent dark/black organic spots/patches.	uBCT/HA		
0.70 to 1.42	2.5Y 4/1 Dark grey clayey sandy SILT. Occasional dark/black organic spots/patches. Sand is fine grained. Some feint horizontal bedding of sand visible (0.70 to 0.80m). Gravelly bed from 0.8 to 0.88m including flint up to 10mm diameter and bivalve molluscs. Moderate molluscan content, more frequent from 1.00 to 1.15m. <i>Cerastoderma edule</i> at 1.03m. Boundary lost	uBCT/HA		
1.42 to 2.57	2.5Y 4/1 Dark grey sandy CLAY. Stiff, drier than above. Occasional small fine horizontally bedded fine to medium grained sand bands from 2.05 to 2.10m, some of which have oxidised to a slightly orange colour, but are mostly light grey and less than 1mm in thickness. Has a slightly			
2.57 to 2.81	blocky structure. 10mm boundary2.5Y 5/2 Greyish brown silty SAND/sandy SILT.Horizontally bedded with silt/sand beds and occasionalorganic bands with recognisable plant remains. At 2.81m a10mm thick bed of predominantly gastropod molluscs.5mm boundary			
2.81 to 2.95	2.5Y 3/1 Very dark grey sandy GRAVEL. Sand is fine to very coarse grained. Gravel is subrounded to subangular			

Depth mbSB	Sediment description	BGS Unit		
0.00 to 0.30	10YR 5/3 Brown SAND. Sand is medium grained. Occasional subrounded to subangular flint up to 35mm diameter. Moderate broken molluscs. 2mm boundary			
0.30 to 0.83				
0.83 to 0.97	2.5Y 5/4 Light olive brown SAND. Sand is medium grained. Contains occasional broken molluscs. Clear boundary	uBCT/HA		
0.97 to 1.83m	10YR 4/1 Dark grey CLAY. Horizontally bedded with fine sand layers up to 1mm in thickness. Occasional organic remains.	uBCT/HA		

Т

Depth mbSB	Sediment description	BGS Unit
0.00 to 0.32	10YR 3/2 Very dark greyish brown gravelly SAND. Sand is fine to coarse grained. Gravel is predominantly subrounded to subangular flint up to 100mm diameter with occasionally bryozoans adhering (at 0.25m). Frequent bivalve molluscs. Burrowed/disturbed boundary.	SS
0.32 to 1.41m	2.5Y 3/1 Very dark grey slightly sandy silty CLAY. Sand is fine grained. Stiff. Plastic. Blue (gleying) streaks. Occasional bivalve molluscs at 1.04m	uBCT/HA

VC96

Depth mbSB	Sediment description	BGS Unit		
0.00 to 0.14	Dark grey SAND. Sand is fine to medium grained. Wet. Occasional cobbles of subrounded to subangular flint up to 80mm diameter. Occasional small broken molluscs and dark/black organic spots.			
0.14 to 2.10	2.5Y 4/1 Grey SAND. Horizontally interbedded silt/clay and organic beds. Occasional whole bivalve mollusc including Scrobicularia/Tellina type at 2.10m			
2.10 to 5.90	2.5Y 6/3 Dark yellowish brown gravelly SAND. Very frequent (c. 40% of total sediment) molluscs mostly broken but occasionally whole (including <i>Cerastoderma edule</i>).Very frequent molluscs from 5.63 to 5.78m (c. 80% of the sediment). Occasional greyer patches of sand from 2.10 to 2.97and 5.45 to 5.60m. From 5.60 to 5.63m a bed of 2.5Y 4/1 Dark grey silty organic CLAY.	SS		

VC104A

Depth mbSB	Sediment description	BGS Unit		
0.00 to 0.20	2.5Y 4/2 Dark greyish brown slightly gravelly silty SAND. Wet. Occasional broken shell. Gravel is subrounded to subangular flint up to 10mm diameter. 20mm boundary.	SS		
0.20 to 0.37	10YR 4/1 Dark greyish brown sandy GRAVEL. Gravel is predominantly flint. Sorted. Coarsening upwards.	SS		
0.37 to 0.48				
0.48 to 0.57	GAP. Boundary lost (geotechnically sampled)			
0.57 to 3.53	10YR 4/2 Dark greyish brown clayey SAND. Sand is fine, well sorted. Occasional small organic black spot up to 4mm diameter.	uBCT/HA		

VC116A

Depth mbSB	Sediment description	BGS Unit		
0.00 to 0.04	10YR 4/4 Dark yellowish brown gravelly SAND/ sandy GRAVEL. Gravel is flint subrounded to subangular up to 35mm diameter. Moderate to frequent broken molluscs. Sand is fine to coarse grained. Wet. Clear, erosive and burrowed boundary			
0.04 to 1.21	7.5YR 3/2 Dark brown gravelly CLAY. Very stiff. Gravel is poorly sorted rounded to angular flint, chalk and occasional granite up to 5mm diameter. At 0.17m a molluscan burrow, 25mm diameter infilled with the overlying sediment.			
1.21 to 1.46	GAP (geotechnically sampled)			
1.46 to 2.95	7.5YR 3/2 Dark brown silty CLAY. Stiff. Some feint horizontally bedded structure with a foliated look. Some fine sand and lighter streaks present from 1.45m onwards. Darker ?organic streaks (less than 1mm in thickness).	IBCT/BB		

Key to BGS unit abbreviations:

Chalk (UCk) Yarmouth Roads (YR) Swarte Bank (SWB) Egmond Ground (EG) Bolders Bank and Lower Botney Cut (BB/IBCT) Upper Botney Cut and Holocene Alluvium (uBCT/HA) Seabed Sediment (SS)



13 APPENDIX 6 VIBROCORE SAMPLES RETAINED FOR STAGE 3 WORK

Vibrocore	Easting	Northing	Sections retained(mbSB)
VC05	420097	5962220	0.00 to 0.50, 1.51 to 5.93
VC06	419114	5962100	
VC06C	419117	5962101	
VC08	417206	5961545	0.97 to 1.41
VC31	395169	5956105	4.77 to 5.15
VC32A	394575	5955906	0.00 to 1.49
VC34	393749	5955607	
VC72	360723	5943524	
VC77	356885	5942814	
VC78	356479	5942741	
VC79	355820	5942458	
VC80	355919	5942734	
VC81	354998	5942776	
VC82	354980	5942041	
VC83	355392	5942244	
VC84A	355429	5942762	
VC85A	354513	5942798	
VC86	354248	5942805	
VC87A	354277	5941772	
VC88	354532	5941844	
VC90	352948	5941400	
VC91	352662	5941593	0.00 to 2.95
VC92	352049	5941136	0.00 to 1.83
VC93	351578	5940997	0.00 to 1.41
VC96	350544	5940709	0.00 to 2.43, 5.43 to 5.90
VC104A	350145	5942010	0.00 to 1.93
VC116	342253	5933412	2.45 to 2.95



14 APPENDIX 7 PRELIMINARY BOREHOLE LOGS

DEPT (m)	^H SOIL DESCRIPTION	SOIL SAMPLE OR PROFILE TEST NO	Undrained Shear Strength s _u [kPa] 0 400 800 1200 1600 200	Cone Resistance q _c [MPa] 00 0 60 120 0	Moisture Content w [%] 40 80 5	Unit Weight γ[kN/m ³] 5 15 25	[tonnes]	Mud Pressure [kg/cm ²] 0 20
0	0.0 m to 1.3 m - loose to medium dense SAND							
2	1.3 m to 12.3 m - Stiff to very stiff dark brown slightly sandy slightly gravelly CLAY. Gravel is fine to coarse subangular to subrounded of mixed	-10 (RC 1 RC 2						
3	lithologies including chalk and flint - at 1.3 m - a subrounded cobble of	RC 3						
4	sandstone	• • • • • • • • • • • • • • • • • • •						
5		• •						
6		RC 5						
8		• • RC 6 • CPT 3						
9		• • RC 7						
10		• • • • • • • • • • • • • • • • • • •						
11		°₽₹ ₫	•	C				
12	- from 10.2 m to 12.3 m - becoming blocky and foliated slightly sandy clay, with traces of fine to medium subangular	• RC 9						
13	to subrounded gravel of mixed				× ¦			
14	- from 11.7 m to 11.9 m - medium bed of slightly silty gravelly fine to medium sand. Gravel is fine to medium	• • CPT 5 RC 10						
15	subangular to subrounded of mixed lithologies 12.3 m to 40.0 m - Medium dense to	RC 11						
16	very dense olive brown fine to medium SAND, with very widely to closely	CPT 6 RC 12						
17	spaced thin to thick laminae of black organic particles, traces of coarse sand-sized to coarse gravel-sized shell							
18	fragments and ocassionally subangular to subrounded cobbles - from 12.3 m to 13.2 m - becoming							
19	slightly silty - at 13.2 m - very thin bed of	RC 15						
20	subangular to subrounded fine to coarse gravel. Gravel is of mixed litholgies - from 13.2 m to 14.6 m - thick bed of	RC 16 CPT 8			× ; × ;			
21	hard to very hard dark brown sandy slightly gravelly clay	RC 17						
22	· · · · · · · · · · · · · · · · · · ·	RC 18			*			
23		CPT 9 RC 19						
24		RC 20			* ! !			
26		RC 21			*			
27		BC 22 CP1 10						
28	- from 27.3 m to 27.4 m - thin bed of sandy fine to coarse gravel, subangular	• • • • • • • • • • • • • • • • • • •			**			
29	to subrounded and of mixed lithology	• • • • • • • • • • • • • • • • • • •						
30		• • • • • RC 25			×			
	LLING REMARKS: e of Mud: Guar-Gum/Seawater	KEY FOR UNDRAINE	D SHEAR STRENGTH: e) ■ su (L	aboratory Vane)		R MOISTURE CON Moisture Content		
	ations: ⁽¹⁾ AC1a-CS	 ▼ s_u (Pocket I ◆ s_u (Fall Cor 		Indrained Triaxial) n situ Vane)		R UNIT WEIGHT: Natural Dry Unit V	/eight(γd)	
Soil F	(2) AC1a-BH Profile is represented by location AC1a-CS	¥ s _u (Remoul	ded In situ Vane) Estim (N _{kt} =	nated from CPT data = 15 - 20)	-	Natural Wet Unit \	Veight (γ_w)	
	TYPE OF BIT: ⁽¹⁾ PCD Bit ⁽²⁾ 5 Wing Drag Bit	COORDINATES : 41802	o remoulded tests. ea Offshore Wind Farm Site Investigal 1.2 mE 5968359.9 mN ⁽¹⁾ WATER I 4.7 mE 5968359.4 mN ⁽²⁾			12/11/2012 - 15/1 25/06/2012 - 27/06		
GeoDin-Sur	stem 7 5/17/11/2012 13:47:54							

DEP (m)		SOIL SAMPLE OR PROFILE TEST NO	Undrained Shear Strength s _u [kPa] 0 400 800 1200 1600 20	Resistance q₀ [MPa]	Moisture Content w [%] 40 80	Unit Weight γ [kN/m ³] 5 15 25 0	[tonnes]	Mud Pressure [kg/cm ²] 0 20
30 31	12.3 m to 40.0 m - Medium dense to very dense olive brown fine to medium	RC 25 RC 26						I
	SAND, with very widely to closely spaced thin to thick laminae of black organic particles, traces of coarse	RC 27			× ¦			
32	sand-sized to coarse gravel-sized shell fragments and ocassionally subangular	••••••••••••••••••••••••••••••••••••••					P	
33	to subrounded cobbles - from 27.4 m to 37.1 m - becoming	• • • RC 29						
34	slightly gravelly slightly silty, with many coarse sand-sized to coarse						1 1 1	
35	gravel-sized shell fragments	• 0 • 0 • 0 • 0						
36	- from 34.2 m to 37.1 m - becoming loose to medium dense very gravelly fine to medium sand	• O RC 31						
37		• • • • RC 32				¦ □		1 - 1 - 1
38		RC 33					1	
39		CP1 14 RC 34			× ¦			
40								
41	40.0 m to 78.9 m - Dense to very dense dark olive grey slightly silty fine to medium SAND, with closely to very	15 CPT					۲.	
42	widely spaced thin to thick laminae of black organic particles and traces of	16* RC 36		R R R	×			
43	coarse sand-sized to coarse gravel-sized shell fragments	RC 37 CPT 17*						
44					×			
45		RC 38 CPT 18" RC 39	2					
		CPT 19*						
46	- from 43.4 m to 48.6 m - becoming silty fine sand							
47		CPT 20*					1	
48								
49		21 RC 42						
50		CPT 22*			×	┍╌┼╍┲┼╌┤╽		
51	- from 48.6 m to 54.0 m - becoming	RC 43			I			
52	medium dense to dense silty to very silty fine sand							
53		2RC 44		 X				
54		RC 45						
55		CPT 24						
56		RC 46						
57		••• -•• 						
58	- from 54.0 m to 63.0 m - becoming							
59	silty fine to medium sand with widely spaced thin to thick laminae of clay and	CPT 27* RC 48						
60	few coarse gravel-sized pockets of clay - at 55.1 m - with a coarse subrounded gravel of mudstone	CPT 28* RC 49			×			
DR	ILLING REMARKS: e of Mud: Guar-Gum/Seawater		ED SHEAR STRENGTH:	Laboratory Vane)	KEY F			
Not				Undrained Triaxial)	KEY F	Moisture Content (v DR UNIT WEIGHT:	v)	
Loc	ations: ⁽¹⁾ AC1a-CS ⁽²⁾ AC1a-BH	♦ s _u (Fall Co		In situ Vane)		Natural Dry Unit We Natural Wet Unit We		
Soil * In	Profile is represented by location AC1a-CS dicates F8 cone used		lded In situ Vane) _ '곷 / '옷 (N _{kt}	mated from CPT data = 15 - 20)				
Į	TYPE OF BIT: ⁽¹⁾ PCD Bit ⁽²⁾ 5 Wing Drag Bit	LOCATION : Horns COORDINATES : 41802	ea Offshore Wind Farm Site Investig 21.2 mE 5968359.9 mN ⁽¹⁾ WATER 24.7 mE 5968359.4 mN ⁽²⁾		DATE	: 12/11/2012 - 15/11/ : 25/06/2012 - 27/06/2		

BOREHOLE AC1a-CS (PRELIMINARY) SHEET 2 OF 3

	EPTH SOIL DESCRIPTION	SOIL SAMPLE OR PROFILE TEST NO	Undrained Shear Strength su [kPa] 0 400 800 1200 1600	Cone Resistance q _c [MPa] 2000 0 60 120	Moisture Content w [%] 0 40 80	Unit Weight γ [kN/m ³] 5 15 25		Mud Pressure [kg/cm ²] 0 20
60 61	40.0 m to 78.9 m - Dense to very dense dark olive grey slightly silty fine to medium SAND, with closely to very	CPC 49						
62	widely spaced thin to thick laminae of black organic particles and traces of coarse sand-sized to coarse gravel-sized shell fragments							
63 64	- from 63.0 m to 64.1 m - thick bed of	GPT 34℃ 51 24℃ 52	Y III					
65	very stiff dark grey slightly sandy clay	33° 53	*					Ŀ
66		CPT 35* CPT						
67		36* 980 54 37*						
68	- from 64.1 m to 72.4 m - becoming very dense	GR2 55 38° CPT 39° CPT 40°						
69 70		40° CPT 41° RC 57						
71		980 58 42*			0			
72		CPT 43* RC 59 CPT 44*						
73		RC 60 CPT 45*						1 1 1 1
74 75		RC 61	a					
76	- from 72.4 m to 78.9 m - becoming silty fine to medium sand, with extremely	RC 62	N/P					
77	closely spaced to closely spaced thin to thick laminae of silt and traces of mica crystals	47* RC 63						
78		CPT 48° R) 64						
79 80	√78.9 m to 81.4 m - Dense to very dense dark greyish brown slightly silty fine to medium SAND, with few coarse	CPT 4RC 65						
81	sand-sized to coarse gravel-sized shell fragments - at 80.4 m - end of borehole AC1a-CS	GPT 50*						
82	- at 81.4 m - end of borehole AQ a-b							
83					I I I I I I I I			
84 85								
86								
87								
88								
89 90								
	DRILLING REMARKS:	(ED SHEAR STRENGTH:	(Laboratory Vane)		OR MOISTURE COM		
	Notes:			(Undrained Triaxial)	KEY F	Moisture Content	(w)	
ι	Locations: ⁽¹⁾ AC1a-CS ⁽²⁾ AC1a-BH	♦ s _u (Fall Co	one) + s _u	(In situ Vane)		Natural Dry Unit V Natural Wet Unit ^v		
s *	Soil Profile is represented by location AC1a-CS Indicates F8 cone used	Half full symbols refer	ulded In situ Vane) · 注 / 文 (N to remoulded tests.					
	TYPE OF BIT: (1) PCD Bit (2) 5 Wing Drag Bit	COORDINATES : 4180	sea Offshore Wind Farm Site Investi 21.2 mE 5968359.9 mN ⁽¹⁾ WATE 24.7 mE 5968359.4 mN ⁽²⁾			: 12/11/2012 - 15/1 : 25/06/2012 - 27/0		
GeOD	Din-System 7.5//17/11/2012 13:47:55	BOREHOLE A	C1a-CS (PRELIMINA	RY) SHEET 3	OF 3			

OREHOLE	AC1a-CS	(PRELIMINARY)	SHEET 3 OF 3

DEPTH (m)	SOIL DESCRIPTION		SAMPLE OR TEST NO	St	ined Shear rength I [kPa] 0 1200 1600 :	Cone Resistance qc [MPa] 2000 0 60 120	Moisture Content w [%] 0 40 80	Unit Weight γ [kN/m ³] 5 15 25		Mud Pressure [kg/cm ²] 0 20
0	0.00 m to 0.57 m - Medium dense to dense dark olive brown silty gravelly fine		RC 1				××	¦□□		
1	to medium SAND, with medium to coarse gravel-sized pockets of clay.		CPT 1				X			
2	Gravel is fine to coarse subangular to subrounded of mixed lithologies		o RC 2							
3	- from 0.0 m to 0.1 m - very loose to loose sand		• RC 3	5						
4	0.57 m to 11.90 m - Very stiff to hard dark brown to very dark greyish brown		OCPT 2	Ž			X			
5	slightly sandy slightly gravelly CLAY, with traces of coarse sand-sized to fine		RC 4				XXX			
	gravel-sized shell fragments - at 4.4 m - with a cobble		• RC 5				X			
6			•							
7	- from 7.5 m - becoming very stiff to		CPT 3 RC 6							
8	hard with medium to widely spaced thin to medium beds of medium dense sand		• RC 7							
9			ORC 8							
10			CPT 4	1						
11			• RC 9	V V	-					
	form 11.0 m harming on the		•							
12	- from 11.8 m - becoming very sandy 11.9 m to 48.9 m - Dense to very dense dark olive brown to dark grevish brown		RC 10		-					
13	slightly silty SAND - from 12.3 m to 14.0 m - with a thick		CPT 5		_		X <u>I I</u>			
14	bed of hard to very hard very dark greysih brown slightly sandy slightly		о С РТ 6				X			
15	gravelly clay - at 12.8 m - with a cobble		RC 12							
16			CPT 7* RC 13		24					
17										
ΠΙ			CPT 8* RC 4							
18	- from 18.3 m - becoming olive grey		C 15							
19		l d	सन् 16							
20		2					X i			
21		Ψ	RC 17 RC 18							
22	X.									
23			CPT 10							
24			RC 20							1
25			RC 21							
26			RC 22							
27	- at 27.0 m - end of borehole AC1b-CS		СРТ							
28			CPT							
29			13*							
30			CPT 14*							
DRILL	LING REMARKS: of Mud: Guar-Gum/Seawater									
Notes		•	s _u (Torvai s _u (Pocket	Penetrometer)		(Laboratory Vane) (Undrained Triaxial)	KEYI	Moisture Content FOR UNIT WEIGHT:	(w)	
Locat	tions: ⁽¹⁾ AC1b-CS	•	s _u (Fall Co	,		(In situ Vane)		Natural Dry Unit V		
Soil Pr	(2) AC1b-BH rofile is represented by location AC1b-CS	*		Ilded In situ Vane	e) ੋਟੁ∕ੋਣ (N	timated from CPT data kt = 15 - 20)	-	Natural Wet Unit	weight (γ _w)	
	cates F8 cone used	LOCATIO	N : Horn		nd Farm Site Investi					
_fu	TYPE OF BIT: ⁽¹⁾ PCD Bit ⁽²⁾ 5 Wing Drag Bit	COORDIN		93.0 mE 59681 91.6 mE 59681		R DEPTH : 31.5 m LA : 31.0 m LA		: 03/11/2012 - 04/1 : 03/07/2012 - 04/0		
V										
GeODin-Syste	m 7.5//05/11/2012 18:09:52									

