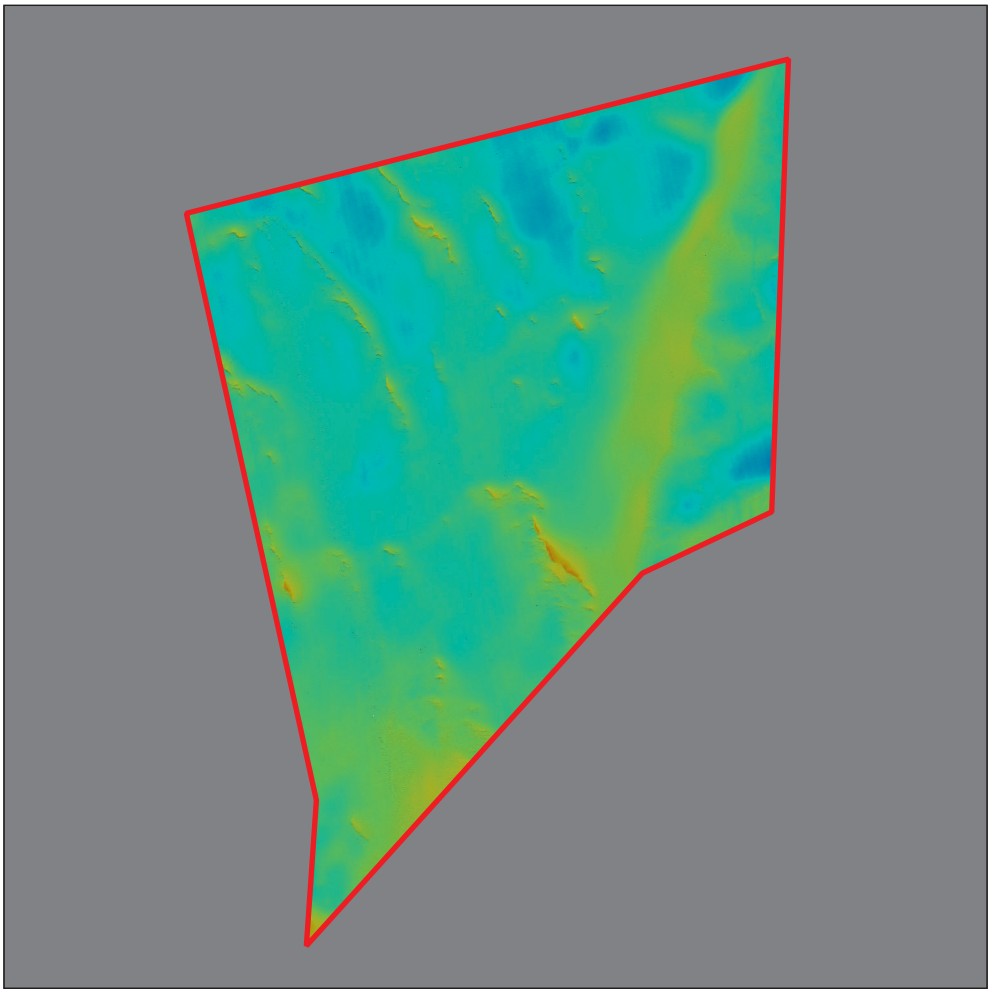
making sense of heritage

Humber Gateway Offshore Wind Farm

Geoarchaeological Assessment



Ref: 85771.01
April 2013

geoservices

HUMBER GATEWAY OFFSHORE WIND FARM

Geoarchaeological Assessment

Prepared for:

E.ON Climate & Renewables
Westwood Way
Westwood Business Park
Coventry
CV4 8LG.

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

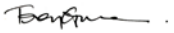
www.wessexarch.co.uk

April 2013

Report Ref: 85771.01

Quality Assurance

Project Code	85771	**Accession Code**		**Client Ref.**	E.ON
Planning Application Ref.		**Ordnance Survey (OS) national grid reference (NGR)**			

Version	Status*	Prepared by	Checked and Approved By	Approver's Signature	Date
v01	E	Andrew Bicket			11/04/2013
File:	85771_HumberGateway_Geoarch_11042013.docx				
v02	F	Andrew Bicket	TIG		17/06/2013
File:	85771_HumberGateway_Geoarch_11042013.docx				
File:					
File:					
File:					

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

DISCLAIMER

HUMBER GATEWAY OFFSHORE WIND FARM

Geoarchaeological Assessment

Contents

Figures

HUMBER GATEWAY OFFSHORE WIND FARM

Geoarchaeological Assessment

Summary

Geoarchaeological assessment has been undertaken of sediments retrieved during geotechnical investigations on the site of the Humber Gateway Offshore Wind Farm (OWF) (Figure 1, 2). This has comprised the assessment of 21 borehole logs and 60 Cone Penetrometry Testing (CPT) logs from 62 locations.

