BARROW OFFSHORE WINDFARM, MIDDLETON SANDS, HEYSHAM
LANCASHIRE

Walkover Survey and Environmental Sampling

Oxford Archaeology North

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RSK ENSR Environment Ltd

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SUMMARY

Following an environmental assessment (Wessex Archaeology 2002), Oxford Archaeology North (OA North) was commissioned by RSK ENSR Environment Limited to undertake a programme of archaeological fieldwork along the overland route of an electric cable (NGR 3435 4610 – 3405 4575) associated with the proposed Barrow Offshore Windfarm, 21.8 kilometres off the western coast of Lancaster. Electricity cabling between the windfarm and a substation at Heysham passes under the sea and onto Middleton Sands, Morecambe Bay.

The archaeological fieldwork was undertaken from 9th to 11th February 2005 to take advantage of a period of extreme low tides and comprised two stages: firstly, a total of eleven palaeoenvironmental sampling cores, up to 1.5m deep, were taken at roughly 100m intervals along the cable route on the intertidal foreshore, which was also the subject of a rapid walkover; secondly, a 100m wide corridor either side of the adjoining dry-land cable route, *c*3km in length, was subjected to a level 1 walkover survey.

Previous archaeological work in the area indicated the presence of features dated from the early prehistoric period through to the modern period (Wessex Archaeology 2002), but only a limited number of features were observed during the dry-land walkover survey. This is likely to be a consequence of present day land-use and former landscaping, which has served to obliterate or conceal any archaeological remains within the dry-land walkover area.

As a result of the coring and the intertidal walkover, no alluvial clay/peat deposits or palaeochannels were evident on the route of the cable; therefore, no further palaeoenvironmental investigations are recommended.

ACKNOWLEDGEMENTS

OA North would like to thank RSK ENSR Environment for commissioning the report and, in particular, Helena Kelly for assistance during the initial stages of the project. Thanks are also due to Trevor Owen who acted as sand pilot and safety advisor.

The dry-land walkover survey was undertaken by Hannah Gajos. The palaeoenvironmental sampling was supervised and undertaken by Denise Druce, assisted in the field by Karl Taylor and David Tonks. The drawings were produced by Mark Tidmarsh while Denise and Hannah co-wrote the report, which was edited by Alison Plummer and Alan Lupton. Alison managed the project with help and advice from Elizabeth Huckerby.

1. INTRODUCTION

1.1 CIRCUMSTANCES OF THE PROJECT

1.1.1 Following proposals for the construction of Barrow Offshore Windfarm and the recommendations of an environmental assessment undertaken by Wessex Archaeology Ltd (Wessex Archaeology 2002), Oxford Archaeology North (OA North) submitted a project design to meet the requirements of an archaeological brief issued by RSK ENSR Environment Limited. The site of the proposed windfarm lies 21.8 kilometres off the western coast of Lancaster (Fig 1), with electricity cabling between the windfarm and a substation at Heysham passing under the sea and onto the intertidal foreshore and dry-land areas of Middleton Sands, Morecambe Bay (NGR SD 3435 4610 – 3405 4575).

1.1.2 The programme of archaeological fieldwork conducted by OA North took place from 9th to 11th February 2005 to take advantage of a period of extreme low tides and comprised palaeoenvironmental sampling and walkover survey. A 1km length of intertidal foreshore was affected by the proposed route of the electricity cable, within which a 11 palaeoenvironmental sampling cores, up to 1.5m deep, were taken at roughly 100m intervals; a rapid walkover survey was also undertaken. The dry-land section of the proposed electricity cable route ran for approximately 1.8km eastwards from Red Nab rocks and over Whittam Hill before turning sharply northwards to the substation via Heysham caravan park, a distance of *c*1km. A 100m wide corridor either side of the proposed cable route was subjected to a level 1 walkover survey, in order to locate any previously unidentified archaeological features.