BOREHOLE AC1b-CS (PRELIMINARY) SHEET 1 OF 3

DEPTH (m)	SOIL DESCRIPTION		SAMPLE OR TEST NO	Undrained Shear Strength su [kPa] 400 800 1200 1600	Cone Resistance qc [MPa] 2000 0 60 120	Moisture Content w [%] 0 40 80	Unit Weight γ [kN/m ³] 5 15 25		Mud Pressure [kg/cm ²] 0 20
30	11.9 m to 48.9 m - Dense to very dense dark olive brown to dark greyish brown		CPT 14*						
31	slightly silty SAND		CPT 15*						
32									
33			CPT 16*						
34		••••							
35			CPT 17						
			CPT 18*						
36			18*						
37			CPT 19*						
38		· · ·							
39			CPT 20*						1
40					5				
41			CPT 21*			6			
			CPT 22*						
42			22*						
43			CPT 23*						
44									
45			CPT 24*	R-					
46		••••		NA.					
			CPT 25*						
47									
48									
49	- from 48.4 m to 48.9 m - medium bed ∖of very stiff to hard clay		27 27 CPT 28 ⁹ T	~					
50	48.9 m to 81.4 m - Very dense SAND	0	29* ∠29* CPT 30*						
51		φ	CPT 31* CPT						
52	60		32* CPT 33* CPT						
52			CP1 34* CPT 35*						
53			CPT 36*						
54		····	CPT 37* CPT 38*						
55			CPT 38* CPT 39* CPT CPT 40*						
56			CPT 41*						
57			CPT 42* CPT						
			43*						
58			44*						
59			CPT 45*						
60		••••	CPT 46*						
Туре	ING REMARKS: of Mud: Guar-Gum/Seawater	KEY FO	R UNDRAINED S s _u (Torvane)	HEAR STRENGTH:	s _u (Laboratory Vane)	KEY ×	FOR MOISTURE CON Moisture Content		
Notes		•	s _u (Pocket Pene	etrometer)	$s_{\scriptscriptstyle u}$ (Undrained Triaxial)	KEY	FOR UNIT WEIGHT: Natural Dry Unit \	Noight ()	
Locat	ions: ⁽¹⁾ AC1b-CS ⁽²⁾ AC1b-BH	•	s _u (Fall Cone)	+	s _u (In situ Vane) Estimated from CPT data		Natural Dry Unit V Natural Wet Unit		
Soil Pr * Indic	ofile is represented by location AC1b-CS cates F8 cone used	₩ Half full	s _u (Remoulded symbols refer to ren		$(N_{kt} = 15 - 20)$				
f	TYPE OF BIT: ⁽¹⁾ PCD Bit ⁽²⁾ 5 Wing Drag Bit	LOCATION COORDIN/	ATES : 421993.0 r	ffshore Wind Farm Site Inv nE 5968116.8 mN ⁽¹⁾ W/ nE 5968114.3 mN ⁽²⁾			: 03/11/2012 - 04/1 : 03/07/2012 - 04/0		

DEPTH (m)	SOIL DESCRIPTION	SOIL SAMPLE OR PROFILE TEST NO	Undrained Shear Strength su [kPa] 400 800 1200 1600 2000	Cone Resistance q₀ [MPa] 00 60 120 0	Moisture Content w [%] 40 80	Unit Weight γ [kN/m ³] 5 15 25		Mud Pressure [kg/cm ²] 0 20
60	48.9 m to 81.4 m - Very dense SAND	CPT 48*						
61		CPT 49*						
62		CPT 50*						
63		CPT 51* T CPT						
64		52* CPT 53*						
		CPT 54* CPT						
65	- from 65.5 m - becoming dense to very	55*						
66	dense sand	CPT 56*					i	
67		CPT 57*						
68		CPT 58*						
69								
70		CPT 59*						
		СРТ						
71		••••						
72		CPT 61*						
73				3				
74		CPT 62*						
75			2					
		CPT 63*	. AP.					
76		СРТ						
77		64*						
78								
79								
80								
		CPT 67*						
81	- at 81.4 m - end of borehole AC b-Br						1	
82								
83							i	
84								
85								
86								
							1	
87								
88								
89							 	
90								
	LING REMARKS: of Mud: Guar-Gum/Seawater	KEY FOR UNDRAINE ▲ su (Torvane	D SHEAR STRENGTH: a) su (La	aboratory Vane)	KEY FC	R MOISTURE CON Moisture Content		
Note	s:			ndrained Triaxial)		R UNIT WEIGHT:	· · · /	
Loca	tions: ⁽¹⁾ AC1b-CS ⁽²⁾ AC1b-BH	♦ s _u (Fall Cor		i situ Vane)		Natural Dry Unit V Natural Wet Unit V		
Soil P	rofile is represented by location AC1b-CS	* su (Remoulded In situ Vane) ≥/≥ ≥/≥ Estimated from CPT data Half full symbols refer to remoulded tests.						
* Indi	TYPE OF BIT: ⁽¹⁾ PCD Bit (2) 5 Wing Drag Bit	LOCATION : Horns COORDINATES : 42199	o remoulded tests. ea Offshore Wind Farm Site Investigati 3.0 mE 5968116.8 mN ⁽¹⁾ WATER D 1.6 mE 5968114.3 mN ⁽²⁾	ion DEPTH : 31.5 m LAT ⁽¹⁾ : 31.0 m LAT ⁽²⁾	DATE	: 03/11/2012 - 04/1 : 03/07/2012 - 04/0		
GeoDin-Syst	em 7.5/05/11/2012 18:09:53							

DEPTH (m)	SOIL DESCRIPTION	SOIL SAMPLE OR PROFILE TEST NO	Undrained Shear Strength su [kPa] 0 400 800 1200 1600	Resistance qc [MPa]	Moisture Content w [%] 40 80 5	Unit Weight γ [kN/m ³] 15 25		Mud Pressure [kg/cm ²] 0 20
0 1 2 3 4 5 6 7 8 9 10	0.0 m to 0.1 m - Medium dense to dense SAND - at 0.0 m - with a cobble 0.1 m to 16.4 m - Very stiff to hard dark brown to very dark greyish brown slightly sandy slightly gravelly CLAY. Gravel is fine to medium angular to subrounded of mixed lithologies including flint and chalk - at 0.1 m - with a cobble	RC 1 RC 1 RC 3 RC 3 RC 4 CPT 2 RC 5 RC 6 CPT 3 RC 7 RC 7 RC 6 CPT 3 RC 7 RC 7 RC 7 RC 7 RC 7 RC 7 RC 7 RC 4 CPT 2 RC 7 RC						
12 13 14 15		RC 9 CPT 5 RC 10 CPT 5 RC 10 CPT 7 RC 12						
17 18 19 20 21 22	16.35 m to 23.05 m - Thinly interlaminated to medium interbedded very stiff to very hard very dark grey to very dark greyish brown slightly sandy CLAY and medium dense to very dense fine to medium SAND, with traces of medium subrounded gravel and fine to medium gravel-sized shell fragments	CPT 9" RC 13 RC 14 CPT 10" RC 15 RC 15 CPT 11" RC 16						
23 24 25 26 27 28 29 30	23.05 m to 63.25 m - very dense dark greenish grey fine SAND, with extremely closely spaced to widely spaced thin laminae to very thin beds of clay and fine to coarse gravel-sized shell fragments and with traces of wood fragments	CPT 12* 12* 12* 12* RC 17 RC						
DRIL Type Notes Loca	tions: ⁽¹⁾ AC2-CS ⁽²⁾ AC2-BH rofile is represented by location AC2-CS	 ▲ s_u (Torvan ▼ s_u (Pocket ◆ s_u (Fall Co 	Penetrometer) • ne) + Ided In situ Vane) $\frac{1}{2}/\frac{1}{2}$	s _u (Laboratory Vane) s _u (Undrained Triaxial) s _u (In situ Vane) Estimated from CPT data (N _{kt} = 15 - 20)	× Moi KEY FOR UN □ Nat	DISTURE CON isture Content (IIT WEIGHT: ural Dry Unit W ural Wet Unit V	ζw) /eight(γ _d)	
-	TYPE OF BIT: ⁽¹⁾ PCD Bit (2) 5 Wing Drag Bit	LOCATION : Horns COORDINATES : 42992	sea Offshore Wind Farm Site Inve 24.3 mE 5967620.1 mN ⁽¹⁾ WA 25.1 mE 5967624.5 mN ⁽²⁾			10/2012 - 22/10 07/2012 - 07/07		

DEPT (m)	^H SOIL DESCRIPTION		SAMPLE OR TEST NO	Undrained Shear Strength su [kPa] 0 400 800 1200 1600	Cone Resistance qc [MPa] 2000 0 60 120	Moisture Content w [%] 0 40 80	Unit Weight γ [kN/m ³] 5 15 25	Bit Load [tonnes] 0 2	Mud Pressure [kg/cm ²] 0 20
30	23.05 m to 63.25 m - very dense dark greenish grey fine SAND, with extremely		RC 21 CPT 18*			×			
31	closely spaced to widely spaced thin laminae to very thin beds of clay and		RC 22 CPT 19*						
32	fine to coarse gravel-sized shell fragments and with traces of wood								
33	fragments		20*				_		
34									
			ମ୍ମକ୍ 24 21*			× ×××××			
35									
36			22*						
37			RC 26 CPT 23*						
38									
39			24* CPC 27						
40									
			0RC 28 25*				┥╎╷╓┓		
41			CPT 2RC 29						
42			CPT 27*						
43			RC 30 CPT						
44			28*						
45			सिद्ध 31 29*	2					
			СРТ						
46			3RČ 32			×			
47			CPT 31*						
48									
49			RC 34				┥╎┆╔╇		
50		2	CPT 34*						
51		φ.	RC 35						
	- from 51.0 m to 52.2 m - closely		CPT 35*						
52	spaced thin laminae to very thin beds of dark greenish grey sandy clay	····	GRC 36 36*						
53			CPT 37* CPT 38* BG 37						
54			GPG 37 39* CPT 40*						
55			CPT 41* (RC 38						1
56			42* CPT 43*			*			
57			CPT 44* CRG 39						
			45* CPT 46* CPT				┥┝┆┲╇┼╴		
58			47* (RC 40 48*						
59			CPT 49* RC 41						
60		• • •	CPT 50*						
Туре	LLING REMARKS: e of Mud: Guar-Gum/Seawater	KEY FO	DR UNDRAINI su (Torvar	ED SHEAR STRENGTH: ne)	s _u (Laboratory Vane)	KE ×	Y FOR MOISTURE CON Moisture Content		
Note		•	s _u (Pocket	Penetrometer)	$s_{\scriptscriptstyle u}$ (Undrained Triaxial)	KE	Y FOR UNIT WEIGHT: Natural Dry Unit V	Veight ()	
Loca	(1) AC2-CS (2) AC2-BH	 ♦ s_u (Fall Cone) + s_u (In situ Vane) Estimated from CPT data 					Natural Wet Unit		
	Profile is represented by location AC2-CS licates F8 cone used	* s_u (Remoulded In situ Vane) $\frac{1}{2}/\frac{1}{2}$ ($N_{kt} = 15 - 20$) Half full symbols refer to remoulded tests.							
ſ	JGRO	LOCATION : Hornsea Offshore Wind Farm Site Investigation COORDINATES : 429924.3 mE 5967620.1 mN ⁽¹⁾ WATER DEPTH : 29.2 m LAT ⁽¹⁾ DATE : 20/10/2012 - 22/10/2012 ⁽¹⁾							

DEPTI (m)	SOIL DESCRIPTION	SOIL S PROFILE		Undrained Shear Strength su [kPa] 0 400 800 1200 1600	Cone Resistance qc [MPa] 2000 0 60 120 0	Moisture Content w [%]	Unit Weight γ [kN/m ³] 5 15 25		Mud Pressure [kg/cm ²] 0 20
	SOIL DESCRIPTION 23.05 m to 63.25 m - very dense dark greenish grey fine SAND, with extremely closely spaced to widely spaced thin laminae to very thin beds of clay and fine to coarse gravel-sized shell fragments and with traces of wood fragments - at 62.2 m - with a cobble 63.3 m to 67.8 m - Very stiff blocky dark grey CLAY with extremely closely spaced thin laminae of light brownish grey silt and extremely closely to closely spaced thin laminae of dark grey fine sand 67.8 m to 80.3 m - dense to very dense dark olive grey slightly silty fine SAND, with few fine gravel-sized to coarse gravel-sized shell fragments - at 75.0 m - end of borehole AC2-CS - at 80.4 m - end of borehole AC2-BH - at 80.4 m - end of borehole AC2-BH - at 80.4 m - end of borehole AC2-BH - at 80.4 m - end of borehole AC2-BH - at 80.4 m - end of borehole AC2-BH - at 80.4 m - end of borehole AC2-BH - at 80.4 m - end of borehole AC2-BH - at 80.4 m - end of borehole AC2-BH - at 80.4 m - end of borehole AC2-BH - at 80.4 m - end of borehole AC2-BH - at 80.4 m - end of borehole AC2-BH - at 80.4 m - end of borehole AC2-BH - at 80.4 m - end of borehole AC2-BH - at 80.4 m - end of borehole AC2-BH - at 80.4 m - end of borehole AC2-BH - at 80.4 m - end of borehole AC2-BH - at 80.4 m - end of borehole AC2-BH - at 80.4 m - end of borehole AC2-BH - at 80.4 m - end of borehole AC2-BH - at 80.4 m - end of borehole AC2-BH - at 80.4 m - end of borehole AC2-BH - at 80.4 m - end of borehole AC2-BH - at 80.4 m - end of borehole AC2-BH - at 80.4 m - end of borehole AC2-BH - at 80.4 m - end		TEST NO	Strength su [kPa]	Resistance qc [MPa]	Content w [%] 40 80 X 1 1 X 1 1	Weight	Load [tonnes]	Pressure [kg/cm ²]
Type Note Loca Soil P	LING REMARKS: o of Mud: Guar-Gum/Seawater s: titions: ⁽¹⁾ AC2-CS ⁽²⁾ AC2-BH rofile is represented by location AC2-CS icates F8 cone used	▲ ▼ ★ Half full s	su (Torvan su (Pocket su (Fall Co su (Remoul symbols refer t	Penetrometer) ● ne) + Ided In situ Vane) ≥/≥	, , , , , , , , , , , , , , , , , , ,	×	COR MOISTURE CON Moisture Content OR UNIT WEIGHT: Natural Dry Unit N Natural Wet Unit	(w) Veight (γ _d)	
	TYPE OF BIT: ⁽¹⁾ PCD Bit ⁽²⁾ 5 Wing Drag Bit								

DEPTH (m)	SOIL DESCRIPTION	SOIL SAMI PROFILE TES	ST NO	Undrained Shear Strength su [kPa] 200 400 600 800 1	Cone Resistance q _c [MPa] 000 0 20 40	Moisture Content w [%] 0 40 80	Unit Weight γ [kN/m ³] 5 15 25		Mud Pressure [kg/cm ²] 0 20
(m) 0 1 2 3 3 4 5 6 7 8 9 9 10 1 11 1 12 1 13 1 14 9 10 1 11 1 13 1 14 9 10 1 13 1 14 1 15 16 17 1 18 9 10 1 12 2 13 2 14 2 14 2 13 2 14 1 14 1	SOIL DESCRIPTION 0.0 m to 0.2 m - Medium dense SAND - at 0.00 m - with a cobble 0.2 m to 16.6 m - Stiff to very stifff dark brown slightly sandy slightly gravelly CLAY, with widely to very widely spaced thin to thick beds of dense to very dense fine to medium subrounded gravel of mixed lithologies. Gravel is fine to coarse subangular to subrounded of mixed lithologies. - from 2.9 m to 3.3 m - fine to medium sand, with traces of fine to medium subrounded gravel of mixed lithologies 16.6 m to 17.9 m - Dense to very dense dark greyish brown very clayey fine SAND, with very closely to closely spaced thin laminae of sandy clay 17.9 m to 22.6 m - Very stiff to hard very dark greyish brown CLAY, with wery closely to closely spaced thin laminae to very thin beds of brown fine sand 28.1 m to 37.6 m - Very stiff to hard very dark greyish brown slightly sandy CLAY, with extremely closely spaced partings of fine sand		ST NO	200 400 600 800 1 200 400 600 800 1 200 1 1 1 1 1 200 1 1 1 1 1 1 200 1 1 1 1 1 1 1 200 1	Resistance q₀ [MPa]	Content w [%]	Weight γ [kN/m³]	Load [tonnes]	Pressure [kg/cm ²]
30	of fine sand		RC 21						
Type c Notes: Locatie Soil Pro * Indice	ING REMARKS: of Mud: Guar-Gum ons: (1) AC3-CS (2) AC3-BH file is represented by location AC3-CS ates F8 cone used TYPE OF BIT: (1) PCD Bit (2) 5 Wing Drag Bit	▲ S _u ▼ S _u ◆ S _u ★ S _u Half full symb	(Torvan (Pocket (Fall Cor (Remoul ools refer t : Horns 5 : 44121	Penetrometer) • su ne) + su		KEY F	OR MOISTURE CON Moisture Content OR UNIT WEIGHT: Natural Dry Unit V Natural Wet Unit V : 17/10/2012 - 19/11 : 07/07/2012 - 08/0	(w) Veight (γ_d) Neight (γ_w)	
GeODin-System	7.5//21/10/2012 09:03:59								

DEPTH (m)	SOIL DESCRIPTION	SOIL SAMPLE OR PROFILE TEST NO	Undrained Shear Strength su [kPa]	Cone Resistance q _c [MPa] 1000.0 20 40 0	Moisture Content w [%]	Unit Weight γ [kN/m ³]	Bit Load [tonnes]	
(m) 30 31 32 33 34 35 36 37 38 39 40 41 42	SOLDESCRIPTION 28.1 m to 37.6 m - Very stiff to hard very dark greyish brown slightly sandy CLA's of fine sand 37.6 m to 81.9 m - Very stiff to hard very dark greyish brown CLAY, with traces of coarse sand-sized shell fragments - from 37.6 m to 45.9 m - very thick bed of dense to very dense olive grey fine to for dense to very dense olive grey fine to sector - at 43.6 m - with a cobble	PROFILE TEST NO 0 RC 21 1 RC 22 CPT 12 1 RC 23 1 RC 24 1 RC 25 1 RC 25 1 RC 26 1 RC 27 1 RC 27 1 RC 28 1 RC 30 1 RC 31 1 RC 31 1 RC 31 1 RC 33 1 RC 33 1 RC 35 1 RC 38 1 RC 39	Strength su [kPa]	Resistance q. [MPa] 20 40 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	Content % 40 80 X 1		Load [tonnes]	Pressure
	- from 55.6 m to 57.3 m - thick bed of medium dense sand	CPT 21 CCPT 21 RC 40						
58 59 60	- at 58.60 m - becoming platy	RC 41 CPT 22 RC 42						
DRILLI Type o Notes: Locatio * Indica	TYPE OF BIT: (1) PCD Bit (2) 5 Wing Drag Bit	COORDINATES : 441215.8	■ s _u etrometer) ● s _u + s _u In situ Vane) →	gation	KEY F	DR MOISTURE CON Moisture Content (DR UNIT WEIGHT: Natural Dry Unit W Natural Wet Unit W : 17/10/2012 - 19/10 : 07/07/2012 - 08/07	w) eight (γ _d) /eight (γ _w) /2012 ⁽¹⁾	