The following geological formations were interpreted, have been recorded within the boreholes and indicated by the CPT logs (Appendix 1).

- Unit 1: Cretaceous Chalk Bedrock
- Unit 2a: Upper Pleistocene Glacial Sediments (Upper Bolders Bank Formation)
- Unit 2b: Upper Pleistocene Glacial Sediments (Lower Bolders Bank Formation)
- Unit 3: Holocene Seabed sediments

No further archaeological work on the boreholes is recommended.

HUMBER GATEWAY OFFSHORE WIND FARM

Geoarchaeological Assessment

Acknowledgements

Wessex Archaeology has been appointed by E.ON Climate & Renewables (E.ON) to assist in the archaeological assessment of Humber Gateway OWF. Wessex Archaeology would like to extend their thanks to E.ON Climate & Renewables, and particularly Philippa Powell, for their assistance and support with all aspects of the project.

Dr Andrew Bicket carried out the geoarchaeological assessment of borehole and CPT logs and compiled this report. The illustrations were prepared by Kitty Foster.

Toby Gane managed the project for Wessex Archaeology and Quality Assurance was undertaken by Jack Russell.

HUMBER GATEWAY OFFSHORE WIND FARM

Geoarchaeological Assessment

1 INTRODUCTION

1.1 Background

1.1.1 Wessex Archaeology (WA) was commissioned by E.ON Climate & Renewables (E.ON) to undertake a Stage 1 review of geotechnical logs from the Humber Gateway Offshore Wind Farm main site (hereafter "the Site"), the locations of which are shown on **Figure 1**.

1.1.2 21 borehole logs from 62 locations were geoarchaeologically assessed. 18 borehole logs and 60 CPT logs were drilled by G-Tec (G-TEC 2012) between 10th March 2011 and 2nd June 2012. Three further boreholes were drilled by Canyon Offshore Ltd (COL) (COL 2012), between 19th February 2012 and 8th March 2012. The locations of the boreholes and CPT samples are given in **Appendix 1** and shown on **Figure 1**.

1.1.3 In addition to this assessment an archaeological assessment of geophysical data is currently underway as part of the Humber Gateway Offshore Windfarm project. A Written Scheme of Investigation (WSI) has been prepared for the site regarding in particular the archaeological assessment boreholes and acquisition of borehole samples (Wessex Archaeology 2011a). Previous archaeological assessments of the seabed have been carried out for the development in association with turbine locations and cable route (Wessex Archaeology 2005; 2009; 2011b; 2012a).

1.2 Aims and objectives

1.2.1 The specific aims and objectives of this investigation were set out in the WSI (Wessex Archaeology 2011):

- *To generate geoarchaeological data for archaeological assessment;*
- *To obtain sub-samples of sequences of archaeological interest that can be considered in decisions about palaeo-environmental assessment, analysis and scientific dating.*

2 METHODOLOGY

2.1.1 The specific method for the acquisition and geoarchaeological assessment of boreholes was set out in the WSI (Wessex Archaeology 2011a).

2.1.2 The detailed methodology for assessment of the geotechnical logs was set out within the WSI (Wessex Archaeology 2011). Each borehole log was assessed and interpreted with reference to the known mapped geological formations recorded by the British Geological Survey (Cameron *et al*. 1992) and to other geoarchaeological assessments undertaken in the same region, i.e. the Humber Regional Environmental Characterisation (REC) (Tappin *et al*. 2011). Data from the interpreted borehole logs was then compiled into a computer program (Rockworks) in order to create a borehole model. The borehole locations were

also viewed in relation to georeferenced maps and charts of the area held within the Wessex Archaeology archive using ArcGIS 10 software.

3 PROJECT BASELINE

3.1 Development Background

3.1.1 The proposed development is located offshore to the east of the mouth of the River Humber (**Figure 1**). It is proposed that 73 turbines will be installed as part of the development. Geotechnical data is to be acquired to support the detailed design of turbine foundations, as well as additional locations, and to inform installation methods. Each location is to be investigated by cone penetration test and by borehole to a minimum depth of 30m below seabed.