2. METHODOLOGY

2.1 PROJECT DESIGN

2.1.1 The project design (*Appendix 2*) was produced to meet the requirements of the brief issued by RSK ENSR Environment Limited. The walkover elements of the archaeological programme adhered to the project design in full, but due to the extreme uniformity of the core samples, it was deemed necessary to increase the spacing between palaeoenvironmental cores from 50m to 100m-200m and to reduce the total of 20 cores to 10. All archaeological work was consistent with the relevant standards and procedures of the Institute of Field Archaeologists, and generally accepted best practice.

2.2 DRY-LAND WALKOVER SURVEY

2.2.1 A walkover survey was conducted along the dry-land section of the proposed route of the electricity cable on 9th February 2005 within a corridor extending for 100m on either side of the cable route. The aims of this survey were to identify any potential new sites, and to identify the landscape context of the route. In addition, it was used to identify any hazards or constraints that would influence future groundworks and areas of disturbance.

2.2.2 Any archaeological features were to be rapidly recorded in terms of type and period and located on 1:2,500 or 1:10,000 OS maps using a handheld GPS. The extent of a site was only defined for sites greater than 50m in size.

2.3 PALAEOENVIRONMENTAL SURVEY OF THE FORESHORE DEPOSITS

2.3.1 ***Core survey:*** a palaeoenvironmental survey of the foreshore deposits on the route of the terrestrial cable was carried out over three days from the 9th to 11th February 2005. The purpose of the survey was to assess the nature of the deposits and their suitability for any palaeoenvironmental investigations and this was achieved by implementing a programme of coring. Cores were taken with an Eiljkelkamp gauge auger to a depth of 1.5m, commensurate with the planned depth of the groundwork. The lithology of the cores was described in the field and the data was entered into a field sediment log, which has been kept with the project archive.

2.3.2 The positions of the cores were obtained by geo-referencing the route of the cable on a 1:50,000 OS map. The core points were then located in the field with the aid of a handheld GPS. The position of each core was accurately surveyed to obtain Northings and Eastings using a Leica satellite positioning system.

2.3.3 ***Foreshore walkover:*** a rapid walkover survey of a 200m easement along the line of the cable route was carried out to record the presence of any palaeochannels. This was augmented by the examination of OS maps and offshore charts.

2.4 ARCHIVE

2.4.1 A full archive has been prepared to a professional standard in accordance with current United Kingdom Institute for Conservation (UKIC 1990) and English Heritage guidelines (English Heritage 1991).

3. BACKGROUND

3.1 LOCATION, TOPOGRAPHY, GEOLOGY AND ARCHAEOLOGY

3.1.1 The cable route reaches dry land at Red Nab rocks (SD 34010 45913), on the southern edge of Heysham nuclear power station. It then runs eastward, past a caravan park, sewage works and industrial estate, before turning north to run up Middleton Road to the electricity sub-station (SD 34173 46014).

3.1.2 The route passes through an area of low, gently undulating relief that does not exceed 15m OD in height. Prior to the mid-twentieth century, all the available mapping shows the route crossing a belt of agricultural land between the settlements of Heysham and Middleton, dotted throughout with occasional farmsteads (Wessex Archaeology 2002). At its north-western end, the route runs along the south western edge of Heysham Moss – an area of marshland drained and turned over to agriculture during the nineteenth century (Middleton *et al* 1995).

3.1.3 The landscape of the surrounding areas includes extensive salt marshes, reclaimed mosses and marshland, a small area of remnant mossland at Heysham, and sand and shingle beaches around the Lune estuary. The underlying geology of the area consists of limited outcrops of carboniferous Millstone Grit sandstones and Triassic red sandstone which form the rocky outcrops seen on the beaches at the site (Countryside Commission 1998, 83).