DEP (m		SOIL SAMPLE OR PROFILE TEST NO	Undrained Shear Strength su [kPa] 0 200 400 600 800	Resistance C q _c [MPa]	oisture content w [%] 40 80 5	Unit Weight γ [kN/m ³] 5 15 25		Mud Pressure [kg/cm ²] 0 20
60	37.6 m to 81.9 m - Very stiff to hard very dark greyish brown CLAY, with traces of						1	
61	coarse sand-sized shell fragments	RC 43 CPT 23	V			1 1 1 1 1 1	1 1 1	
62		RC 44						
63								
64	- at 63.8 m - with a medium gravel-sized pocket of crystals	RC 45 CPT					1	
65	- from 65.0 m - widely to very widely spaced polished striated surfaces	24	>∛ ▼<<					
66	spaced pointined strikted surfaces	RC 46						
67		RC 47 CPT						
68		25			×			
69		RC 48	₹ ₹					
70		RC 49	•					
71		CPT 26						
72		RC 50						
73		RC 51						
74		CPT 27						
75		RC 52						
76			· AP.					
77		RC 53 CPT 28						
Π		RC 54	Y					
78								
79		RC 55 CPT 29					1 1 1	
80	- at 80.4 m - end of borehole AC3-CS	RC 56	K K K K K K K K K K K K K K K K K K K					
81	- at 80.9 m - end of borehole AC3-BH							
82								
83								
84								
85								
86								
87							1 1 1	
88								
89								
90								
Ту	ILLING REMARKS: be of Mud: Guar-Gum	KEY FOR UNDRAIN ▲ s _u (Torva	ED SHEAR STRENGTH: ne)	s _u (Laboratory Vane)	KEY FOF	R MOISTURE CON Moisture Content		
No	tes:	▼ s _u (Pocke	t Penetrometer)	\boldsymbol{s}_u (Undrained Triaxial)		R UNIT WEIGHT:		
Lo	(1) AC3-CS (2) AC3-BH	♦ s _u (Fall C		s _u (In situ Vane) Estimated from CPT data		Natural Dry Unit V Natural Wet Unit V		
	Profile is represented by location AC3-CS idicates F8 cone used	* s_u (Remoulded In situ Vane) $\frac{1}{2}$ / $\frac{1}{2}$ (N _{kt} = 15 - 20) Half full symbols refer to remoulded tests.						
	TYPE OF BIT: (1) PCD Bit (2) 5 Wing Drag Bit	LOCATION : Hornsea Offshore Wind Farm Site Investigation COORDINATES : 441215.8 mE 5967863.5 mN ⁽¹⁾ WATER DEPTH : 29.1 m LAT ⁽¹⁾ : 441212.7 mE 5967868.0 mN ⁽²⁾ : 30.1 m LAT ⁽²⁾ : 07/07/2012 - 08/07/2012 ⁽²⁾						

DEPTH (m)	SOIL DESCRIPTION		SAMPLE OF TEST NO	su [kPa]	Cone Resistance qc [MPa] 000 0 60 120	Moisture Content w [%] 0 40 80	Unit Weight γ [kN/m ³] 5 15 25	Mud Pressure [kg/cm ²] 0 10
0	0.0 m to 0.9 m - Very dark greyish brown gravelly fine to coarse SAND, with many coarse sand-sized to coarse gravel-sized shells and shell fragments. Gravel is fine to coarse of mixed lithologies - from 0.4 m to 0.5 m - thin bed of soft		RC 1 CPT 1 RC 2					
3 4 5 6	Clay 0.9 m to 18.5 m - Stiff to hard very dark grey slightly sandy slightly gravelly CLAY. Gravel is fine to coarse angular to sub-angular of mixed lithologies - from 0.90 m to 4.50 m - becoming sandy		RC 3 CPT 2 RC 4					
7 8 9	- at 7.5 m - with a thin bed of dark greyish brown slightly clayey gravelly sand		RC 6 RC 6 RC 74					
10 11 12 13	- at 11.6 m - with a thick bed of very dark greyish brown clayey sand		RC 8 RC 9 CPT 5 RC 10					
14 15 16 17	- from 15.40 - becoming slightliy sandy		RC 11 CPT 6 RC 12			~~ × × ~ · · · · · · · · · · · · · · · ·		
18 19 20 21 22	18.5 m to 35.0 m - Medium dense to dense dark greyish brown slightly clayey fine SAND, with extremely closely to closely spaced thin to thick laminae of cla and black matter (possible organic) - at 19.6 m - with a thin bed of dark brown sandy clay - at 20.3 m - with a thin bed of dark brown		RC 14 RC 14 RC 15 CPT 8 RC 16			* - * - * - * - * - * - * - * - * - * - * - * - * - * - * - * - * - * -		
23 24 25 26	clay - from 24.4 m - with shell fragments		RC 17 CPT 9 RC 18					
27 28	- at 26.3 m - with a thin bed of brown clay		RC 19 CPT 10 RC 20					
Туре	ING REMARKS: of Bit: - CS locations: TC Hexagon Bit - BH locations: 5 Wing Drag Bit		CPT Řt 21 UNDRAINE su (Torvane	D SHEAR STRENGTH:) Su	(Laboratory Vane)	KEY F	OR MOISTURE CON Moisture Content	
Notes Soil Pr	of Mud: Guar Gum water mixture : (1) DC1-CS (2) DC1-BH offile is represented by location DC1-CS ates F8 cone used	♦ ₩ Half full sy	s _u (Fall Cor s _u (Remoul mbols refer t	e) + su ded In situ Vane) ≥/≥ (N _k o remoulded tests.		KEY F	OR UNIT WEIGHT: Natural Dry Unit V Natural Wet Unit V	
GeoDin-System	JGRO		ES : 41924 : 41924	a Offshore Wind Farm Site Investig 4.8 mE 5966400.2 mN ⁽¹⁾ WATEF 9.6 mE 5966400.7 mN ⁽²⁾ C1-CS (PRELIMINAR	R DEPTH : 33.9 m LAT : 33.6 m LAT	(2)	: 08/10/2012 - 10/10 : 24/06/2012 - 25/00	

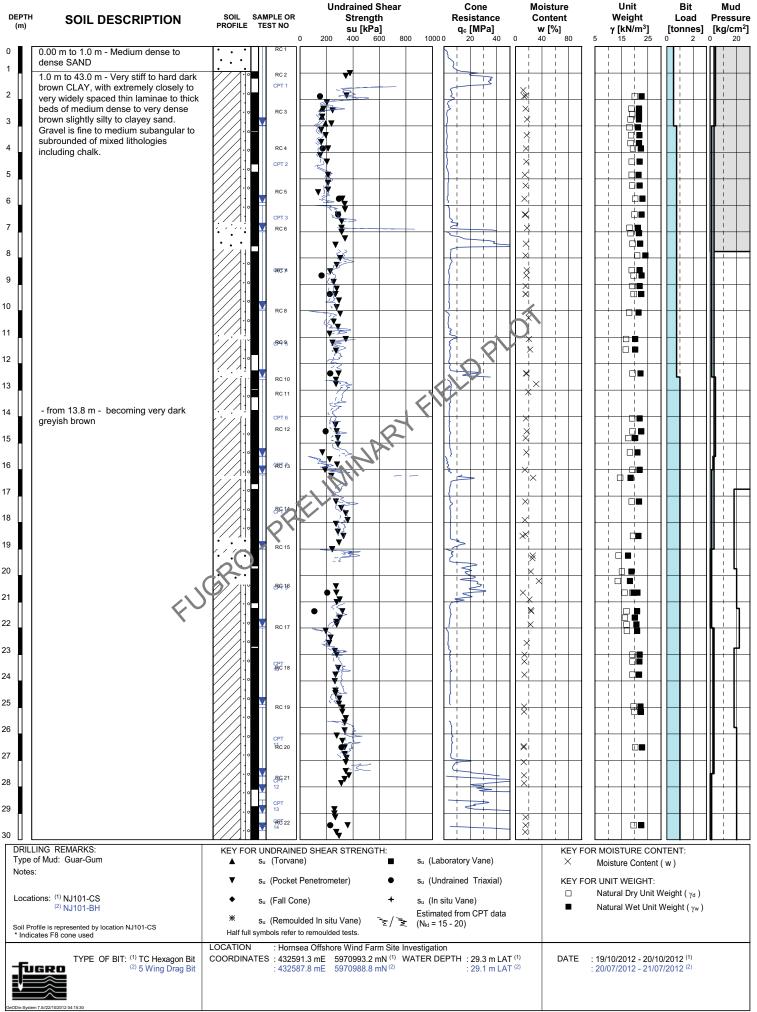
BOREHOLE DC1-CS (PRELIMINARY) SHEET 1 OF 3

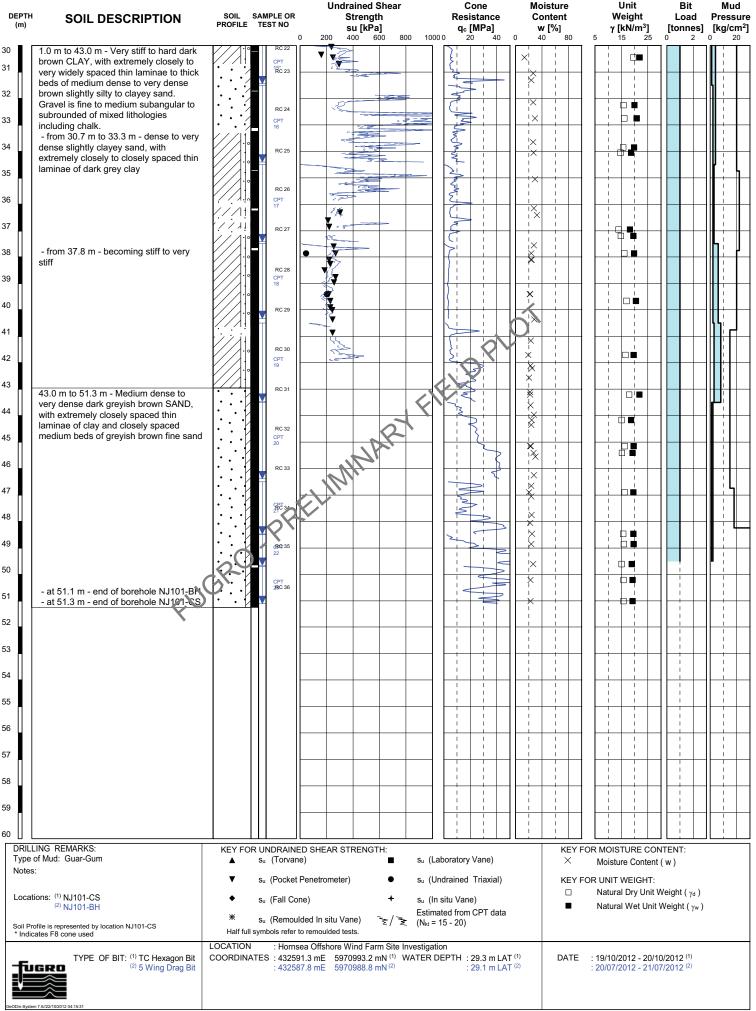
DEPTH (m)	SOIL DESCRIPTION	SOIL SAMPLE OR PROFILE TEST NO	su [kPa]	Cone Resistance qc [MPa] 00 0 60 120 0	Moisture Content w [%]	Unit Weight γ [kN/m ³] 5 15 25	Mud Pressure [kg/cm ²] 0 10
30 31 32	18.5 m to 35.0 m - Medium dense to dense dark greyish brown slightly clayey fine SAND, with extremely closely to closely spaced thin to thick laminae of clay and black matter (possible organic)	,					
33	- at 32.8 m - with a thin bed of very dark greyish brown clay	RC 23 CPT 12					
34 35		RC 24					
36	35.0 m to 64.5 m - Dense to very dense dark grey fine to medium SAND, with widely to very widely spaced thin laminae						
37	of black matter (possibly organic) and with traces of shell fragments - at 35.4 m - with a thick bed of sandy	RC 26					
38	gravel, with many shell fragments - from 36.7 m - with a thin bed of very dark grey clay with extremely closely	CPT 15* RC 27		~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~			
39 40	spaced thin laminae of black sand/silt - at 37.9 m - with a medium bed of thinly interbedded dark greyish brown clay and	CPT 16*					
41	dark grey fine sand	RC 28 CPT 17*					
42		RC 29 CPT 18*					
43		RC 30 CPT 19*					
44		RC 31	.21				
46		CPT 20*			× ·		
47		CPT 21*					
48 49							
50	- from 49.0 m to 51.1 m - with many shell	23* RC 34 CPT 24* 25*					
51	fragments	CPT BC 35					
52		CPT 27" RC 36 CPT					
53 54		RC 37 CPT					
55		29* 29* CPT 50 38					
56		CPT 31*					
57		RC 39 CPT 32*					
59	- from 58.8 m to 59.2 m - medium bed of	RC 40 CPT 33*					
60	very stiff to hard clay						
Туре	of Bit: - CS locations: TC Hexagon Bit - BH locations: 5 Wing Drag Bit of Mud: Guar Gum water mixture	▲ s _u (Torvane		Laboratory Vane) Undrained Triaxial)	×	OR MOISTURE COM Moisture Content OR UNIT WEIGHT:	
	s: ⁽¹⁾ DC1-CS ⁽²⁾ DC1-BH	♦ su (Fall Cor	ne) + s _u (Estir	In situ Vane) nated from CPT data		Natural Dry Unit V Natural Wet Unit	
	ofile is represented by location DC1-CS cates F8 cone used	Half full symbols refer to	ded In situ Vane) 🛬 / 🛬 (N _{kt}	= 15 - 20)			
Į		COORDINATES : 41924	4.8 mE 5966400.2 mN ⁽¹⁾ WATER 9.6 mE 5966400.7 mN ⁽²⁾			: 08/10/2012 - 10/1 : 24/06/2012 - 25/0	
GeODin-Syste	m 7.5//12/10/2012 02:59:21		C1-CS (PRELIMINAR)	Y) SHEET 2 O	F 3		

BOREHOLE DC1-CS (PRELIMINARY) SHEET 2 OF 3

DEPTH (m)	SOIL DESCRIPTION		SAMPLE OR TEST NO	su [kPa]	Cone Resistance q₀ [MPa] 1000 0 60 120 0	Moisture Content w [%] 40 80	Unit Weight γ [kN/m ³] 5 15 25		Mud Pressure [kg/cm ²] 0 10
61 . 62 . 63 . 64 . 65 . 66 . 67 . 68 . 69 . 70 . 71 . 72 . 73 . 74 . 75 . 76 . 77 . 78 . 79 .	 35.0 m to 64.5 m - Dense to very dense dark grey fine to medium SAND, with widely to very widely spaced thin laminae of black matter (possibly organic) and wit traces of shell fragments - at 64.2 m with medium gravel-sized nodular ferrous concretions 64.5 m to 73.9 m - Dense to very dense dark greenish grey fine to medium SAND with extremely closely spaced thin to thic laminae of clay - at 70.9 m - with a medium bed of greenish black very sandy clay with extremely closely spaced thin laminae an partings of fine sand 73.9 m to 80.4 m - Dense to very dense dark greenish grey slightly silty fine SANE with extremely closely to closely spaced thin to thic laminae of clay with traces of shell fragments - at 75.4 m - with a medium bed of stiff to very stiff clay - from 77.6 m - with very closely spaced partings and fine gravel-sized pockets of black possibly organic particles - at 80.1 m - end of borehole DC1_CS - at 80.4 m - end of borehole DC1_CS 	d	CPT CPT RC 54 CPT RC 50 CPT RC 51 CPT RC 54 CPT RC 55 CPT RC 56 CPT RC 57 CPT CPT CPT RC 56 CPT RC 56 CPT						
89 90 DRILLII	NG REMARKS:	KEY FOR		D SHEAR STRENGTH:		KEY FC			
Type of Type of Notes: Soil Profi	Bit: - CS locations: TC Hexagon Bit - BH locations: 5 Wing Drag Bit Mud: Guar Gum water mixture ⁽¹⁾ DC1-CS ⁽²⁾ DC1-BH le is represented by location DC1-CS tes F8 cone used	▲ ▼ ₩ Haif full sy	su (Torvane su (Pocket F su (Fall Con su (Remould ymbols refer to : Hornse) ■ Penetrometer) ● e) + led In situ Vane) [™] ⁄ [™] ∕ [™]		KEY FC	Moisture Content DR UNIT WEIGHT: Natural Dry Unit V Natural Wet Unit ¹	(w) Veight (γ _d) Weight (γ _w)	
GeoDin-System 7	5/12/1020/12 02:59:22	COORDINAT		I.8 mE 5966400.2 mN ⁽¹⁾ WA 9.6 mE 5966400.7 mN ⁽²⁾	TER DEPTH : 33.9 m LAT ⁽¹⁾ : 33.6 m LAT ⁽²⁾	DATE	: 08/10/2012 - 10/10 : 24/06/2012 - 25/00		