3.1.2 As noted within the WSI (Wessex Archaeology 2011a) it was proposed that borehole and CPT logs from both the main site and cable route would be assessed. Logs from borehole and CPT locations were only received for the main site. This report does not include coverage of the cable routes.

3.2 Geoarchaeological Background

3.2.1 The British Geological Survey has mapped the solid and drift geology within the site as Upper Pleistocene glacial and sub-glacial deposits of the Bolders Bank Formation. This is overlain in places by a thin veneer of mobile Holocene seabed sediments typically sands and gravels. The Bolders Bank Formation overlies Cretaceous Chalk Bedrock over much of the region (Cameron *et al*. 1992, Tappin *et al*. 2009).

3.2.2 The Humber Regional Environmental Characterisation (REC) identified the archaeological potential of the Bolders Bank Formation as for derived artefacts only dating to the Palaeolithic (Tappin *et al*. 2011). In addition the Humber MAREA (Wessex Archaeology 2012b) identified a number of palaeogeographic features of archaeological interest outside the Site boundary (Wessex Archaeology 2012b). The scheme of geoarchaeological interpretation developed below is comparable with the Humber MAREA assessment (Wessex Archaeology 2012b: 22).

4 RESULTS

4.1.1 The following results section summarises the sediments noted and recorded within the 21 boreholes logs, supplemented by the CPT logs. Depths are given in metres relative to Lowest Astronomical Tide/Chart Datum (LAT/CD) (Figure 2).

4.1.2 On the basis of the geoarchaeological assessment the following geoarchaeological units were identified:

- Unit 1: Cretaceous Chalk Bedrock
- Unit 2a: Upper Pleistocene Glacial Sediments (Lower Bolders Bank Formation)
- Unit 2b: Upper Pleistocene Glacial Sediments (Upper Bolders Bank Formation)
- Unit 3: Holocene Seabed sediments

4.1.3 A borehole model showing these units and the boreholes in which they occur are shown as a Rockworks diagram on **Figure 2**.

Unit 1 Cretaceous Chalk Bedrock (-36.93 mLAT to at least -75.93 mLAT)

4.1.4 This formation was recorded within boreholes **BH08**, **BH10**, **BH**, **BH13**, **BH23**, **BH26**, **BH28**, **BH33**, **BH34**, **BH37**, **BH40**, **BH44**, **BH48**, **BH55**, **BH**62, **BH**70a, and **BH75**. (**Figure 2**). It was not fully penetrated at any location although a thickness of 41m of the formation was drilled within borehole **BH75**. The upper part of the unit is typically reworked by glacial processes associated with the formation and deposition of the Upper Pleistocene deposits (Units 2a and 2b) overlying Unit 1 (**Figure 2**).

Unit 2a Upper Pleistocene Glacial Sediments (-31.75m LAT to -58.9 mLAT)

4.1.5 This formation is also interpreted extensively across the site boreholes and is observed in all boreholes except **BH52** and **BH75a** (due to the shallow depth of this sample). It was fully penetrated in all relevant boreholes except for **BH01**, **BH05** and **BH50**. The Unit ranges in thickness from 2.15 (**BH48**) to at least 24.2m (**BH05**).

4.1.6 The interface between Unit 1 and Unit 2a is typically reworked presumably by glacial action during the last glacial. Unit 2a is characterised by reworked or structureless chalk with a finer sedimentary matrix usually clay, silt and sand with occasional gravels within the borehole profiles; reflecting the diamicton described by Cameron *et al*. (1992:113-115).

4.1.7 The Unit may relate directly to the Lower Bolders Bank Formation which has been investigated in the vicinity of the Site during the Humber REC (Tappin *et al*. 2011).

Unit 2b Upper Pleistocene Glacial Sediments (-13 mLAT to 55.34 mLAT)

4.1.8 This formation was interpreted within all boreholes. It was fully penetrated in all of these boreholes except borehole **BH52** which displays a particularly thickness of the Unit (c. 40m). The unit ranged in thickness from 14.1m (**BH70a**) to 39.72m (**BH52**) (**Figure 2**).

4.1.9 The unit comprised reddish and brown clayey and sandy sediments (particularly sandy and silty in the upper parts of the unit) with gravel components, perhaps occurring under glacio-fluvial conditions towards the close of the Devensian glacial (MIS 2).