3.1.4 Archaeological evidence for activity in the area dates from the Neolithic to the twentieth century, and a more complete historical background can be found in the Wessex Archaeology Ltd environmental assessment (Wessex Archaeology 2002). The region has been extensively studied in great detail during the English Heritage funded North West Wetlands Survey undertaken by Oxford Archaeology North in their former guise as Lancaster University Archaeology Unit, and further information can be found in Middelton *et al* (1995). The most important archaeological features within the area comprise a Neolithic polished flint axehead from Red Nab point, 44m north of the proposed cable route, and a Bronze age perforated stone hammerhead along with a number of earthworks and possible barrows of indeterminate date (*ibid*).

4. WALKOVER SURVEY RESULTS

4.1 INTRODUCTION

4.1.1 The proposed route of the electricity cable covers several main areas (Fig 4). It reaches land at the Red Nab rocks, continues east through the Heysham Nuclear Power Station, and crosses Money Close Lane onto Heysham Golf Course. The route crosses Whittam Hill, and continues downwards into the Petroleum Refinery Industrial Estate. The route turns north at this point, and crosses Middleton Way Road. It then continues into a caravan park, and across fields to an electrical sub-station.

4.2 RESULTS

4.2.1 The rocks at Red Nab did not reveal any archaeological features, nor were any surface finds visible. However, the sands around the rocks may well provide some stray prehistoric finds, or submerged wreck deposits (Wessex Archaeology 2002).

4.2.2 The land within the Heysham Nuclear Power Station could not be crossed, due to lack of access. The fence perimeter runs close to the proposed route, however, and the site could be seen clearly from this point. The land is currently being used as a concrete hard-standing, and is level ground. The land due east of Heysham nuclear power station has been landscaped, including a drainage pond and pedestrian pathways. No archaeological features were observed in this section of the proposed route.

4.2.3 Heysham Golf Course lies on an upward slope leading east to Whittam Hill. As expected, the course is heavily landscaped. The land lying to the south of the golf course is wooded, with a probable post-medieval field boundary having been re-used as a modern fence line. The boundary bank stands *c*0.5m high, and is aligned east/west, running for approximately 20m towards the summit of Whittam Hill. A hedgerow has been planted on the top of the boundary bank. No further archaeological features were observed.

4.2.4 The proposed route continues down the eastern slope of Whittam Hill, through a petroleum refinery, which covers both the slope, and the level ground to the east. The landscape is covered with scrub, and consists of a series of large square sink-holes, with a system of dykes and concrete and brick-built bridges. Large spoil heaps are located around the area. No coherent evidence for archaeological remains could be seen within this disturbed area of land.

4.2.5 The route then turns north, through a modern industrial estate, and across Middleton Way into a caravan park. This park has also been heavily landscaped. To the north of the caravan park lies an electrical sub-station within a field laid to pasture. Although no archaeological features were identified within this field, the land rises onto a small plateau in a low-lying area, which may preserve below ground remains. The route then continues along the railway cutting, where no archaeological features were observed.

The results of the walkover survey suggest that the potential in this area is fairly limited, due to industrial activity and general landscaping.

5. PALAEOENVIRONMENTAL SURVEY RESULTS

5.1 INTRODUCTION

5.1.1 The discovery of intercalated peat and clay deposits during the construction of Heysham Docks, plus the presence of areas of peat inland, east of Heysham, suggest that the electricity cable route, where it traverses the intertidal foreshore area from mean low to mean high water, could pass submerged land surfaces and associated palaeochannels. Important for palaeoecological reconstruction, these peat and clay deposits represent changes in the coastline in response to Holocene relative sea level change. Accordingly, a walkover survey and programme of coring, commensurate with the depth of construction, was undertaken in the intertidal area in order to determine the nature of the deposits affected.

5.2 RESULTS

5.2.1 ***Core Survey:*** it was anticipated that cores would be taken to depths of 1.5m, commensurate with the planned depth of the groundwork. However, given the nature of the deposits, this was only possible at two locations, where depths of 1.52m (Core 11) and 1.67m (Core 10) were reached. Elsewhere, depths ranged from 0.60m-1.43m and, on the whole, were determined by the ability to penetrate the deposits. The original proposal stated that 20 cores would be taken at 50m intervals along the line of the proposed cable route; however, given the uniformity and nature of the deposits, the number of cores was reduced to ten, which were taken at 100m-200m intervals.