BOREHOLE DC1-CS (PRELIMINARY) SHEET 3 OF 3





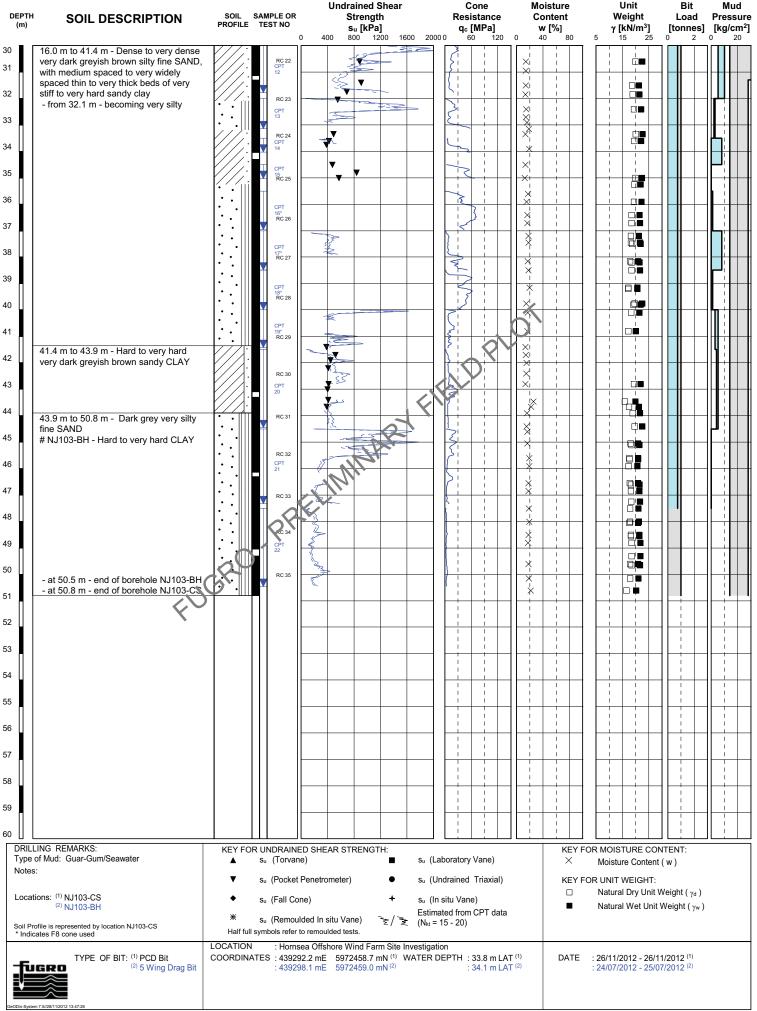
	PTH m)	SOIL DESCRIPTION	SOIL SAMPLE O PROFILE TEST NO	o s _u [kPa]	Cone Resistance q _c [MPa] 600 2000 0 60 120	Moisture Content w [%] 0 40 80	Unit Weight γ [kN/m ³] 5 15 25	Bit Load [tonnes] 0 2	Mud Pressure [kg/cm ²] 0 20
0 1 2 3 4 5 6 7 8 9 10 11 12		0.0 m to 0.4 m - Very loose to loose SAND 0.4 m to 12.7 m - Firm to very stiff dark brown slightly gravelly CLAY. Gravel is fine to coarse subangular to subrounded of mixed lithologies, including chalk and lint - from 0.40 m to 1.20 m - medium dense to very dense dark brown clayey gravelly fine to coarse gravel-sized shell fragments. Gravel is fine to coarse subangular to subrounded of mixed lithologies - from 6.7 m - becoming slightly sandy slightly gravelly - at 7.4 m - very thin bed of gravelly clayey fine to medium sand. Gravel is fine to coarse subangular to subrounded of mixed lithologies	· · · · · · · · · · · · · · · · · · ·						
 13 14 15 16 17 18 19 20 		12.7 m to 17.2 m - Hard to very hard very dark greyish brown slightly gravelly sandy CLAY. Gravel is fine to coarse subangular to subrounded of mixed lithologies - from 15.0 m - becoming very dark grey slightly sandy slightly gravelly - from 15.7 m to 16.3 m - medium bed of dark olive brown slightly gravelly silty fine to medium sand 17.2 m to 29.3 m - Medium dense to very dense dark grey silty fine to medium SAND, with extremely closely spaced to medium spaced thin to thick laminae of clay and silt, and with traces of coarse sand-sized to coarse gravel-sized shell fragments							
 21 22 23 24 25 26 27 28 29 30 		- from 24.7 m - becoming very dark grey very silty fine sand 29.3 m to 51.8 m - Stiff to hard very dark grey slickensided CLAY	RC 1 CPT 10 CPT 11 RC 1 CPT 12 RC 1 CPT 12 RC 1 CPT 12 RC 1 CPT 12 RC 1 RC 1 R						
T N L	ype of lotes: .ocatio	NG REMARKS: Mud: Guar-Gum/Seawater ins: ⁽¹⁾ NJ102-CS ⁽²⁾ NJ102-BH le is represented by location NJ102-CS	 ▲ s_u (Tor ▼ s_u (Poc ◆ s_u (Fall * s_u (Ren 	cket Penetrometer) I Cone) moulded In situ Vane)	s _u (Laboratory Vane) s _u (Undrained Triaxial) s _u (In situ Vane) Estimated from CPT data ≩ (N _{kt} = 15 - 20)	×	FOR MOISTURE CON Moisture Content (FOR UNIT WEIGHT: Natural Dry Unit W Natural Wet Unit V	ίw) /eight(γd)	
*		TYPE OF BIT: ⁽¹⁾ PCD Bit (2) 5 Wing Drag Bit	LOCATION : Ho COORDINATES : 43	afer to remoulded tests. ornsea Offshore Wind Farm Site 37322.4 mE 5966456.5 mN ⁽¹⁾ 37326.6 mE 5966460.4 mN ⁽²⁾	Investigation		: 17/11/2012 - 18/11 : 31/07/2012 - 01/08		

BOREHOLE NJ102-CS (PRELIMINARY) SHEET 1 OF 2

DEPT (m)	SOIL DESCRIPTION	SOIL SAMPL PROFILE TEST		Undrained Shear Strength su [kPa] 400 800 1200 1600 2	Cone Resistance q₀ [MPa] 2000 0 60 120	Moisture Content w [%] 0 40 80	Unit Weight γ [kN/m ³] 5 15 25	Bit Load [tonnes] 0 2	Mud Pressure [kg/cm ²] 0 20
30 31	29.3 m to 51.8 m - Stiff to hard very dark grey slickensided CLAY		RC : 21 3						
	- from 29.3 m to 33.6 m - becoming		RC 22						
32	slightly sandy, with traces of coarse sand-sized to medium gravel-sized shell fragments and traces of fine		PT 4	¥		* *			
33	gravel-sized pockets of black organic clay		RC 23					1	
34			RC 24						
35			PT 5						
36			RC 25						
37			RC 26	×					
38			:РТ 6						
39			RC 27						
40			RC 28						
41			PT 7						
42			RC 29						
43			RC 30						
44			PT 8	at at					
45			RC 31						
46			RC 32						
48			PT 9 R0 33						
40									
50			RC 34						
51	- end of borehole NJ102-CS at 50.2 m		PT 0						
52	- end of borehole NJ102-BH at 51.8 m			<u>{</u>				-	
53									
54									
55									
56									
57								-	
58									
59									
60									
Туре	LING REMARKS: a of Mud: Guar-Gum/Seawater		RAINED S Forvane)	HEAR STRENGTH:	(Laboratory Vane)	KEY F	OR MOISTURE CON Moisture Content		
Note			Pocket Pen		(Undrained Triaxial)	KEY F	OR UNIT WEIGHT: Natural Dry Unit V	Veight (v.a.)	
	ations: ⁽¹⁾ NJ102-CS ⁽²⁾ NJ102-BH		all Cone)		(In situ Vane) imated from CPT data		Natural Wet Unit V		
Soil F * Ind	rofile is represented by location NJ102-CS icates F8 cone used	Half full symbols	s refer to rer	noulded tests. Mishore Wind Farm Site Investig					
_f	TYPE OF BIT: ⁽¹⁾ PCD Bit ⁽²⁾ 5 Wing Drag Bit	COORDINATES :	437322.4	mE 5966456.5 mN ⁽¹⁾ WATEF mE 5966460.4 mN ⁽²⁾			: 17/11/2012 - 18/1 : 31/07/2012 - 01/08		
	hem 7.5//2011/2012 16:41:26								

BOREHOLE NJ102-CS (PRELIMINARY) SHEET 2 OF 2

DEPTH (m)	SOIL DESCRIPTION		SAMPLE OR TEST NO	Undrained Shear Strength su [kPa] 0 400 800 1200 1600 2	Cone Resistance qc [MPa] 2000 0 60 120 0	Moisture Content w [%] 40 80	Unit Weight γ [kN/m ³] 5 15 25	Mud Pressure [kg/cm ²]
1	0.0 m to 0.2 m - Medium dense SAND 0.2 m to 16.0 m - Stiff to very stiff dark brown slightly sandy slightly gravelly CLAY. Gravel is fine to coarse subangular to subrounded of mixed		CPT 1 RC 2					
3	lithologies, including chalk		RC 3			× · · · · · · · · · · · · · · · · · · ·		
6			RC 4			× · · · · · · · · · · · · · · · · · · ·		
7 8 9	- from 8.5 m to 16.0 m - with extremely		CPT 3 RC 6			×		
	closely spaced to medium spaced thin laminae to thin beds of very silty fine sand		RC 7					
11 12			RC 9					
13 14			ਜਦੋਂ ਜਿ					
15	- from 15.4 m to 15.8 m - # NJ103-BH - medium bed of hard clay		₩ 9€7 f2	E NR		-×		
17	16.0 m to 41.4 m - Dense to very dense very dark greyish brown silty fine SAND, with medium spaced to very widely spaced thin to very thick beds of very stiff to very hard sandy clay		RC 11 CPT 7 RC 13					
19 20	 from 16.0 m to 18.9 m - becoming slightly gravelly from 20.1 m to 21.7 m - becoming 		0R0 14 RC 15					
21	clayey fine sand - from 21.7 m to 23.9 m - becoming fine		RC 16 CPT 9			×		
23	to medium		RC 17					
25			RC 18 CPT 10			×		
26 27			RC 19			*		
28 29			CPT RC 20					
30			CPT 12 RC 22			 		
	NG REMARKS: f Mud: Guar-Gum/Seawater	KEY FC	R UNDRAIN su (Torvar	ED SHEAR STRENGTH: ne) Su	(Laboratory Vane)	KEY F	OR MOISTURE CON Moisture Content	
Notes:		▼			(Undrained Triaxial)	KEY F	OR UNIT WEIGHT:	
Locatio	ons: ⁽¹⁾ NJ103-CS ⁽²⁾ NJ103-BH	•	s _u (Fall Co		(In situ Vane)		Natural Dry Unit \ Natural Wet Unit	
Soil Prot * Indica	file is represented by location NJ103-CS ttes F8 cone used	₩ Half ful		llded In situ Vane) Est to remoulded tests.	timated from CPT data _{et} = 15 - 20)			
fa	TYPE OF BIT: ⁽¹⁾ PCD Bit ⁽²⁾ 5 Wing Drag Bit	LOCATION	ATES : 4392	sea Offshore Wind Farm Site Investig 92.2 mE 5972458.7 mN ⁽¹⁾ WATEI 98.1 mE 5972459.0 mN ⁽²⁾			: 26/11/2012 - 26/1 : 24/07/2012 - 25/0	



BOREHOLE NJ103-CS (PRELIMINARY) SHEET 2 OF 2

DEPTH (m)	SOIL DESCRIPTION		SAMPLE OR TEST NO	Undrained Shear Strength su [kPa] 0 400 800 1200 1600	Cone Resistance q _c [MPa] 2000 0 60 120 0	Moisture Content w [%]	Unit Weight γ [kN/m ³] 5 15 25		Mud Pressure [kg/cm ²] 0 20
0	0.0 m to 0.3 m - Very loose to loose								
1	SAND 0.3 m to 6.6 m - Stiff to very stiff dark		RC 1					i i	
	brown slightly sandy slightly gravelly		CPT 1			X-X-X		li i	
2	CLAY, with extremely closely spaced to very closely spaced thin laminae to thin		RC 2	₹		* -		1	1
3	beds of very silty fine sand. Gravel is		RC 3			X			
	fine to coarse subangular to subrounded of mixed lithologies, including chalk			3		× · · · · · · · · · · · · · · · · · · ·			
4	- from 0.3 m to 1.9 m - # NJ104-CS -							i	
	silty very sandy subangular to subrounded fine to medium GRAVEL		RC 4 CPT 2			X			
5				¥ ▼		X X X		1	
6	- from 5.6 m to 6.6 m - thick bed of very	· · ///	RC 5	∬ [♥]		≫ ¦			
	silty fine sand			3		X			
7	6.6 m to 16.7 m - Very stiff to very hard								
8	very dark grey slightly sandy slightly gravelly CLAY, with extremely closely		- ଅନ୍ତ			X I I			
•	spaced to widely spaced thin to thick laminae of very silty fine sand. Gravel is		>			* !			
9	fine to coarse subangular to subrounded		RC 7						1
	of mixed lithologies, including chalk			7		× · · · · · · · · · · · · · · · · · · ·			
10	- from 9.8 m to 10.0 m - medium bed of medium dense to dense slightly gravelly		BC 8			* !			
11	clayey fine to medium sand		RC 8 CPT 4				<u> </u> □ ■		
·· 👖						XI I XI I		ĥ –	
12			RC 9	Ť,		XIIII			
	- from 12.6 m to 12.8 m - medium bed		CPT 5			× -			
13	of dense very silty fine sand		RC 10						1
14									n i I
	- at 14.5 m - with a subangular cobble					× ! !			
15	of quartzite		RC 11 CPT 6			×			
						X			
16			RC 12						
17	16.7 m to 28.1 m - Dense to very dense	$\left \cdot \right\rangle$	Ť			××-			
	olive grey slightly silty fine to medium		CPT 7 RC 1	M <u>2</u>		* ¦			
18	SAND, with extremely closely spaced to closely spaced thin to thick laminae of					* !			
19	silt and traces of coarse sand-sized to medium gravel-sized shell fragments	•••	R C 14						66
19	medium gravel-sized shell hagments								
20			СРТ						
		6	10* RC 15			X			Γ
21		ŊŢ ∵ Ĭļ	CPT 11*			<u> </u>			
22	- from 21.1 m to 21.9 m - becoming clayey fine sand	· · · ·/	11* RC 16						
			(RC 17 12*			X			
23		• • •							
24		· · · ·	ТСРТ						i i
24			14* RC 19			XII			╏╎╶┢┛
25			CPT		-+				1
	- from 25.1 m to 28.1 m - becoming silty		15* RC 20 CPT			×			
26			16*						
27			CPC 21 17*		3				
- 	28.1 m to 36.6 m - Medium dense to	\ . •. •				× :	┆╓┲		
28	dense very dark greyish brown silty fine		RC 22 CPT						1
	SAND, with extremely closely spaced to closely spaced thin to thick laminae of	••••	18* RC 23						
29	clay and silt, and traces of coarse	:··∥				× :			╟┟┊┼╴┖
30	sand-sized to medium gravel-sized shell fragments		CPT ASC 24			×	▏▕▁▕▋▋		
DRILL	ING REMARKS:	KEY FC		ED SHEAR STRENGTH:		KEY	FOR MOISTURE CON	TENT:	
Type Notes	of Mud: Guar-Gum/Seawater	A	s _u (Torvan	e) 🔳	s _u (Laboratory Vane)	×	Moisture Content	w)	
140165		•	s _u (Pocket	Penetrometer)	\boldsymbol{s}_{u} (Undrained Triaxial)		FOR UNIT WEIGHT:		
Locat	ions: ⁽¹⁾ NJ104-CS	•	s _u (Fall Co	ne) +	s _u (In situ Vane)		Natural Dry Unit W		
	⁽²⁾ NJ104-BH	*	s. (Remou	lded In situ Vane) 🛬 / 🋬	Estimated from CPT data $(N = 15, 20)$		Natural Wet Unit V	veignt (γ _w)	
	ofile is represented by location NJ104-CS ates F8 cone used			to remoulded tests. \leq / \leq	(N _{kt} = 15 - 20)				
		LOCATION		ea Offshore Wind Farm Site Inv		a)	10/11/2011	100.10 (1)	
-fu	TYPE OF BIT: ⁽¹⁾ PCD Bit GRO ⁽²⁾ 5 Wing Drag Bit	COORDIN		01.7 mE 5965239.0 mN ⁽¹⁾ WA 04.0 mE 5965234.5 mN ⁽²⁾	ATER DEPTH : 30.3 m LAT (: 30.1 m LAT (: 18/11/2012 - 18/11 : 09/07/2012 - 10/07		
GeODin-Sueton	m 7.5//21/11/2012 07:06:30								

DEPTH (m)	SOIL DESCRIPTION	SOIL SAMPLE OR PROFILE TEST NO	Undrained Shear Strength s _u [kPa] 0 400 800 1200 1600	Resistance q _c [MPa]	Moisture Content w [%] 40 80 5	Unit Weight γ [kN/m ³] 5 15 25	Bit Load [tonnes] 0 2	Mud Pressure [kg/cm ²] 0 20
	 SOIL DESCRIPTION 28.1 m to 36.6 m - Medium dense to dense very dark greyish brown silly fine SAND, with extremely closely spaced thin to thick laminae of clay and silt, and traces of coarse sand-sized to medium gravel-sized shell fragments - from 30.6 m to 30.8 m - medium bed of hard to very hard clay 36.6 m to 51.4 m - Stiff to hard dark brown slightly sandy CLAY, with widely spaced to very widely spaced medium beds of very silty fine sand - from 36.6 m to 46.0 m - with extremely closely spaced to very closely spaced to very closely spaced to very thin beds of silty fine to medium sand - from 46.0 m - becoming very dark grey, with traces of fine to medium gravel-sized shell fragments and traces of fine to medium gravel-sized shell fragments and traces of fine to medium subangular to subrounded gravel of mixed lithologies, including chalk - at 50.1 m - end of borehole NJ104-CS - at 51.4 m - end of borehole NJ104-CS 	PROFILE TEST NO RC 24 CT SC 25 RC 26 CT 20 RC 26 CT 20 RC 27 RC 28 RC 28 CT 21 RC 29 RC 30 RC 31 RC 31 RC 31 RC 32 RC 33 RC 34 RC 34 CT 24 RC 35 RC 37 RC 37 CT 25	s _u [kPa]	q. [MPa] 0 60 120 0 1 1 1	w [%] 40 80 X 1 X <t< td=""><td>γ [kN/m³]</td><td>[tonnes]</td><td>[kg/cm²]</td></t<>	γ [kN/m³]	[tonnes]	[kg/cm ²]
59								
Type Notes Locat	ING REMARKS: of Mud: Guar-Gum/Seawater : ions: ⁽¹⁾ NJ104-CS (2) NJ104-BH ofile is represented by location NJ104-CS ates F8 cone used	 ▲ s_u (Torvan ▼ s_u (Pocket ◆ s_u (Fall Co 	Penetrometer) ● s ne) + s Ided In situ Vane) ͡≤ / ͡≥ (j	iu (Laboratory Vane) iu (Undrained Triaxial) iu (In situ Vane) Estimated from CPT data N _{kt} = 15 - 20)		MOISTURE CON Moisture Content UNIT WEIGHT: Natural Dry Unit W Natural Wet Unit W	(w) /eight (γ _d)	
GeoDin-System	TYPE OF BIT: (1) PCD Bit (2) 5 Wing Drag Bit	COORDINATES : 44190	ea Offshore Wind Farm Site Inves 01.7 mE 5965239.0 mN ⁽¹⁾ WAT 04.0 mE 5965234.5 mN ⁽²⁾			18/11/2012 - 18/11 09/07/2012 - 10/07		