4.1.10 The Unit is interpreted as the sub-glacially-formed (Upper) Bolders Bank Formation which is extensively mapped by the BGS across the region (Cameron *et al*. 1992; Tappin *et al*. 2011; Carr 1999).

Unit 3 Holocene Seabed sediments (-13.05 mLAT to -17.4 mLAT)

4.1.11 This formation was recorded within eight of the boreholes (BH), typically as a thin veneer of sandy, gravelly mobile sediment between 0.1m (**BH52** and **BH55**) and 0.75m (**BH26**) thickness (Cameron *et al*. 1992; Tappin *et al*. 2011). It ranged in thickness from 2.70 (**BH8A**) to 14.00m (**BH20B**). The formation comprised a mix of gravel, sand silt, and clay with numerous inclusions of wood, roots, concrete, bricks, stone (limestone, quartz and slate), plastic, metal ash and slag. Of particular note were boreholes **BH8** and **BH8A** where “Railway hardcore with black ash” was recorded at the top of the unit overlying a relatively inclusion free layer of gravel and sand. The unit is interpreted as Made Ground.

5 DISCUSSION

5.1.1 In order to set the interpreted sedimentary sequence into its archaeological context the following comments regarding the potential of the identified Units can be made:

5.1.2 Unit 1, Upper Cretaceous chalk bedrock is of little archaeological interest as it was deposited over *c*. 65 million years ago. The surface of Unit 1 has been extensively reworked by glacial processes with the deposits from the most recent Devensian glaciation (Unit 2a and 2b) directly overlying Unit 1.

5.1.3 Unit 2a and 2b are interpreted as members of the Bolders Bank Formation, Upper Pleistocene supra-glacial and sub-glacial sediments, which have been previously identified as having limited archaeological potential except for artefacts reworked from terrestrial contexts (Tappin *et al*. 2011), which if recovered would be of archaeological interest. To north, south and particularly the east of the Site geomorphological features of archaeological interest have been identified (Tappin *et al*. 2011; Gaffney *et al*. 2009), particularly of Holocene date reflecting palaeolandscapes of Mesolithic age.

5.1.4 Unit 3, interpreted as mobile Holocene seabed sediments, is considered to be of archaeological interest for the preservation of ship and aircraft wreck remains and debris and if encountered, reworked artefacts of prehistoric or later origin. The sporadic preservation of this Unit across the site and mobile nature of the sediments suggests that preservation of wreck material may be relatively poor or transitory with archaeological material effectively lying upon the surface of the Upper Pleistocene formations and in places, covered in a thin layer of Holocene sediment.

5.1.5 No defined organic-rich horizons such as peat deposits have been logged in the borehole logs, and CPT logs do not resolve peat deposits clearly. However, photographed core logs may indicate the presence of organic-rich material in D80 BH52E L22E (COL 2012) at a downcore depth of 16.5-16.73m) a level which is recorded as ‘overdrill’ in the corresponding CPT log at a depth of around -32m LAT/CD (G-Tec Appendix 2A:p41, 2012). A record of a pocket of organic material was made at a depth of around 32m LAT within BH50 (D10 BH50B L10B, COL 2012) indicating material of a terrestrial origin, possibly reworked are occasionally recovered in boreholes but their archaeological interest cannot be clearly established as these depths approximate the base of the (Upper) Bolders Bank Formation which is sub-glacially formed, and the material is presumably reworked and out of context.

6 RECOMMENDATIONS

6.1.1 The sediment sequences identified within the site are of low archaeological interest as they are of glacial or geological origin. However, reworked material of prehistoric archaeological interest may be preserved within Unit 2a and b and 3 (prehistoric and later material). The specific importance of Unit 3 will be addressed within the ongoing archaeological assessment of geophysical data for the potential for encountering aircraft and ship wrecks (Report ref: 85770.02).

6.1.2 If future geotechnical work is carried out the detailed recording of peat and sediments of archaeological interest should continue to be recorded as set out in the WSI (Wessex Archaeology 2011a) to aid any future geoarchaeological assessments, particularly in the route of the cable route for which no geotechnical data has been assessed, as per the WSI (Wessex Archaeology 2011a).

7 REFERENCES

Cameron, T.D.J., Crosby, A., Balson, P.S., Jeffery, D.H., Lott, G.K., Bulat, J., Harrison, D.J., 1992, The geology of the Southern North Sea. British Geological Survey, United Kingdom Offshore Report, London HMSO.