5.2.2 The ten cores revealed that, at least to 1.67m, the foreshore deposits on the route of the cable consist of sand. The location of each sampling point in relation to the cable route is shown in Figure 2, and the stratigraphy of the deposits is shown in Figure 3. The latter diagram utilised the TSPPlus plotting program, which plots the cores relative to each other (Duller 1995). As the deposits were relatively simple, no OD height data has been utilised. It was anticipated that OD heights relative to sea level would have only been important where any organic/peat deposits had been discovered.

5.2.3 The deposits were very uniform along the route of the pipeline and consist of between 0.23m and 0.50m of loose orange sand (10YR 4/2), which overlies a deposit of denser orange-grey sand (10YR 4/1), which was proved to a depth of 1.67m. Although the depth of the transition of the upper and lower sand deposits appears to fluctuate between the cores (by up to 0.30m), it is possible that this is as a consequence of variations in the depth of the overlying looser sand, and, therefore, not a real feature. In a few of the cores, the top 0.03m-0.10m of the lower dense orange-grey sand contained streaks of very dark grey sand (10YR 4/1) (Plate 1), which are likely to represent deposits of reduced or less oxidised laminations, which disappear on exposure to air. The exact mechanisms involved in creating these laminations are unclear, but they are likely to represent post-depositional processes. In places, the uppermost wet,

looser, sand had been eroded away, leaving areas of less eroded denser sand (Plate 2) and an additional core (Core 5) was taken in order to take advantage of this. However, only 0.86m of the denser sand could be penetrated and therefore did not contribute to our understanding of the deposits. Core 5 has not been included in the stratigraphy plot (Fig 3). It is possible that this denser sand represents a much older deposit. No palaeochannels were evident from the coring survey.

5.2.4 ***Foreshore walkover:*** no palaeochannels were observed on the foreshore and it is likely that if any exist, the sand deposits now prevalent in the area would cover them. Additionally, there are no possible palaeochannels shown on the OS maps/marine charts.

6. DISCUSSION

6.1 THE WALKOVER SURVEY

6.1.1 The absence of any archaeological features within the 200m wide corridor covered by the dry-land walkover survey is likely to relate to a number of factors, most notably the large amount of modern disturbance and landscaping that has taken place in the areas around Whittam Hill and Heysham Golf Course. Other factors, such as modern land use, have meant that there was little exposed ground in which to observe stray finds. Those stray finds that have occurred in the area, particularly of prehistoric date, were likely to have eroded out of the sand, and the chances of their recovery during the latest stage of walkover survey are more dependent upon recent meteorological conditions. The only possible archaeological feature within the area was the re-used post-medieval field boundary to the south of Heysham Golf Course, while many of the earthworks identified in the environmental assessment as likely to be of prehistoric date, lie further inland (Wessex Archaeology 2002). It is likely that until the surrounding areas of marsh and mossland were reclaimed in the nineteenth century (*ibid*), they were unsuitable for any form of exploitation that would have left a permanent, coherent and immediately visible trace in the landscape.

6.2 THE PALAEOENVIRONMENTAL SURVEY

6.2.1 The existing tidal flat deposits on the foreshore of Middleton Sands, to a depth of at least 1.67m, consist of sand. An uppermost loose wet sand, which is highly mobile and prone to erosion, overlies a much denser, more resistant deposit, which may have accumulated to some depth. It is possible that this lower deposit represents a much older period of sand accumulation, however, no associated palaeochannels were evident. The chronology of these phases of deposition is difficult to establish due to the lack of any datable organic material within each layer. It is unclear, for example, how these foreshore deposits relate to the alluvial clay and peat deposits that underlay the reclaimed land east of Heysham (Middleton *et al* 1995). It is possible that intercalated clay and peat deposits exist below the foreshore sand, however, this would only be determined if a number of deeper mechanical cores are sunk.