DEPTH (m)	SOIL DESCRIPTION	SOIL SAMPLE OR PROFILE TEST NO	Undrained Shear Strength s _u [kPa] 0 400 800 1200 1600 2000 0	Resistance Cor q _c [MPa] w	sture Unit itent Weight [%] γ [kN/m³] 80 5 15 25	Bit Load [tonnes] 0 2 0	
0 1 2 3 4 5 6 7 8 9	0.0 m to 0.4 m - Very loose to loose dark brown slightly gravelly clayey medium to coarse SAND, with fine to medium gravel-sized shell fragments and traces of fine to medium gravel-sized pockets of black fine to medium sand. Gravel is fine to coarse angular to subangular of mixed lithologies 0.4 m to 9.4 m - Firm to very stiff very dark greyish brown slightly sandy slightly gravelly CLAY. Gravel is fine to coarse angular to subrounded of mixed lithologies, including chalk	CPT 1 RC 2 CPT 1 RC 2 CPT 1 RC 2					
10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25	 9.4 m to 12.6 m - Hard to very hard very dark greyish brown slightly gravelly sandy CLAY, with extremely closely spaced to medium spaced thin laminae to medium beds of fine to medium and traces of fine to medium and traces of fine to subrounded of mixed lithologies, including chalk - end of borehole NJ105-BH at 10.6 m 12.6 m to 15.1 m - Hard to very hard very dark greyish brown CLAY, with traces of fine gravel-sized shell fragments - from 14.7 m to 15.1 m - medium bed of slightly sandy silt 15.1 m to 27.6 m - Dense to very dense very dark greyish brown silty to very silty fine to medium SAND, with traces of coarse sand-sized to coarse gravel-sized shell fragments - end of borehole NJ105-CS at 15.4 m - from 16.3 m to 16.5 m - thin bed of slightly sandy silt - from 18.2 m - becoming fine sand - from 21.2 m to 23.4 m - becoming 	CPT 2 CPT 2 CP					
Type Note: Loca Soil Pi	27.6 m to 29.6 m - Very stiff to very hard very dark grey slightly sandy CLAY, with closely spaced to widely spaced thin laminae of black organic material 29.6 m to 50.81 m - Very dense dark grey slightly silty to silty fine to medium SAND, with traces of coarse sand-sized to coarse gravel-sized shell fragments and traces of mica crystals LING REMARKS: of Mud: Guar-Gum/Seawater s: tions: ⁽¹⁾ NJ105-CS ⁽⁴⁾ NJ105a-BH ⁽²⁾ NJ105-CSa ⁽⁵⁾ NJ105b-BH ⁽³⁾ NJ105-BH rofile is represented by location NJ105-CS cates F8 cone used	KEY FOR UNDRAIN ▲ su (Torvar ▼ su (Fall Co * su (Remou Half full symbols refer	Penetrometer) s_u (Unc one) $+$ s_u (In s ulded In situ Vane) $\frac{1}{3}/\frac{1}{2}$ (N _{kt} = 19) to remoulded tests.	,	KEY FOR MOISTURE COL X Moisture Content KEY FOR UNIT WEIGHT: Natural Dry Unit M Natural Wet Unit	(w) Weight(γd)	
fi	TYPE OF BIT: (1) TC Hexagon Bit (2) PCD Bit (3) 5 Wing Drag Bit (4) 5 Wing Drag Bit (5) 5 Wing Drag Bit	COORDINATES : 4444 : 4444 : 4444 : 4444	sea Offshore Wind Farm Site Investigation 90.6 mE 5970257.5 mN ⁽¹⁾ WATER DE 88.5 mE 5970251.1 mN ⁽²⁾ 87.9 mE 5970255.2 mN ⁽³⁾ 83.0 mE 5970255.1 mN ⁽⁴⁾ 93.5 mE 5970255.3 mN ⁽⁵⁾		DATE : 15/12/2012 - 15/1 : 23/11/2012 - 24/1 : 22/07/2012 - 22/0 : 25/07/2012 - 25/0 : 30/07/2012 - 31/0	1/2012 ⁽²⁾ 7/2012 ⁽³⁾ 7/2012 ⁽⁴⁾	

DEPTI (m)	SOIL DESCRIPTION	SOIL SAMPLI PROFILE TEST		Undrained S Strengt s _u [kPa 400 800 12	h	Cone Resistance q _c [MPa] 000 0 60 120	Moisture Content w [%] 0 40 80	Unit Weight γ [kN/m ³] 5 15 25	Bit Load [tonnes] 0 2	Mud Pressure [kg/cm ²] 0 20
30	29.6 m to 50.81 m - Very dense dark grey slightly silty to silty fine to medium	••• ••• ••• •••	0711 97 0712						1	
31	SAND, with traces of coarse sand-sized to coarse gravel-sized shell fragments	17	0 [°] 12						1	1
32	and traces of mica crystals		чт 6 р 13							
33			т							
34	- from 34.2 m to 34.3 m - thin bed of		G ¹⁴							
35	very silty fine sand - end of borehole NJ105a-BH at 35.0 m	21	·							
36	- from 35.2 m to 35.4 m - # NJ105b-BH - very thin bed of clay	1* R	C 15						1	
			т						1	
37			0716						1	
38		• • • •	РТ 0717							
39		7* CF 8* CF								
40		• • • • • • • • • • • • • • • • • • • •	ថ្មី 18							
41			т							
42		13	11							
43	- from 42.2 m to 46.8 m - becoming dense to very dense		* T							
			č 20		6					
44		CF 16	C 21		5					
45		CF	т	1/						
46			G-22	- MP'						
47	- from 46.8 m to 48.2 m - becoming fine to medium sand									
48				×			×			
49	- from 48.2 m - becoming dense to very dense very silty fine sand, with		T C 24							
50	extremely closely spaced thin to thick laminae of silt									
	- end of borehole NJ105-CSa at 50.2 m - end of borehole NJ105b-BH at 50.8 m		G 25							
51	E C									
52										
53										
54										
55										
56										
57										
58										
59										
	LING REMARKS:									
	of Mud: Guar-Gum/Seawater		RAINED SI orvane)	HEAR STRENGT		(Laboratory Vane)		FOR MOISTURE COI Moisture Content		
			ocket Pene	trometer)		(Undrained Triaxial)		FOR UNIT WEIGHT: Natural Dry Unit V	Veight (va)	
Loca	tions: ⁽¹⁾ NJ105-CS ⁽⁴⁾ NJ105a-BH ⁽²⁾ NJ105-CSa ⁽⁵⁾ NJ105b-BH ⁽³⁾ NJ105-BH		all Cone)		Fsti	(In situ Vane) mated from CPT data		Natural Wet Unit		
	rofile is represented by location NJ105-CS cates F8 cone used	* s _u (R Half full symbols				= 15 - 20)				
Ţ	TYPE OF BIT: ⁽¹⁾ TC Hexagon Bit ⁽²⁾ PCD Bit ⁽³⁾ 5 Wing Drag Bit ⁽⁴⁾ 5 Wing Drag Bit ⁽⁵⁾ 5 Wing Drag Bit	COORDINATES :	444490.6 r 444488.5 r 444487.9 r 444483.0 r	nE 5970251.1 r	nN ⁽¹⁾ WATER nN ⁽²⁾ nN ⁽³⁾ nN ⁽⁴⁾	ation CDEPTH : 32.3 m LAT : 32.5 m LAT : 31.6 m LAT : 32.9 m LAT : 32.2 m LAT	(2) (3) (4)	: 15/12/2012 - 15/1 : 23/11/2012 - 24/1 : 22/07/2012 - 22/0 : 25/07/2012 - 25/0 : 30/07/2012 - 31/0	1/2012 ⁽²⁾ 7/2012 ⁽³⁾ 7/2012 ⁽⁴⁾	

	EPTH (m)	SOIL DESCRIPTION		SAMPLE OR TEST NO	Undrained Streng s _u [kP 200 400	th	Cone Resistance q₅ [MPa] 00 0 60 120	Moisture Content w [%] 0 40 80	Unit Weight γ [kN/m ³] 5 15 25		Mud Pressure [kg/cm ²] 0 20
0		0.0 m to 1.1 m - Dark olive brown fine to medium SAND, with traces of coarse		RC 1	A 400						
1		sand-sized to fine gravel-sized shell		RC 1 RC 1 RC 2 RC 2							
2		fragments // 1.1 m to 18.2 m - Stiff to hard dark	· ·/°	RC 2 RC 2							
3		brown slightly sandy slightly gravelly CLAY, with widely to very widely spaced		RC 3							
		medium to thick beds of slightly silty gravelly fine to medium sand and with		RE 3							1
4		traces of fine gravel-sized shell fragments. Gravel is fine to coarse									
5		subangular to subrounded of mixed lithologies including chalk and flint		RC 4							1
6		- from 1.1 m to 1.5 m - with coarse gravel-sized pockets of slightly gravelly		RC 5 RC 5	V V						
7		fine to medium sand - from 1.8 m to 2.5 m - thick bed of		RC 5	V V						1
		clayey gravelly fine to medium sand - at 4.0 m - end of borehole NJ106-CSb		RE®	v						1
8		- at 5.4 m - with a cobble			v				┥┝┼┾╞┉		
9				RC 7 RC 7	▼ ▼						1
10		- at 9.9 m - end of borehole NJ106-CSa			••						
11				RC 8	• •						
					v					i	1
12				RC 9	•						
13					- V				┥┝┼┼╘┢━┼╌		1
14				RC 10	• •	K					1
15					v	2					
				RC 11	T						1
16			··· ° ///i•			·					
17		- from 16.0 m to 17.3 m - with coarse		RC 12							
18		gravel-sized pockets of silty fine to medium sand									1
19		- at 16.7 m - with a subangular cobble of grey sandstone		R2 13		v					
		18.2 m to 20.1 m - Very hard dark olive brown slightly sandy slightly gravelly		RC 14					┤ ╎ ⋳		1
20	l h	CLAY, with coarse gravel-sized pockets of silty fine to medium sand. Gravel is		1014	• • •						1
21		fine to coarse subangular to subrounded of mixed lithologies including chall		RC 15							
22		- from 19.4 m to 20.1 m - thick bey of slightly silty fine to medium sand			• •					l l	
23		20.1 m to 34.7 m - Very stiff to hard very dark grey CLAY, with coarse		RC 16	▼						
		gravel-sized pockets of silty fine to medium sand and with few fine			¥* ,						
24		subangular gravel of mixed lithologies including chalk		RC 17	•						
25		- from 22.9 m to 28.7 m - with lenses of silt			- V				┥┝┊┢┊		
26				RC 18	•						
27					v						
21				RC 19	•			ix i			
28											
29				RC 20	•						
30				RC 21	v						
		ING REMARKS: f Mud: Guar-Gum/Seawater	KEY FO	R UNDRAINE su (Torvan	D SHEAR STRENG		aboratory Vane)	KE'	Y FOR MOISTURE COM		
	Votes:		- •		Penetrometer)		Jndrained Triaxial)		Y FOR UNIT WEIGHT:	(**)	
L	ocatio	ons: ⁽¹⁾ NJ106-CS	٠	su (Fall Co	,		n situ Vane)		Natural Dry Unit V		
	oil D-	⁽²⁾ NJ106-CSa ⁽³⁾ NJ106-CSb	*		ded In situ Vane)	Estin	nated from CPT data = 15 - 20)	a 📕	Natural Wet Unit	vveight (γ _w)	
		file is represented by location NJ106-CS ates F8 cone used	Half full		o remoulded tests. ea Offshore Wind Fa		,				
_	6			TES : 42936	2.0 mE 5970075.7 3.3 mE 5970080.2	mN ⁽¹⁾ WATER			E : 10/11/2012 - 11/1 : 12/11/2012 - 12/1		
		(3) PCD Bit			6.8 mE 5970080.2		: 28.8 m L/		: 12/11/2012 - 12/1		

	SOIL DESCRIPTION	SOIL SAMPLE PROFILE TEST I	OR	Undrained Shear Strength su [kPa] 0 400 600 80		Cone esistance q _c [MPa] ₆₀ 120	Moisture Content w [%] 0 40 80	Unit Weight γ [kN/m ³] 5 15 25		Mud Pressure [kg/cm ²] 0 20
30 31	20.1 m to 34.7 m - Very stiff to hard very dark grey CLAY, with coarse gravel-sized pockets of silty fine to	R	C 21	*						
32	medium sand and with few fine subangular gravel of mixed lithologies including chalk	R	0.22	• •						
33	- from 32.5 m to 33.1 m - medium bed of dark grey clayey fine to medium sand	R	0 23	v						
34 35	34.7 m to 44.5 m - Very dark greyish	R.	C 24	▼ ▼						
36	brown very silty fine to medium SAND, with medium to widely spaced very thin to thin beds of slightly silty fine to	R	C 25							
37	medium sand and traces of coarse sand-sized to coarse gravel-sized shell fragments	R	C 26				X : X :			
38 39	- at 46.2 m - with a medium gravel-sized pocket of organic material		C 27							
40							× · · · · · · · · · · · · · · · · · · ·			
41		R	0.28							
42		R	C 29							
44	- from 43.9 m to 44.5 m - extremely closely spaced thin laminae of clay and	R	C 30							
45	silt, with laminae of black organic particles and traces of coarse sand-sized to medium gravel-sized shell		0.31	- P			×			
46 47	fragments 44.5 m to 50.1 m - Dark grey slightly silty fine to medium SAND, with widely		C 32	MR.						
48	spaced thin laminae to very thin beds of clay, with few pockets and lenses of organic particles and traces of coarse	R								
49	sand-sized to medium gravel-sized shell fragments - at 47.5 m - very thin bed of compressed organic material		C 34							
50 51	- at 50.1 m - end of borehole NJ106-CS									
52	< <u>-</u>									
53										
54 55										
56										
57					 					
58										
59 60										
Ty	RILLING REMARKS: ype of Mud: Guar-Gum/Seawater lotes:	▲ su (T	orvane)	AR STRENGTH:	su (Laborat		×	OR MOISTURE CON Moisture Content		
Lo	ocations: ⁽¹⁾ NJ106-CS ⁽²⁾ NJ106-CSa		ocket Penetro all Cone)	meter) •	s _u (In situ V		KEY F	OR UNIT WEIGHT: Natural Dry Unit V Natural Wet Unit V		
	(3) NJ106-CSb oil Profile is represented by location NJ106-CS Indicates F8 cone used	Half full symbols		itu Vane)	(N _{kt} = 15 - 2	rom CPT data 0)				
	TYPE OF BIT: ⁽¹⁾ PCD Bit ⁽²⁾ PCD Bit ⁽³⁾ PCD Bit	COORDINATES : 4	429362.0 mE 429363.3 mE	5970075.7 mN ⁽¹⁾ V 5970080.2 mN ⁽²⁾ 5970080.2 mN ⁽³⁾		H : 28.7 m LAT : 28.8 m LAT : 28.8 m LAT	(2)	: 10/11/2012 - 11/11 : 12/11/2012 - 12/11 : 12/11/2012 - 12/11 : 12/11/2012 - 12/11	1/2012 ⁽²⁾	

OREHOLE NJ106-CS (PRELIMINARY) SHEET 2 OF 2	BOREHOLE	2

DEPTH (m) SOIL DESCRIPTION	SOIL SAMPLE OR PROFILE TEST NO	Undrained Shear Strength su [kPa] 200 400 600 800 1	Cone Resistance qc [MPa] 1000 0 120 0	Moisture Content w [%] 40 80	Unit Weight γ [kN/m ³] 5 15 25	Bit Mud Load Pressure [tonnes] [kg/cm²] 0 2 10
0 0.0 m to 0.4 m - Loose to medium de		2				
1 O.4 m to 11.4 m - Stiff to hard dark br 0.4 m to 11.4 m - Stiff to hard dark br slightly sandy slightly gravelly CLAY, 2 medium to widely spaced thin to med beds of medium dense to very dense 3 to rounded of mixed lithologies - at 0.4 m - with a cobble 4 - at 3.8 m - with a cobble	with ium R63					
 at 6.0 m - end of borehole RS-BH at 6.0 m - end of borehole RS-BH 	CPT 2 RC 5 RC 6 CPT 1					
 9 10 - at 10.3 m - with a very thin bed of yellowish brown slightly gravelly clave fine to medium subangular to rounded of mix lithologies - at 10.6 m - with a cobble, possible gabbro 11.4 m to 17.7 m - Dense to very den yellowish brown slightly silty fine to co SAND, with fine to medium gravel-siz shell fragments and with medium to v spaced thin beds of clayey sand	RC 10 RC			$\begin{array}{c c c c c c c c c c c c c c c c c c c $		
 17 - at 17.5 m - with a very thin bed of w fragments 17.7 m to 24.9 m - Very weak, mediu density, white becoming light grey CH Fractures are very widely spaced (200,1290,2740) infilled (2,4,8) with li grey comminuted chalk (Grade C1) 21 22 	rood					
 23 24 25 24.9 m to 27.7 m - Very weak, mediu very high density, light grey CHALK. 	СРТ 9			X I 		1 1 1 4
 Fractures are closely to medium space (100,400,1300) infilled (1,1,3) with wh comminuted chalk (Grade B2) Z7 7.7 m to 34.6 m - Very weak to weak medium density to very high density, grey CHALK. Fractures are closely to medium spaced (70,350,1800) clean (Grade A4) from 28.5 m to 30.0 m - with occassional dark grey staining and th 	ite RC 20 CPT 10 RC 21 CPT 10 RC 21 CPT 10 RC 21 CPT 10 RC 22 CPT 00 RC 21 CPT 00 RC 21 CPT 00 RC 20 CPT 00 RC 20 RC 20		=			
30 beds of dark grey chalk DRILLING REMARKS: Type of Bit: - CS locations: TC Hexagon Bit - BH locations: 5 Wing Drag Bit Type of Mud: Guar Gum water mixture Notes: ⁽¹⁾ RS-CS (2) RSa-BH (4) RS-CSa Soil Profile is represented by location RS-CS * Indicates F8 cone used	KEY FOR UNDRAINED SH ▲ su (Torvane) ▼ su (Pocket Penett ◆ su (Fall Cone) 米 su (Remoulded In Half full symbols refer to remo	n situ Vane) → Su sutu Vane) → Su → Su	(Laboratory Vane) (Undrained Triaxial) (In situ Vane) timated from CPT data _{kt} = 15 - 20)	×	R MOISTURE CON Moisture Content (R UNIT WEIGHT: Natural Dry Unit W Natural Wet Unit W	w) /eight(γ _d)
TUGRO	COORDINATES : 363516.0 m : 363504.9 m : 363513.7 m)	: 10/10/2012 - 11/10 : 13/07/2012 - 15/07 : 02/07/2012 - 02/07 : 12/10/2012 - 13/12	/2012 ⁽²⁾ /2012 ⁽³⁾

GeODin-System 7.5//15/10/2012 09:41:55

BOREHOLE RS-CS (PRELIMINARY) SHEET 1 OF 3

DEPT (m)			SAMPLE OR TEST NO	Undrained Shear Strength su [kPa] 200 400 600 800 100	Cone Resistance q _c [MPa]	Moisture Content w [%] 0 40 80	Unit Weight γ [kN/m ³] 5 15 25		Mud Pressure [kg/cm ²] 0 10
30	27.7 m to 34.6 m - Very weak to weak,		CPT C2PT						1
31	medium density to very high density, ligh grey CHALK. Fractures are closely to		RC 23						
32	medium spaced (70,350,1800) clean (Grade A4)		CPT 14*			*			
52			RC 24 CPT						
33			RC 24 CPT 15* CPT 16* CPT						
34			17* RG-25						
	」 □ - from 34.5 m to 34.6 m - Very weak,		18*			X			1
35	medium density, light grey chalk. Frature		19* CPT ŘČ 26			*			1
36	are very cloesly spaced (50,50,50) infilled (20,20,20) with comminuted chalk and) 	CPT		- +~~				
	medium gravel-sized fragments of chalk (Grade C4)		21*			X			1
37	34.6 m to 51.2 m - Very weak, medium		RC 27 CPT 23* CPT						
38	density, light grey CHALK. Fractures are close to medium spaced (10,300,2350)		24*						
	infilled (1,1,3) with light grey communited chalk (Grade B2 - B3)		CPT					1	1
39			26* CPT						1
40			27* RC 29			X I			1
			CPT 28*			$\dot{\mathbf{n}}$			1
41			CPT RC 30						
42			CPT 0PT 31*						i
40			CPT RC 31						
43			CPT						
44			34* B⊊₁32			× ! ! !			i
45			35*	2	2				
43			8¢133		- <u>M</u>				
46			36* RC 34			*			1
47	- at 46.5 m - becoming white to light grey		RC 34 CPT 37*						║╎┍ ┛
			RC 35 BETE			X I			
48			39° €€ 36			т т Х 1			
49	- at 48.5 m - end of borehole RS-CS		CPT Atc 7						
			CPT 42			×			
50			CPT 43 CPT			× !			
51			CPT						
52	51.2 m to 55.9 m - Very weak, medium density, light grey CHALK. Fractures are		45 CPT 46			* 1			┝╶╻╎┍┼┺╼
52	medium to very widely spaced		CPT RC 9 CPT						
53	(350,1193,2250) clean (Grade A1)		48 CPT 49 CPT					1	I
54	- at 53.6 m - with a thin lamina of black		CPT FRC 10 CPT 51						1
	staining								1
55			СРТ 52 АС Т11 СРТ					1	1
56			54 CPT			×			
	55.9 m to 61.0 m - Very weak, medium density, light grey CHALK. Fractures are		55 CPT B&C 12					1	I I
57	closely to medium spaced (80,529,1620) infilled (0,1,3) with light grey communited		57 CPT			× ! !			1
58	chalk (Grade B2)		58 CPT \$80:13						1
			CPT 60						1
59			CPT 61 CPT BSC 14					1	- <u>I</u>
60									
	LLING REMARKS: e of Bit: - CS locations: TC Hexagon Bit		UNDRAINED su (Torvane)	SHEAR STRENGTH:	aboratory Vane)	KEY F	OR MOISTURE CON		
	- BH locations: 5 Wing Drag Bit e of Mud: Guar Gum water mixture		su (Pocket Pe	· ·	Jndrained Triaxial)		Moisture Content OR UNIT WEIGHT:	(w)	
	es: ⁽¹⁾ RS-CS ⁽³⁾ RS-BH			, , , , , , , , , , , , , , , , , , ,	,		Natural Dry Unit V	Weight (γ_d)	
	⁽²⁾ RSa-BH ⁽⁴⁾ RS-CSa		su (Fall Cone	Estin	n situ Vane) nated from CPT data		Natural Wet Unit	Weight (γ _w)	
	Profile is represented by location RS-CS dicates F8 cone used				= 15 - 20)				
-	fugeo	LOCATION	: Hornsea ES : 363516.	Offshore Wind Farm Site Investiga 0 mE 5944069.9 mN ⁽¹⁾ WATER 9 mE 5944067.7 mN ⁽²⁾			: 10/10/2012 - 11/1 : 13/07/2012 - 15/0		
			: 363513.	7 mE 5944066.4 mN ⁽³⁾ 6 mE 5944067.4 mN ⁽⁴⁾	: 24.8 m LAT : 23.9 m LAT	(3)	: 02/07/2012 - 02/0 : 12/10/2012 - 13/1	7/2012 ⁽³⁾	