Canyon Offshore Ltd., 2012, 'Geotechnical Investigation Report, Part A: Field Operations and Data (Phase 2)', Unpublished Report ref: C1371A-REP-1-0.

Carr, S J., 1999, 'The micromorphology of Last Glacial Maximum sediments in the southern North Sea', *Catena* 35: 123–145.

G-Tec, 2012, 'Humber Gateway Offshore Wind Farm, Appendix A: Field Borehole Log, Project no. 11_053_EG_Geosea_Humber', Unpublished Report.

G-Tec, 2012, 'Humber Gateway Offshore Wind Farm, Appendix B: CPTu Interpretation, Project no. 11_053_EG_Geosea_Humber', Unpublished Report.

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.

Wessex Archaeology, 2005, 'Humber Gateway Offshore Wind Farm and Marine Cable Route, Technical Report: Archaeology', Unpublished Report ref: 60280.01.

Wessex Archaeology, 2009, 'Humber Gateway Offshore Wind Farm: Archaeological Assessment of Geophysical Data', Unpublished Report ref: 60288.03.

Wessex Archaeology, 2011a, 'Humber Gateway Offshore Wind Farm, Geoarchaeological Review (Turbine Locations): Written Scheme of Investigation Method Statement', Unpublished Report ref: 60289.03.

Wessex Archaeology, 2011b, 'Humber Gateway Offshore Wind Farm: Geophysical Review (Turbine Locations)' Unpublished Report, ref: 60289.05.

Wessex Archaeology, 2012a, Humber Gateway Offshore Wind Farm: Archaeological Review of Groundtruthing Survey for Seabed Features (Turbine Locations)' Unpublished Report, ref: 60289.06.

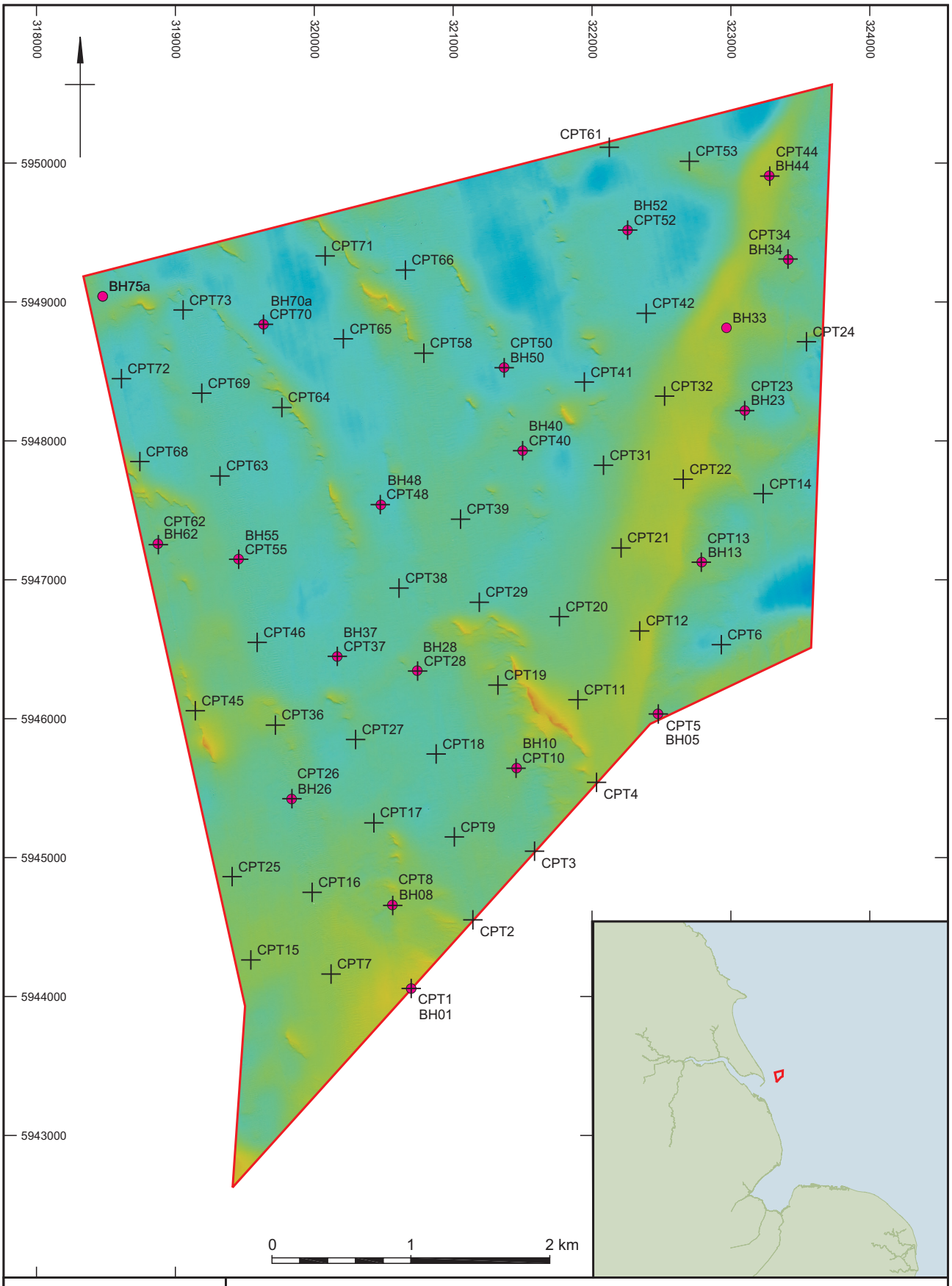
Wessex Archaeology, 2012b, 'Humber and Outer Wash Marine Aggregate Regional Environmental Assessment: Archaeological Desk-based Assessment', Unpublished Report, ref: 75710.05.