6.3 RECOMMENDATIONS FOR FURTHER WORK

6.3.1 The rather limited potential for archaeological remains within the cable route and the depth of the recorded sand deposits (which exceed the depth of any groundworks associated with the development) mean that there are no recommendations for further archaeological work at the site.

7. BIBLIOGRAPHY

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Ordnance Survey, 2002 1:50 000, Sheet **102**

SECONDARY SOURCES

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8. ILLUSTRATIONS

8.1 LIST OF FIGURES

8.2 LIST OF PLATES

Figure 1: Location Map

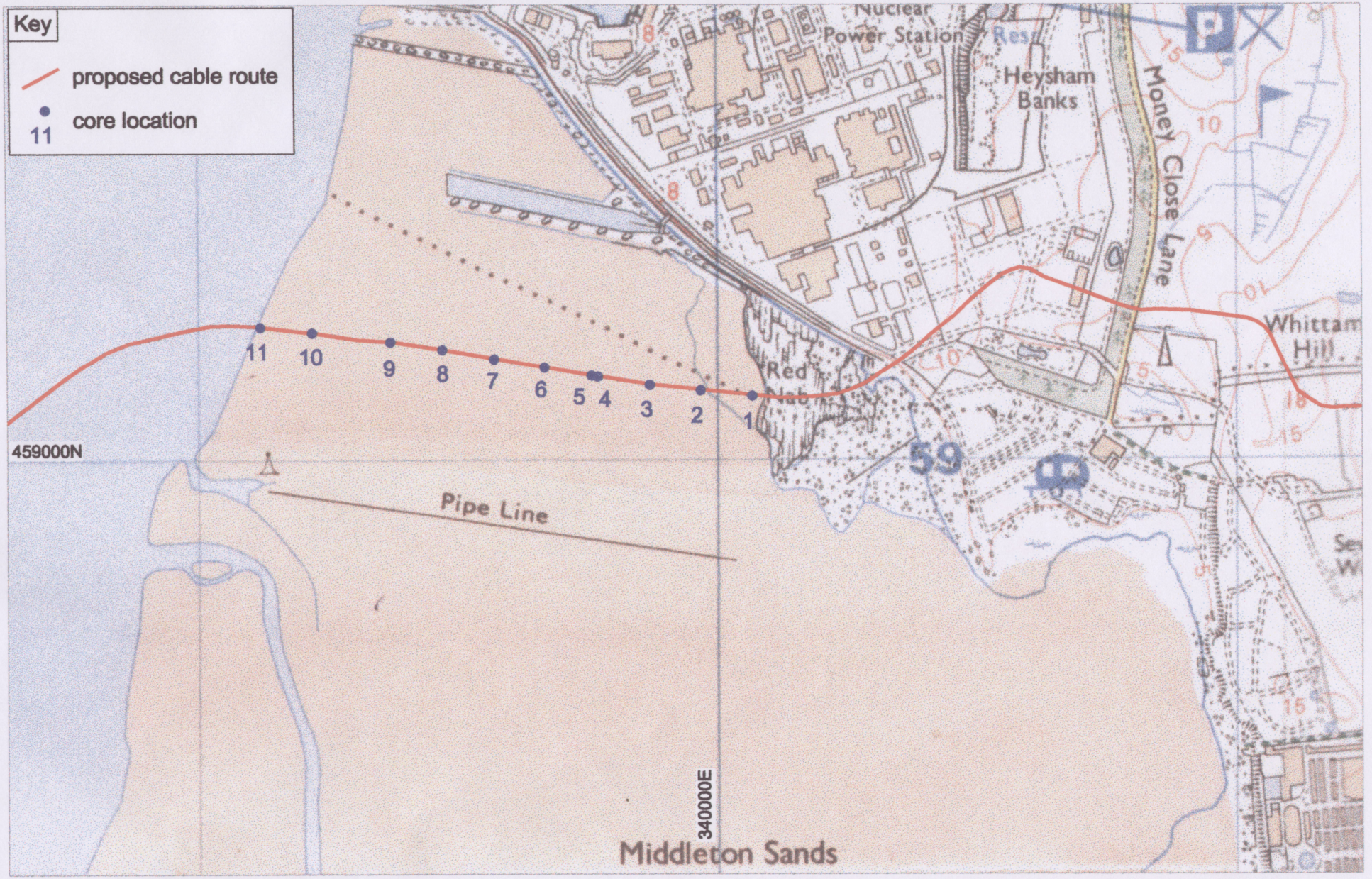

Figure 2: Core locations

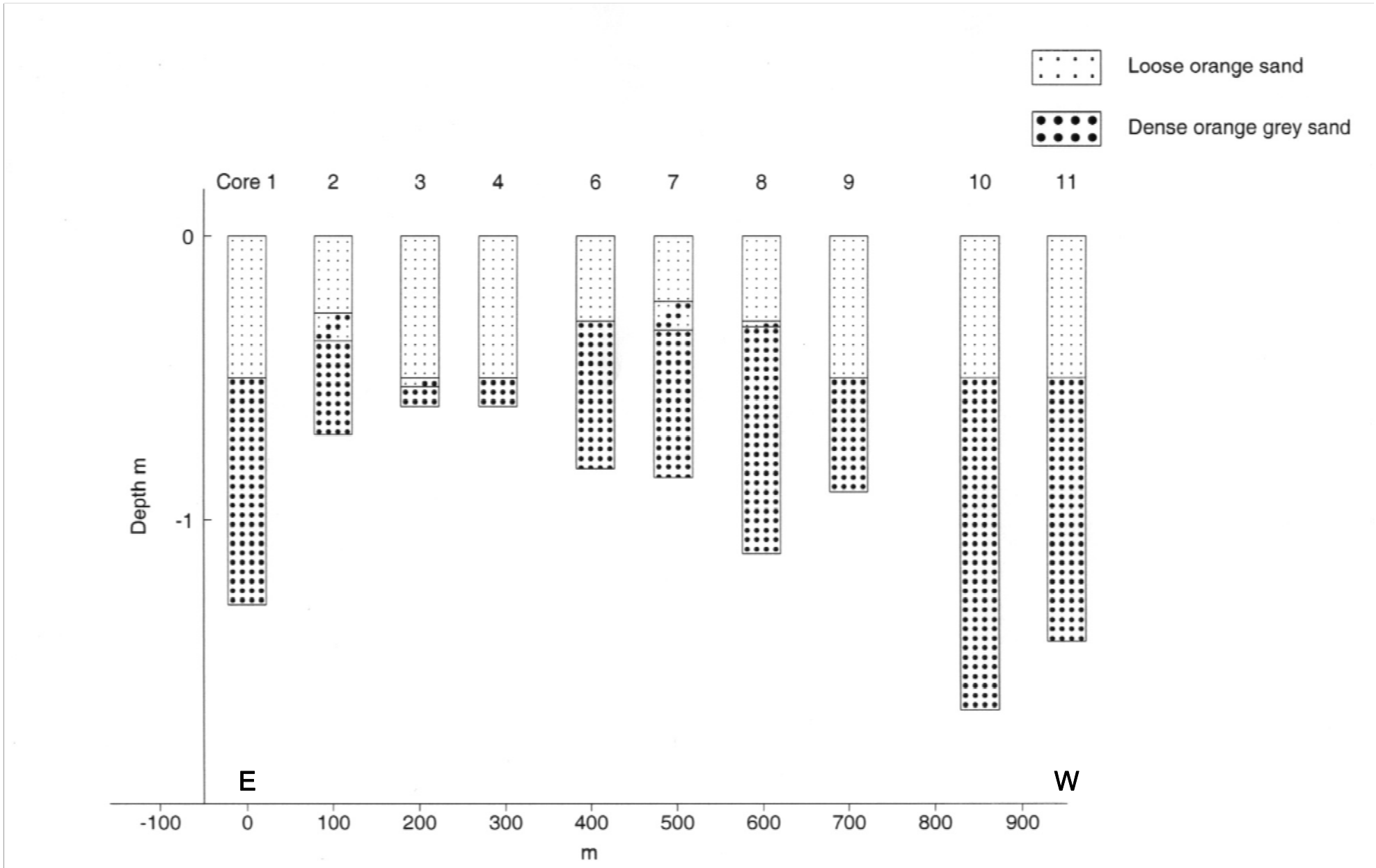

Figure 3: Stratigraphy of the foreshore deposits

Figure 4: Section of proposed cable route subject to walkover survey

Plate 1: Lower deposit of dense sand with laminations

Plate 2: Area where uppermost deposit of orange sand has been eroded away exposing lowermost dense sand.

Plate 3: Working shot showing view across sands

APPENDIX 1: PROJECT BRIEF

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1 November 2004

Alan Lupton
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Your Ref:
Our Ref: RSK/HE/P/P40120/06/02

Dear Alan

Re: Barrow Offshore Wind Farm

Barrow Offshore Wind Limited (BOW), formerly known as Warwick Offshore Wind Limited, pre-qualified with the Crown Estate to develop a wind farm site in the eastern Irish Sea near Barrow-in-Furness. I have been instructed to obtain tenders for a programme of foreshore coring at Heysham, Lancashire as part of the pre-construction archaeological works associated with the Barrow offshore wind farm.