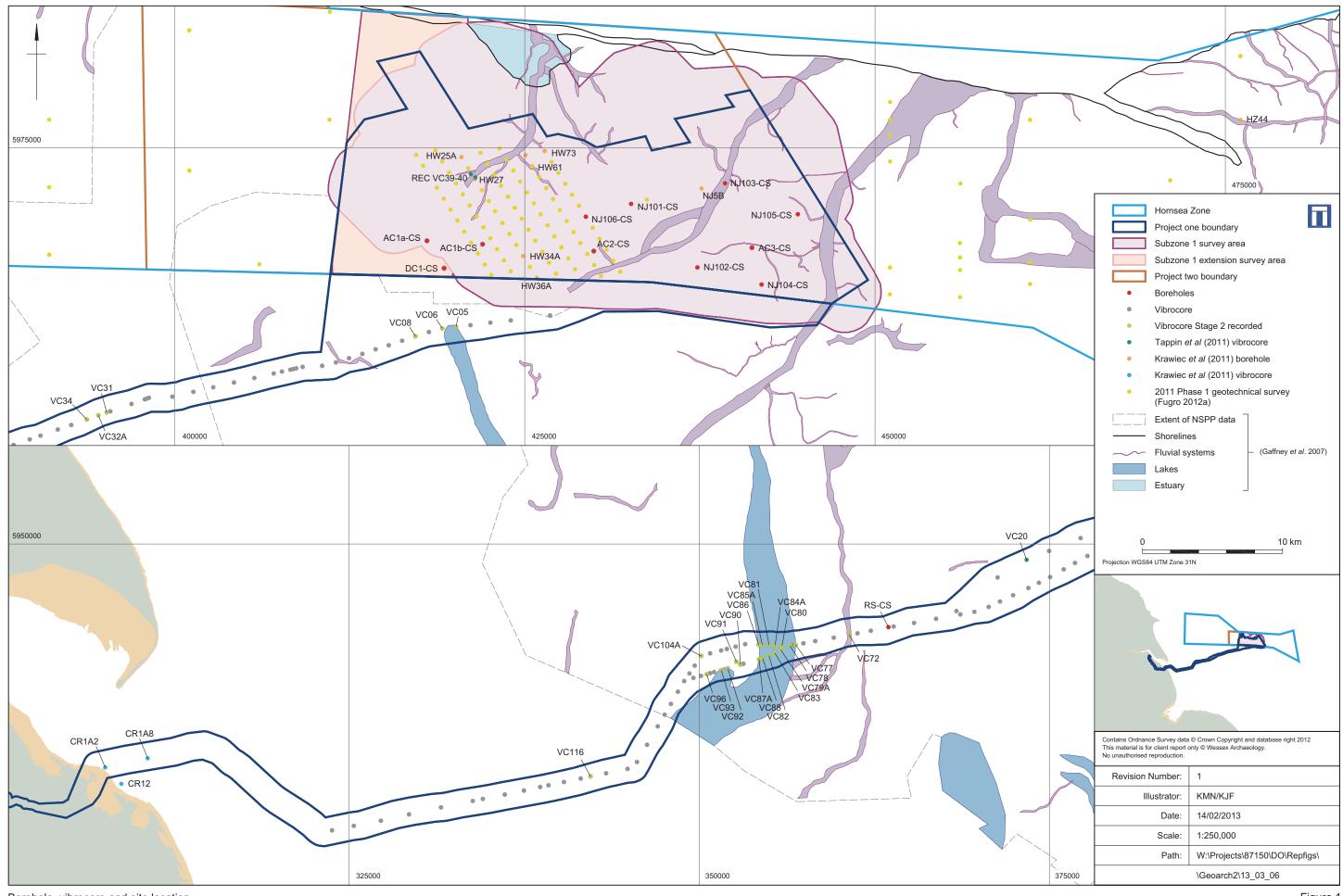
BOREHOLE RS-CS (PRELIMINARY) SHEET 2 OF 3

-System 7.5//15/10/2012 09:41:55

	PTH n)	SOIL DESCRIPTION		SAMPLE OR TEST NO	Undrained Shear Strength su [kPa] 200 400 600 8	q	Cone esistance [c [MPa] 60 120	Moisture Content w [%] 0 40 80	Unit Weight γ [kN/m ³] 5 15 25		Mud Pressure [kg/cm ²] 0 10
60		55.9 m to 61.0 m - Very weak, medium density, light grey CHALK. Fractures are		RСП4 6₽т		-					1
61	۱h	closely to medium spaced (80,529,1620)		64 CPT 68C 15 CPT					┥┝┼╒┿┼╴		
62		infilled (0,1,3) with light grey communited chalk (Grade B2)		66 CPT		-+	1				1
		61.0 m to 63.9 m - Very weak to weak, medium density to high density, light grey		67 CPT 88C 16							
63		CHALK. Fractures are closely to medium spaced (140,372,850) clean (Grade A2 -		CPT 69 CPT							1
64	ᅬᄂ	A3)		70 CPT 花 17			- 1			1	1
65		63.9 m to 76.5 m - Very weak to weak, medium density occassionally high		CPT 72 CPT			-			l i L	1
		density, white becoming light grey CHALł Fractures are medium to widely spaced	<.	73 CPT ŘC 18		-					1
66		(200,800,2770) infilled (1,2,3) with light grey communited chalk and occassionally		CPT 75 CPT						i	1
67		with fine gravel of chalk (Grade B1 - B2)		76 CPT RC 19							
68			F C	CPT 78 CPT			-			I I	1
00				79 CPT 86 20							1
69				CPT 81 CPT			- !			1	1
70		- from 69.3 m to 70.8 m - with traces of		CPT 82 CPT 80C 21		-+				1	1
71		black staining		CPT 84 CPT							1
				85 CPT RC 22							1
72				CPT 87			A ⁱ X⊢		┤┟┼╞╇┼╴		1
73				CPT 88 CPT 86 23				* :			1
74				CPT 90							
74		- at 74.4 m - with a coarse gravel-sized		CPT 91 CPT BC 24						1	1
75		inclusion of very dark grey pyritic clay		092-24 CPT 93 CPT							1
76				94 CPT RC 25			-				1
		76.5 m to 81.3 m - Very weak, medium		CPT 96 CPT	Mr.	-+	- 1				1
77	1	density, white occassionally mottled grey CHALK. Fractures are widely spaced		97 BET26			- <u> </u>				
78		(500,1660,3860) clean (Grade A1)					- i - I			i	1
79				CPT							1
				₩0127 CPT 102 CPT			-				1
80		- at 80.1 m - end of borehole RSa-BH		103 RC 28							1
81		- at 81.3 m - end of borehole RS-CSa		NG 20				× 1			
82		X									1
00											
83											1
84											
85						1	1			1	
86											
00											
87											
88											
89											
55											
90		NG REMARKS:									
		f Bit: - CS locations: TC Hexagon Bit - BH locations: 5 Wing Drag Bit		UNDRAINED S s _u (Torvane)	HEAR STRENGTH:	s _u (Laborato	ry Vane)		FOR MOISTURE COI Moisture Content		
Ту	ype o	f Mud: Guar Gum water mixture	•	su (Pocket Pen	etrometer)	s _u (Undraine	ed Triaxial)		FOR UNIT WEIGHT:	A	
N	otes:	⁽¹⁾ RS-CS ⁽³⁾ RS-BH ⁽²⁾ RSa-BH ⁽⁴⁾ RS-CSa	•	s _u (Fall Cone)	+	s _u (In situ Va	,		Natural Dry Unit Natural Wet Unit		
		file is represented by location RS-CS		su (Remoulded	, _, _	Estimated fro (N _{kt} = 15 - 20				5 (1-7	
*	Indica	tes F8 cone used	Half full sy	mbols refer to rer: : Hornsea C	noulded tests. Offshore Wind Farm Site I	vestigation					
	.fu	IGRO		ES: 363516.0 : 363504.9	mE 5944069.9 mN ⁽¹⁾ M mE 5944067.7 mN ⁽²⁾		: 24.4 m LA	r (2)	: 13/07/2012 - 15/0	7/2012 ⁽²⁾	
	V				mE 5944066.4 mN ⁽³⁾ mE 5944067.4 mN ⁽⁴⁾		: 24.8 m LA : 23.9 m LA		: 02/07/2012 - 02/0 : 12/10/2012 - 13/1		

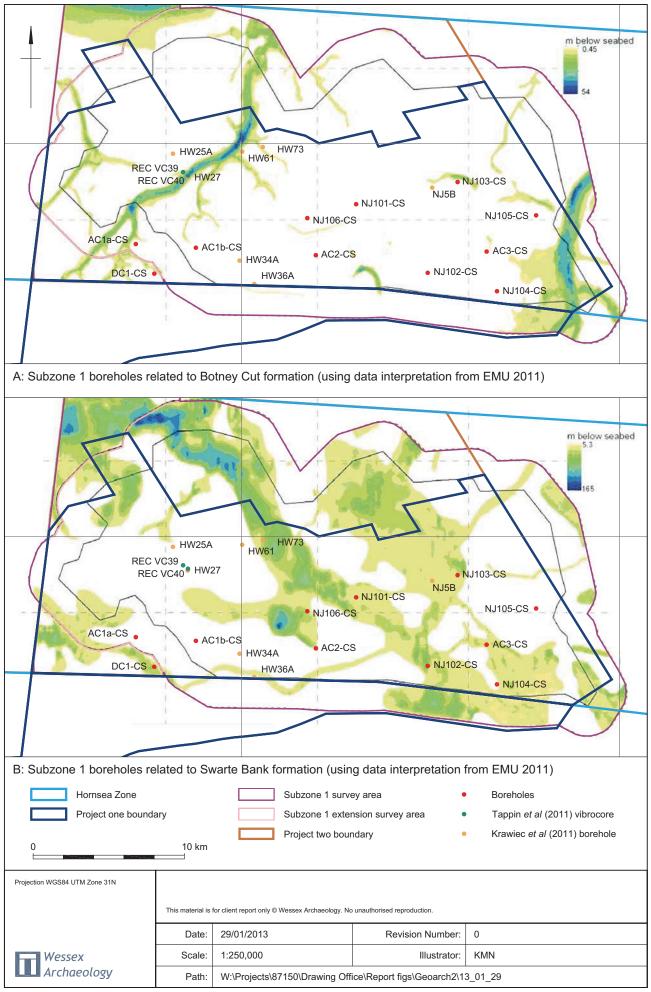
GeODin-System 7.5//15/10/2012 09:41:55

BOREHOLE RS-CS (PRELIMINARY) SHEET 3 OF 3

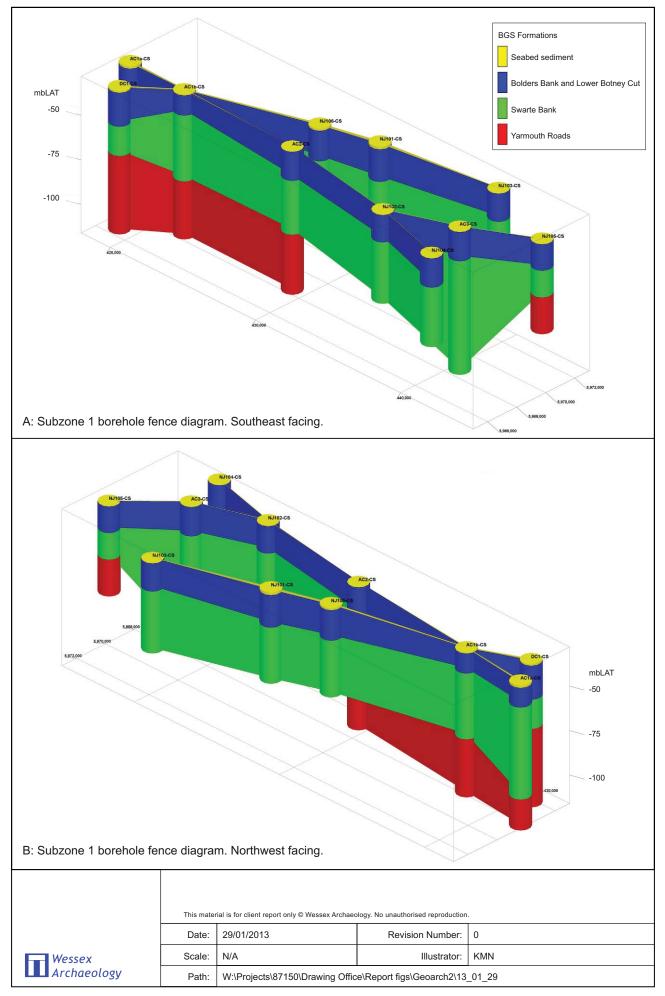


Borehole, vibrocore and site location

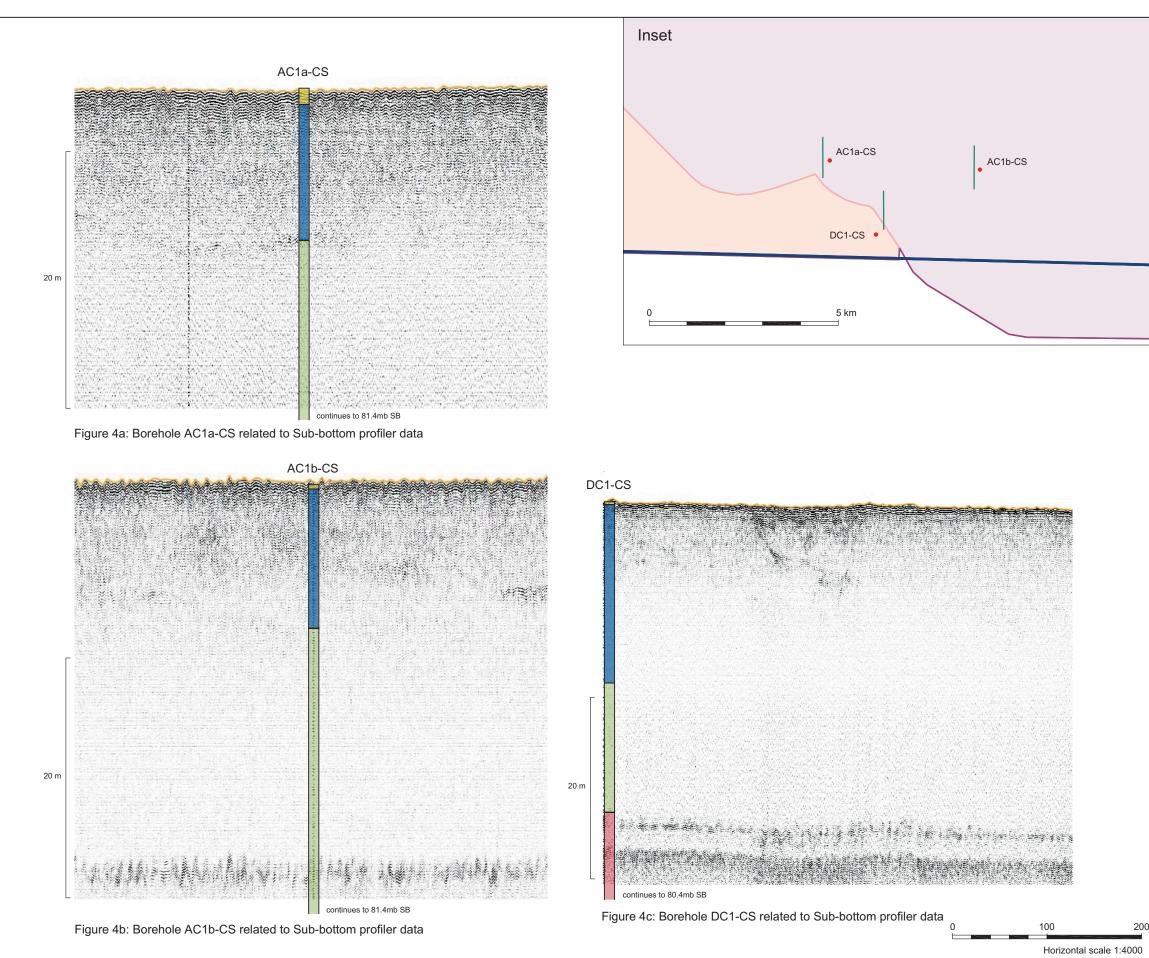
Figure 1



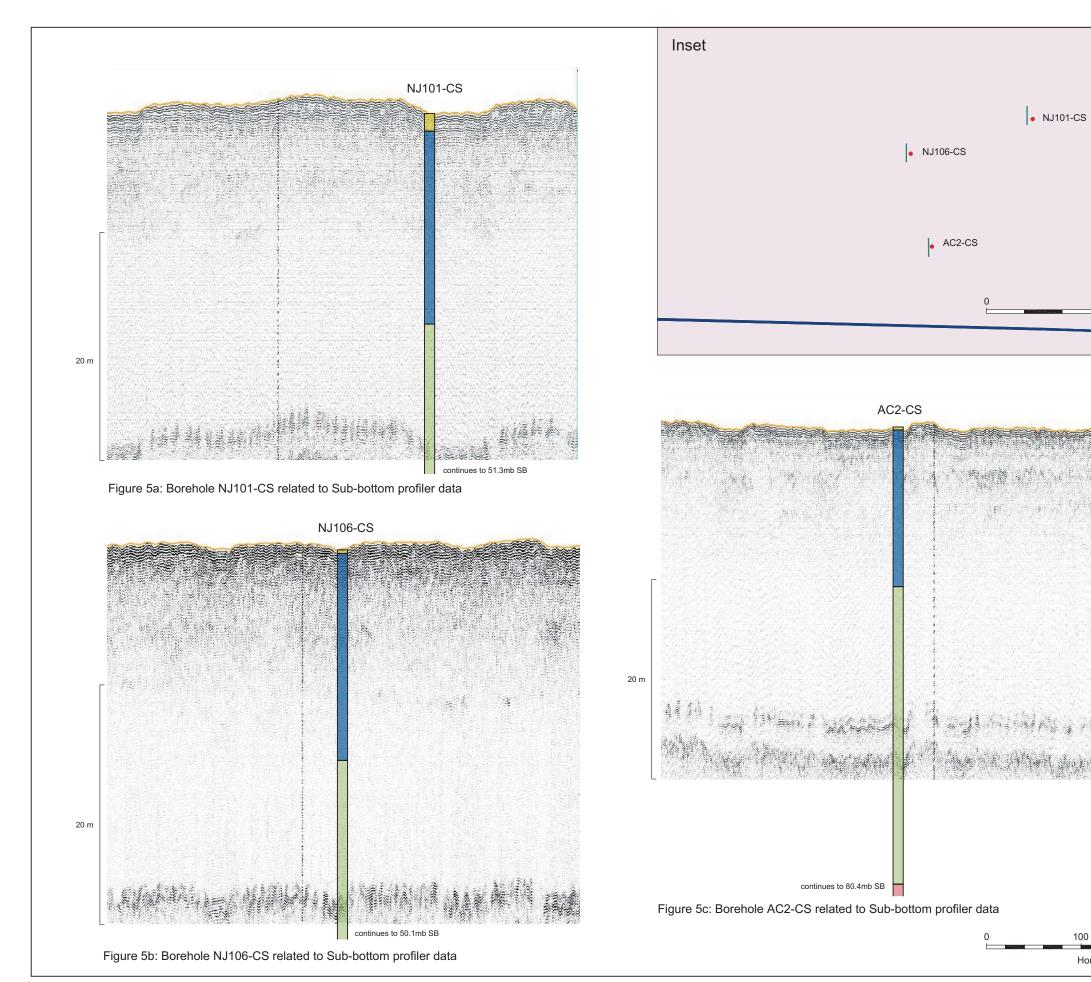
Subzone 1 boreholes in relation to Botney Cut and Swarte Bank formations