APPENDIX 1: BOREHOLE & CPT TARGET LOCATIONS

Location ID	Easting UTM 31N	Northing UTM 31N
BH01	320698	5944057
BH05	322475	5946035
BH08	320562	5944659
BH10	321457	5945645
BH13	322790	5947128
BH23	323100	5948218
BH26	319837	5945422
BH28	320742	5946346
BH33	322968	5948814
BH34	323413	5949306
BH37	320165	5946448
BH40	321500	5947929
BH44	323276	5949909
BH48	320480	5947540
BH50	318874	5947259
BH52	319634	5948839
BH55	318477	5949041
BH62	318477	5949041
BH70a	321367	5948528
BH75	322256	5949517
BH75a	319455	5947149

Location ID	Easting UTM 31N	Northing UTM 31N
CPT1	320698	5944058
CPT10	321453	5945643
CPT11	321898	5946136
CPT12	322344	5946632
CPT13	322787	5947127
CPT14	323232	5947620
CPT15	319543	5944263
CPT16	319985	5944750
CPT17	320429	5945250
CPT18	320878	5945746
CPT19	321322	5946242
CPT2	321142	5944552
CPT20	321765	5946735
CPT21	322209	5947229
CPT22	322657	5947724
CPT23	323099	5948218
CPT24	323544	5948714
CPT25	319409	5944863
CPT26	319839	5945424
CPT27	320298	5945850
CPT28	320744	5946343
CPT29	321188	5946838
CPT3	321586	5945046
CPT31	322083	5947824
CPT32	322523	5948322
CPT34	323411	5949309
CPT36	319720	5945954
CPT37	320166	5946449
CPT38	320611	5946940
CPT39	321053	5947436
CPT4	322033	5945542
CPT40	321500	5947929
CPT41	321945	5948424
CPT42	322390	5948918
CPT44	323280	5949906
CPT45	319143	5946057
CPT46	319589	5946549
CPT48	320476	5947541
CPT5	322477	5946034
CPT50	321368	5948527
CPT52	322257	5949518
CPT53	322701	5950013
CPT55	319456	5947148

Location ID	Easting UTM 31N	Northing UTM 31N
CPT58	320789	5948631
CPT6	322931	5946533
CPT61	322125	5950113
CPT62	318877	5947253
CPT63	319321	5947747
CPT64	319767	5948240
CPT65	320210	5948735
CPT66	320656	5949230
CPT68	318744	5947851
CPT69	319190	5948343
CPT7	320121	5944162
CPT70	319634	5948839
CPT71	320079	5949332
CPT72	318612	5948448
CPT73	319056	5948943
CPT8	320565	5944656
CPT9	321009	5945149