The wind farm comprises the construction of 30 turbines with associated sub-sea cabling between each of the turbines and running from the wind farm to a landfall point between Heysham Business Park and the power station. Subsequent underground cabling will connect the wind farm to the electricity network via an electrical sub-station.

A desk based assessment undertaken by Wessex Archaeology, on behalf of RSK as part of an Environmental Impact Statement (EIS), identified that it is likely for former land-surfaces, as indicated by peat horizons on the foreshore, to survive in the areas where the sub-sea cables come ashore. As well as providing palaeo-environmental evidence for the development of the landscape during the Holocene these areas could also contain drowned 'land sites' dating from the Palaeolithic to the Roman period. However, the character and extent of these postulated land-surfaces is not known, and it is not certain that such surfaces are present within the footprint of this development. Consequently, it is proposed to evaluate this potential through a programme of foreshore coring.

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Archaeological coring across the foreshore should continue from the Mean High Water springs to Mean Low Water springs in the area where the cable reaches landfall (see the attached plan). Provision will be made for a pre-survey walkover, complete recovery of cores and a programme of palaeo-environmental assessment. This will identify the scope of any necessary palaeo-environmental analysis.

Specifically, costs should be provided for all of the following activities (taken from the *Barrow-in-Furness offshore wind farm, Archaeological Protocol, Wessex Archaeology 2004*) :

1. Walkover Survey

The line of the foreshore and terrestrial cable route will be visually inspected by an appropriately qualified archaeologist for the presence of archaeological sites. Potential new archaeological sites will be recorded to sub-meter accuracy in accordance with the OS national grid. The presence of palaeo-channels will also be noted, as well as surface conditions and any hazards to further archaeological recording.

2. Coring

Cores will be collected using a suitable coring / borehole method under the supervision of an appropriately qualified archaeologist. Cores will be taken at 75 meter intervals along the line of the cable route. If there is evidence for the presence of palaeo-channels running down the beach, cores will be collected at right angles to the line of the channel at intervals of 25-50 meters.

3. Sampling, Assessment and reporting

Core logs, comprising an archaeological description of the sediments, will be generated for all cores. These core logs will be used to categorise and model the beach deposits along the line of the cable route. Sub-samples will be taken from selected cores and assessed for palaeo-environmental material (pollen, diatoms and foraminifera). Assessment will comprise laboratory analysis of the samples to a level sufficient 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 later. A report will be produced setting out the results of each laboratory assessment together with an outline of the archaeological implications of the combined results, and will identify whether any detailed analysis is recommended.