Borehole fence diagrams



	Wessex Archaeolog	y		
	Subzor	one boundary ne 1 survey area ne 1 extension survey area ttom profile location les		
	Bolders Swarte	d Sediment s Bank and Lower Botney Cut Bank uth Roads		
	This material is for client report only © Wessex Archaeology. No unauthorised reproduction.			
	Revision Number:	0		
	Illustrator: Date:	KJF 06/03/2013		
	Scale:	Inset 1:100,000		
) m	Path:	W:\Projects\87150\DO\Repfigs\		
	1 aui.	\Geoarch2\13_03_06		

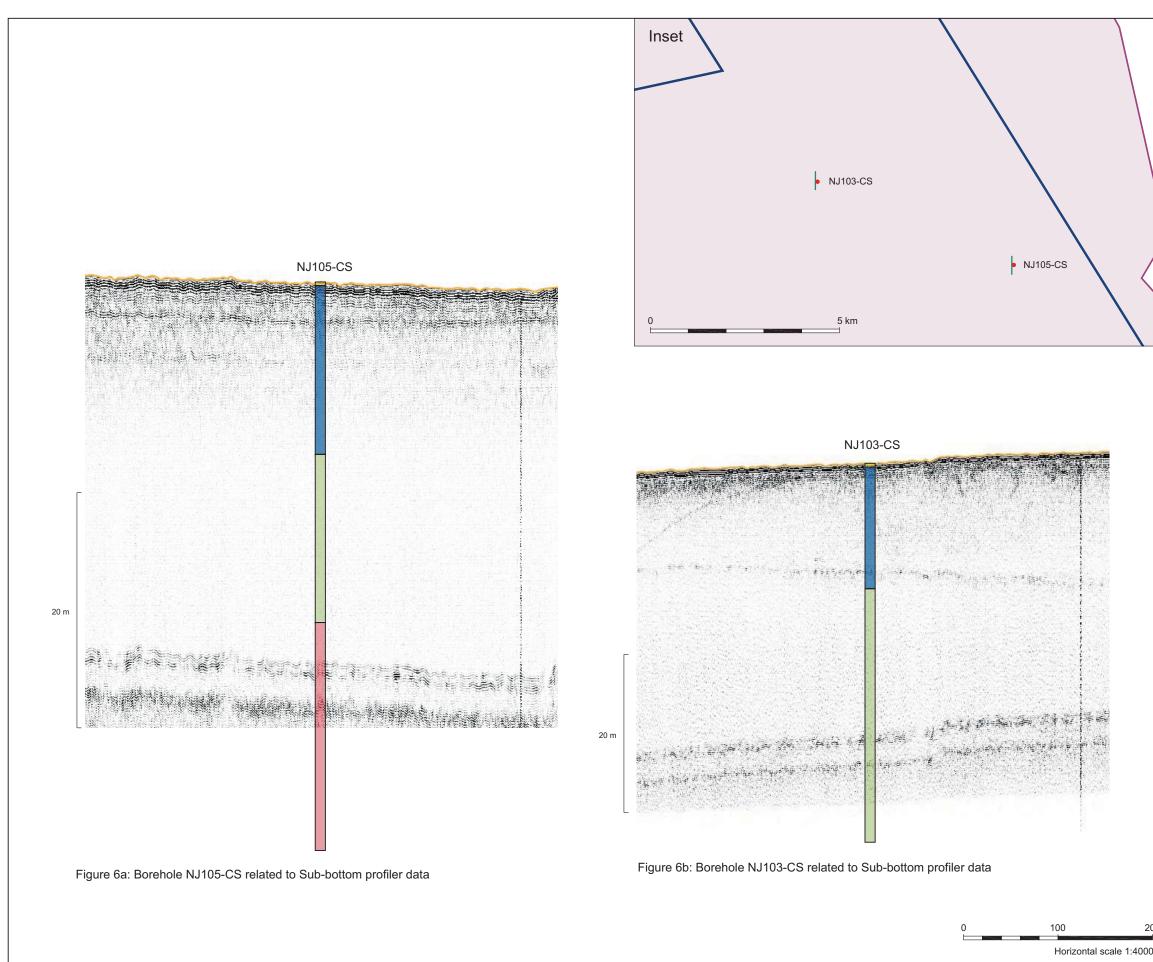


Borehole locations NJ101-CS, NJ106-CS and AC2-CS related to Sub-bottom profiler data

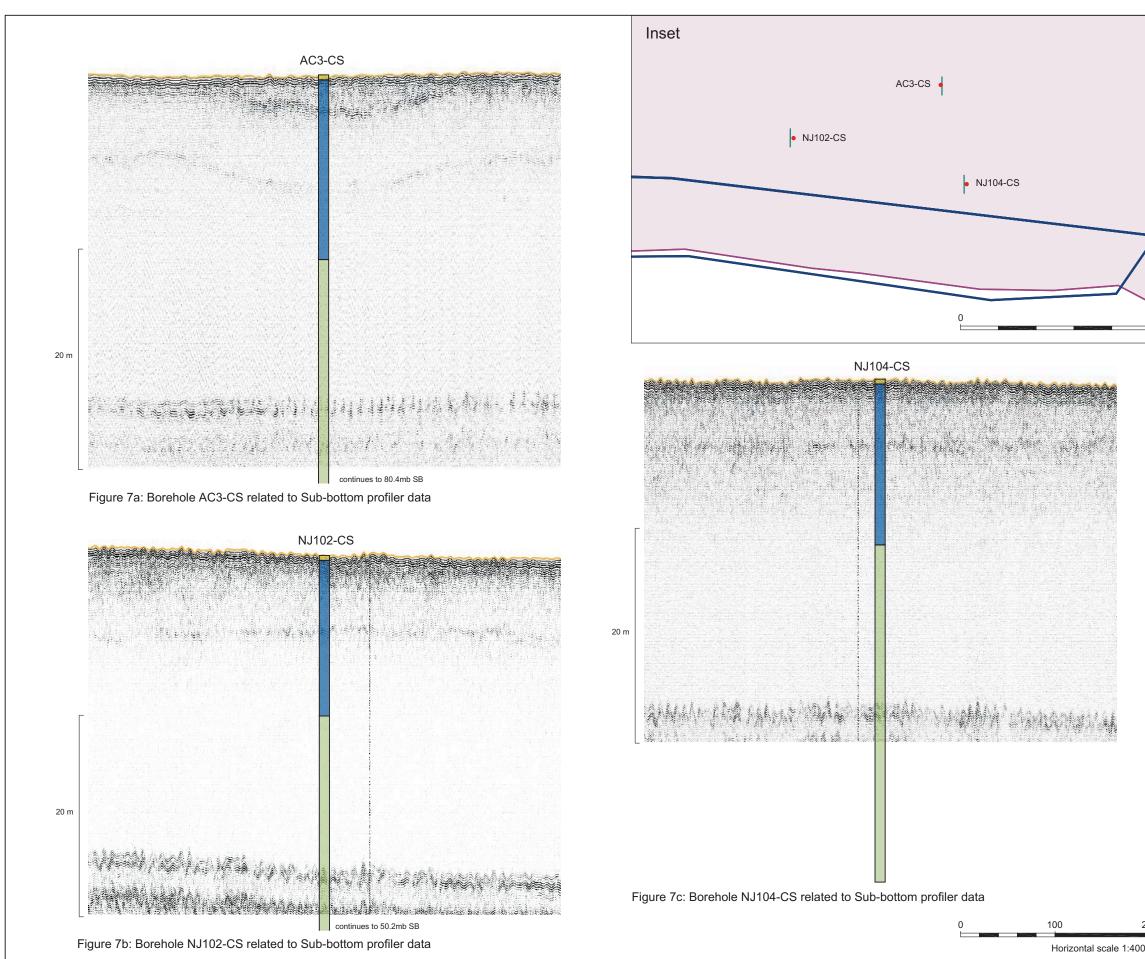
Horizontal scale 1:4000

100

	Wessex Archaeolog	У				
5 km	Subzor	one boundary ne 1 survey area htom profile location lles				
	Bolders Swarte	d Sediment s Bank and Lower Botney Cut Bank uth Roads				
This material is for client report only © Wessex Archaeology.						
	No unauthorised reproduction. Revision Number:	0				
	Illustrator:	KJF				
	Date:	06/03/2013				
	Scale:	Inset 1:100,000				
00 m	Path:	W:\Projects\87150\DO\Repfigs\				
)		\Geoarch2\13_03_06				

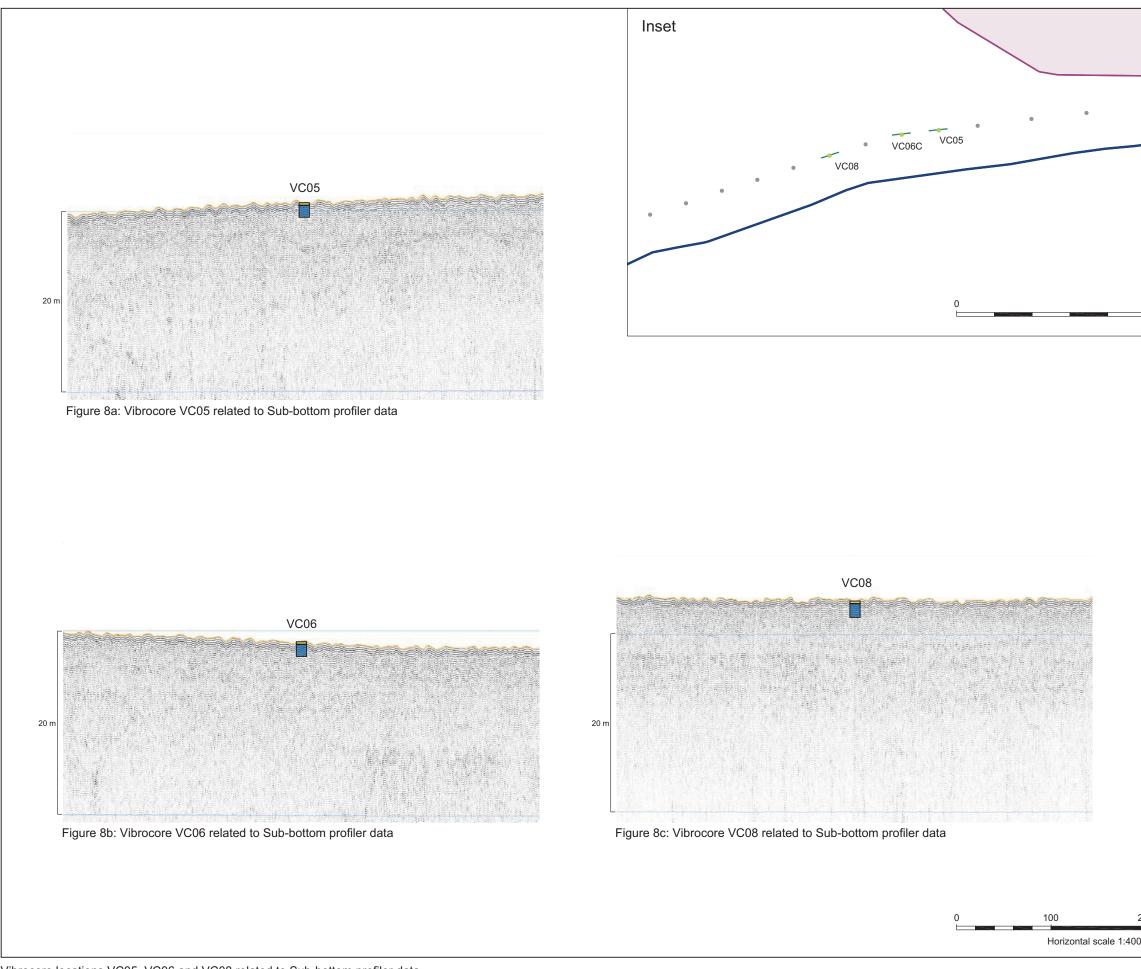


	Wessex Archaeolog	y			
	Subzor	one boundary le 1 survey area ttom profile location les			
	Bolders Swarte	l Sediment Bank and Lower Botney Cut Bank ıth Roads			
	This material is for client report on No unauthorised reproduction.				
	Revision Number:	0			
	Illustrator:	KJF			
	Date: Scale:	06/03/2013			
0 m	Path:	Inset 1:100,000 W:\Projects\87150\DO\Repfigs\			
	Paul:	w. IF TOJECIS IOT TOULDO (Repligs)			

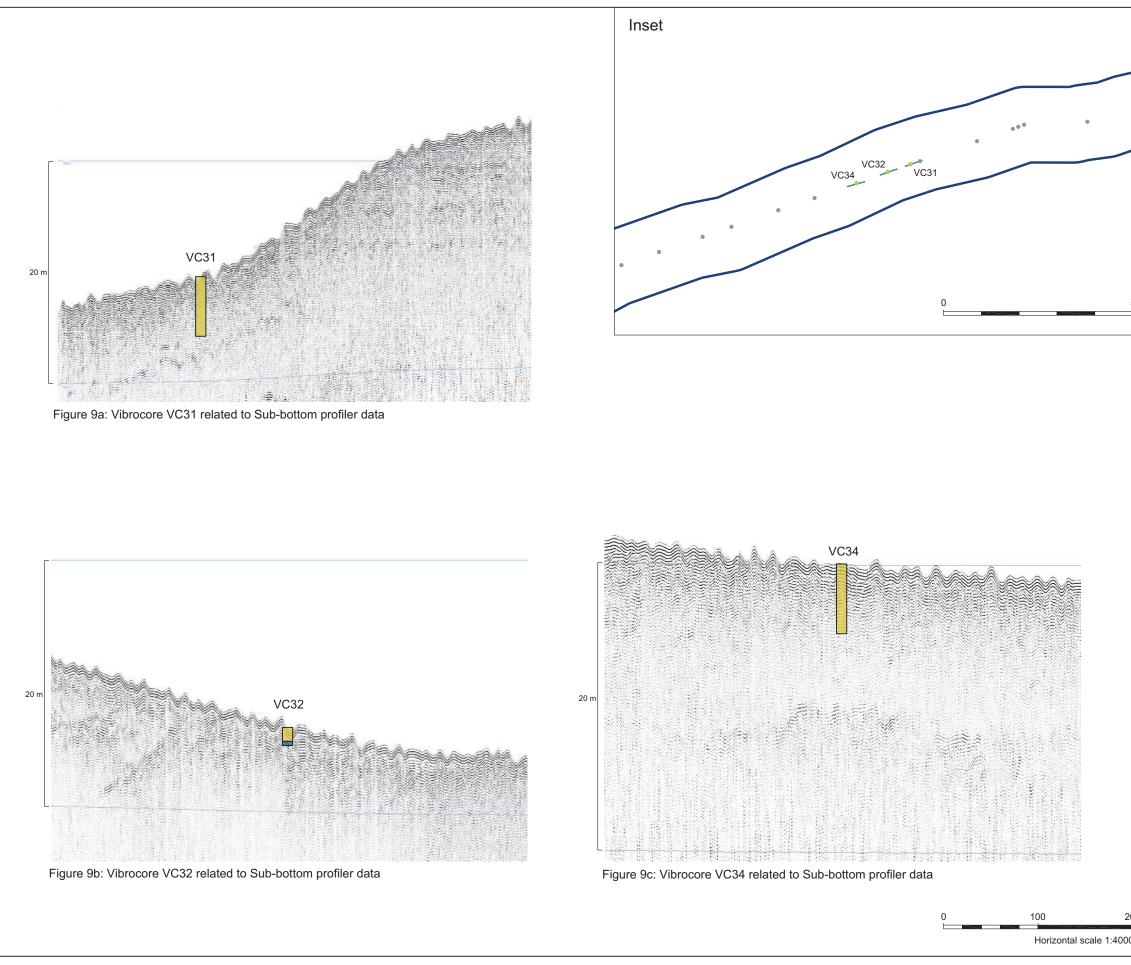


Borehole locations AC3-CS, NJ102-CS and NJ104-CS related to Sub-bottom profiler data

	Wessex Archaeolog	y
5 km	Subzor	one boundary ne 1 survey area ttom profile location les
	Bolders Swarte	d Sediment s Bank and Lower Botney Cut Bank uth Roads
	This material is for client report o	only © Wessex Archaeology.
	No unauthorised reproduction.	
	Revision Number:	0 KJF
	Date:	06/03/2013
	Scale:	Inset 1:100,000
200 m	Path:	W:\Projects\87150\DO\Repfigs\
00		\Geoarch2\13_03_06

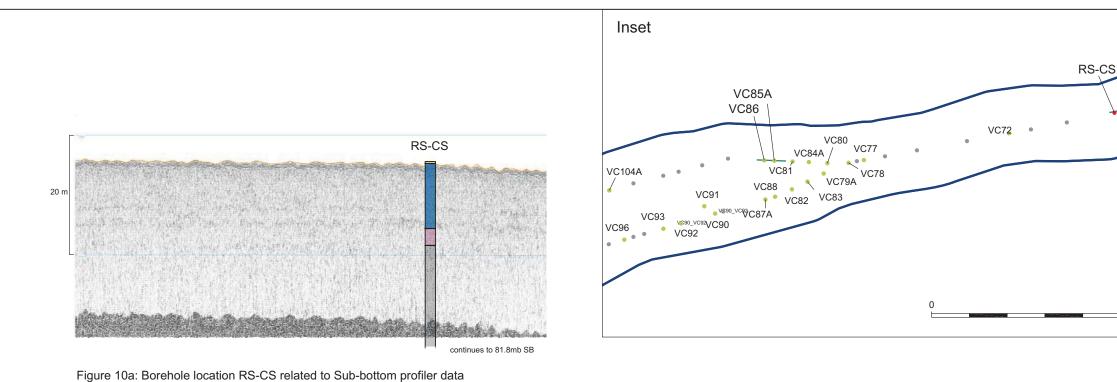


	Wessex Archaeolog	y		
5 km ⊐	5 km Project one boundary Subzone 1 survey area Sub-bottom profile location Vibrocore Vibrocore Stage 2 recorded			
		d Sediment s Bank and Lower Botney Cut		
	This material is for client report of No unauthorised reproduction.	only © Wessex Archaeology.		
	Revision Number:	0		
	Illustrator:	KJF		
	Date:	06/03/2013		
200 ~	Scale:	Inset 1:100,000		
200 m – 00	Path:	W:\Projects\87150\DO\Repfigs\		
00		\Geoarch2\13_03_06		