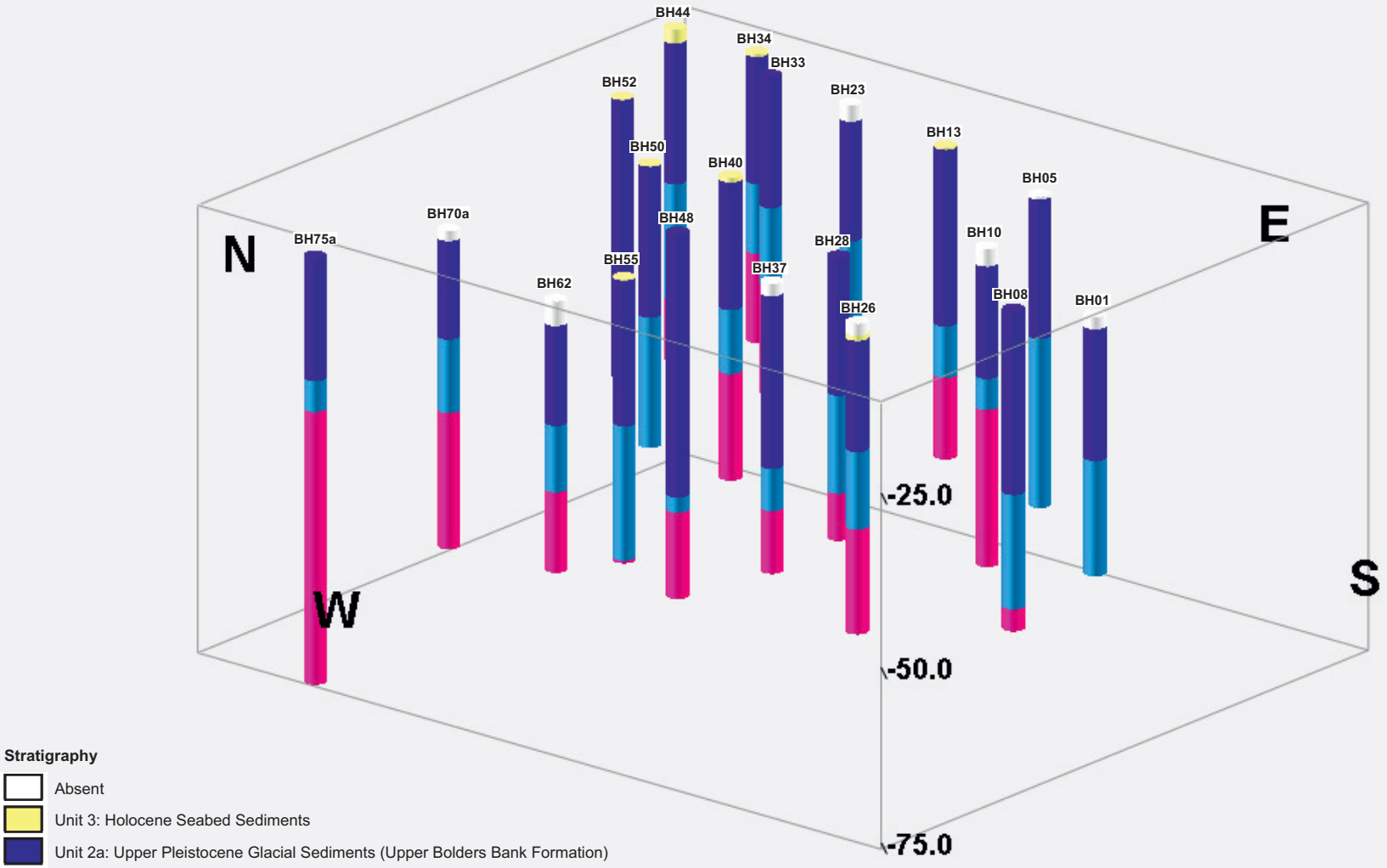
Study Area
Borehole locations
CPT locations

Bathymetric data supplied by Osiris.

Date:	15/04/13	Revision Number:	0
Scale:	1:40,000 @A4	Illustrator:	KJF
Path:	W:\Projects\85771\Drawing Office\Report figs\DBA\13_04_15		

Site Location, Borehole and CPT locations

Figure 1



Date:	17/04/13	Revision Number:	0
Scale:	N/A	Illustrator:	KJF
Path:	W:\Projects\85771\Drawing Office\Report figs\DBA\13_04_15		

Rockworks Borehole model

Figure 2

wessex archaeology

salisbury rochester sheffield edinburgh

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