Vibrocore locations VC31, VC32 and VC34 related to Sub-bottom profiler data

	Wessex Archaeolog	y
•		
5 km ∐	Sub-bo Vibrocc	one boundary ttom profile location pre pre Stage 2 recorded
		d Sediment s Bank and Lower Botney Cut
	This material is for client report of No unauthorised reproduction.	
	Revision Number:	0
	Illustrator:	KJF
	Date:	06/03/2013
200 m	Scale:	Inset 1:100,000
00	Path:	W:\Projects\87150\DO\Repfigs\
		\Geoarch2\13_03_06



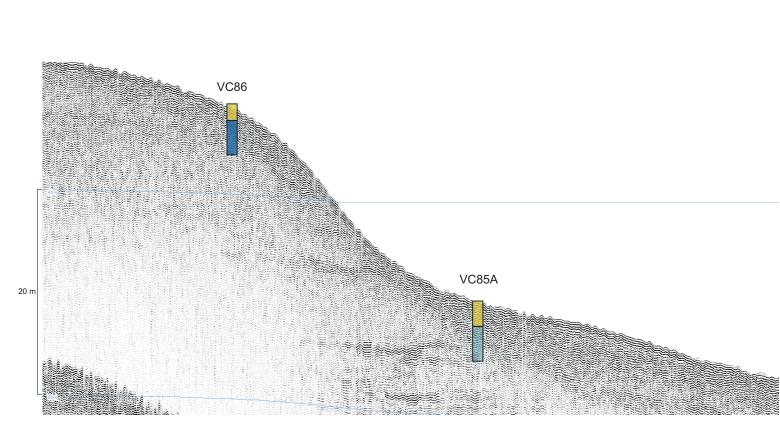
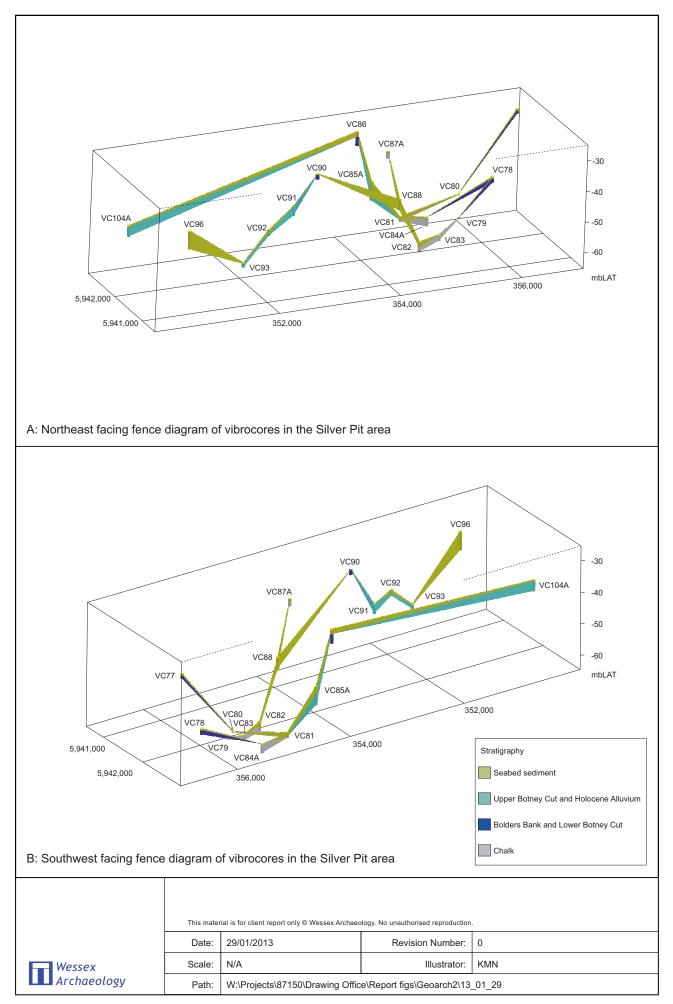


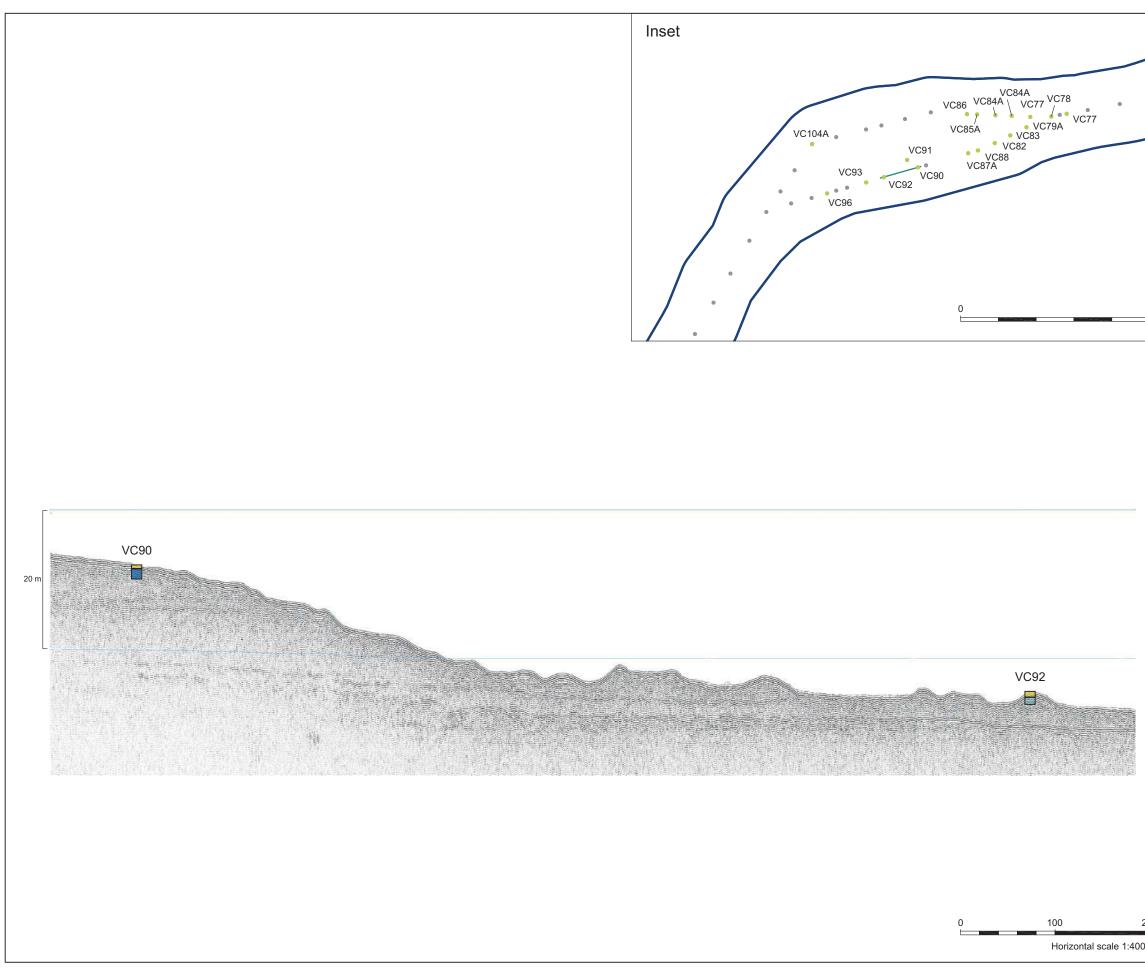
Figure 10b: Vibrocores VC85A and VC86 related to Sub-bottom profiler data

100 2 Horizontal scale 1:400

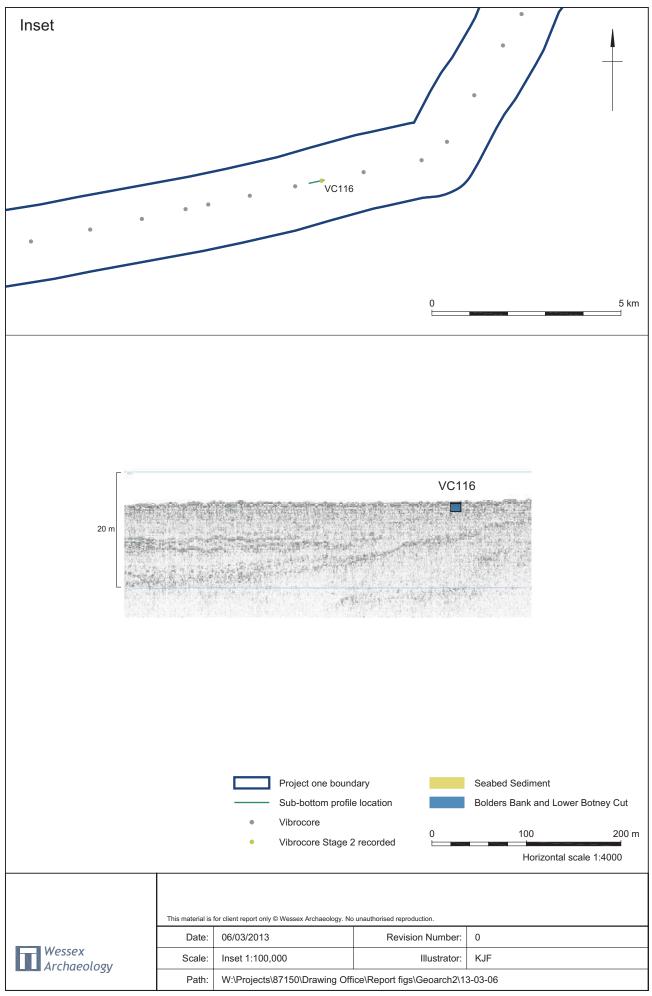
	Wessex Archaeolog	y
~		A land
5 km ⊒	Boreho	one boundary les ore Stage 2 recorded
	Upper Dolders	d Sediment Botney Cut and Holocene Alluvium & Bank and Lower Botney Cut d Ground
	This material is for client report of No unauthorised reproduction.	
	Revision Number:	0
	Illustrator:	KMN
	Date:	29/01/2013
	Scale:	Inset 1:100,000
200 m 200 m	Path:	W:\Projects\87150\DO\Repfigs\ \Geoarch2\13_01_29



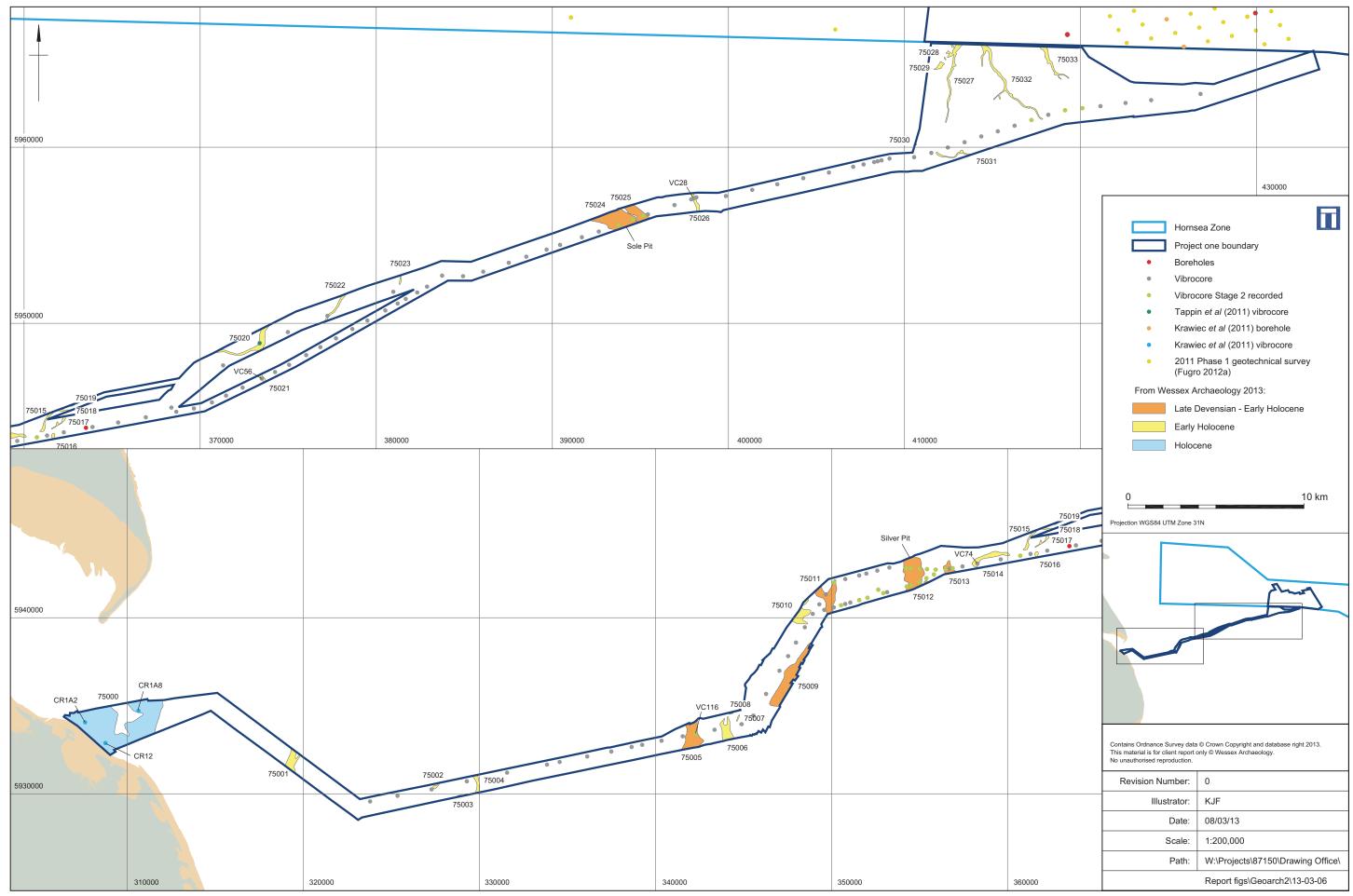
Vibrocore fence diagrams



	Wessex Archaeolog	y
5 km ⊐	Sub-bo Vibrocc	one boundary ttom profile location ore ore Stage 2 recorded
	Upper I	d Sediment Botney Cut and Holocene Alluvium Bank and Lower Botney Cut
	This material is for client report of No unauthorised reproduction.	only © Wessex Archaeology.
	Revision Number:	0
	Illustrator:	KJF
	Date:	06/03/2013
200	Scale:	Inset 1:100,000
200 m	Path:	W:\Projects\87150\DO\Repfigs\
00		\Geoarch2\13_03_06



Vibrocore location VC116 related to Sub-bottom profiler data



Vibrocores related to Palaeolandscape features of Archaeological Potential (Wessex Archaeology 2013)

Figure 14



Plate 1a: AC2-CS at 61.5m below SB



Plate 1b: DC1-CS at 57.4m below SB

	This material is for client report only © Wessex Archaeology. No unauthorised reproduction.			n.
	Date:	29/01/2013	Revision Number:	0
Wessex	Scale:	N/A	Illustrator:	KMN
Wessex Archaeology	Path:	W:\Projects\87150\Drawing Office\Report figs\Geoarch2\13_01_29		

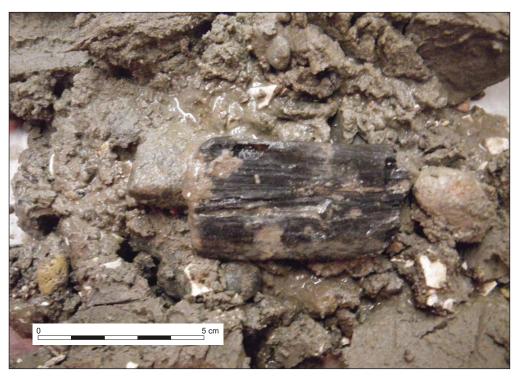


Plate 2a: NJ101-CS at 47.75m below SB



Plate 2b: DC1-CS at 20.10m below SB

		This material is for client report only © Wessex Archaeology. No unauthorised reproduction.				
		Date:	29/01/2013	Revision Number:	0	
	Wessex	Scale:	N/A	Illustrator:	KMN	
Archaeology		Path:	W:\Projects\87150\Drawing Office\Report figs\Geoarch2\13_01_29			



Plate 3a: AC2-CS at 2.50m below SB



Plate 3b: NJ103-CS at 1.95m below SB

	This material is for client report only © Wessex Archaeology. No unauthorised reproduction.			
Wessex Archaeology	Date:	29/01/2013	Revision Number:	0
	Scale:	N/A	Illustrator:	KMN
	Path:	W:\Projects\87150\Drawing Office\Report figs\Geoarch2\13_01_29		



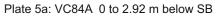
Plate 4a: NJ-103-CS at 0.1m below SB



Plate 4b: AC2-CS at 0 m below SB

This material is for client report only © Wessex Archaeology. No unauthorised reproduction.				
	Date:	29/01/2013	Revision Number:	0
Wessex Archaeology	Scale:	N/A	Illustrator:	KMN
	Path:	W:\Projects\87150\Drawing Office\Report figs\Geoarch2\13_01_29		





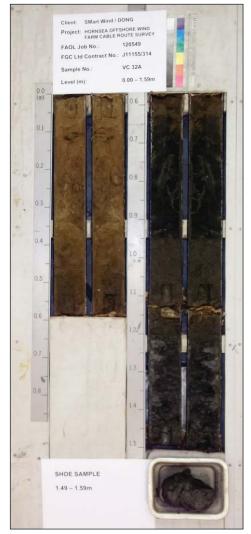


Plate 5b: VC32a 0.00 to 1.49 m below SB

This material is for client report only © Wessex Archaeology. No unauthorised reproduction.				
	Date:	29/01/2013	Revision Number:	0
Wessex Archaeology	Scale:	N/A	Illustrator:	KMN
	Path:	W:\Projects\87150\Drawing Office\Report figs\Geoarch2\13_01_29		



Plate 6a: VC78 0 to 1.92 m below SB

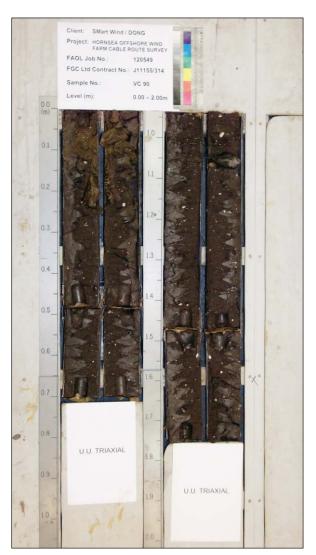


Plate 6b: VC90 0 to 1.75 m below SB

	This material is for client report only © Wessex Archaeology. No unauthorised reproduction.				
	Date:	29/01/2013	Revision Number:	0	
	Scale:	N/A	Illustrator:	KMN	
Wessex Archaeology	Path:	W:\Projects\87150\Drawing Office\Report figs\Geoarch2\13_01_29			







WESSEX ARCHAEOLOGY LIMITED. Registered Head Office: Portway House, Old Sarum Park, Salisbury, Wiltshire SP4 6EB. Tel: 01722 326867 Fax: 01722 337562 info@wessexarch.co.uk Regional offices in Edinburgh, Rochester and Sheffield For more information visit www.wessexarch.co.uk



Wessex Archaeology Ltd is a company with limited liability registered in England, No. 1712772 and VAT No. 631943833. It is also a Registered Charity in England and Wales, No. 287786; and in Scotland, Scottish Charity No. SC042630.