4. Analysis and Dating

Pollen, diatoms and/or foraminifera recovered during Stage 3 will, if appropriate, be subject to detailed laboratory analysis. This will be supported by radiocarbon dating of suitable sub-samples. This will result in a report that discusses the successive environments within the coring area, provides a model of environmental change over time, and an outline of the archaeological implications of the analysis.

Please provide a fixed price for stages 1-3 and rates for the work identified within stage 4.

For health and safety purposes there will be **no lone site work** on this project. A full risk assessment will be required from the successful contractor, which will take particular account of the location of the work on the Morcambe Bay mud flats.

Please could you return your tender by 12pm Wednesday 10 November 2004.

If you have any queries, please do not hesitate to contact me.

Yours sincerely

Helena

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APPENDIX 2: PROJECT DESIGN

1. INTRODUCTION

1.1 Following a desk based assessment undertaken by Wessex Archaeology in 2002, Oxford Archaeology North (OA North) was commissioned by RSK Environment Limited (hereafter referred to as the client) to prepare a project design for an environmental archaeological sampling strategy and a walkover survey for the purposes of an archaeological evaluation in the areas of a proposed wind farm development at Barrow-in-Furness, Lancashire. The main development area lies 21.8 kilometres off the western coast of Lancaster. It is linked to the coast by a cable route that continues in-shore to a point on the southern edge of Heysham.

1.2 Development Proposal

The wind farm comprises the construction of 30 turbines with associated sub-sea cabling between each of the turbines and up to 5 parallel cables running from the centre of the wind farm to a landfall point between Heysham Business Park and power station. Subsequent 33/132kv underground cabling will connect the wind farm to the electricity network via an existing electrical sub-station.

1.3 OA North has the professional expertise and resources to undertake the project detailed below to a high level of quality and efficiency. OA North is an Institute of Field Archaeologists (IFA) registered organisation, registration number 17, and all its members of staff operate subject to the IFA Code of Conduct.

2. OBJECTIVES

2.1 The following programme has been designed to provide for adequate palaeo-environmental sampling of any archaeological deposits that are likely to be disturbed during groundworks relating to the laying of sub-sea and terrestrial cables on the foreshore area. In addition, the line of the foreshore and the terrestrial cable route will be the subject of a walkover survey in order to identify and record the location of previously unknown sites in the area of the development.

2.2 A written report will assess the significance and the potential within a local and regional context of the data generated by the palaeoenvironmental sampling and the walkover survey. To achieve these aims, the following methodology is proposed:

3. METHOD STATEMENT

3.1 WALKOVER SURVEY

3.1.1 ***Visual Inspection:*** a level I walkover survey (*Appendix* 1) will be undertaken which will encompass, where accessibility permits, a one-hundred metre corridor along either side of the route of the terrestrial cable, walked in a systematic fashion. Archaeological features identified within the landscape will be recorded using the relevant OA North pro forma, and the features accurately positioned with the use of either a GPS, which can achieve accuracies of +-0.1m with respect to the OS national grid, or, by manual survey techniques which will tie in new features to features already shown on the relevant OS map.

3.2 PALAEOENVIRONMENTAL SAMPLING - ROUTE OF THE TERRESTRIAL CABLE

3.2.1 ***Cable coring fieldwork:*** cores will be taken with an Eiljkelkamp gauge auger by an OA North Environmental archaeologist to a depth commensurate with the planned depth of the

groundworks. A total of 20 cores will be taken at 50m intervals along the line of the proposed cable route. The geographical position of the cores will be determined by GPS and optical level. The lithology of the cores will be recorded in the field on a proforma and the descriptions may be supplemented by the results of laboratory examination (see sections 3.2.6-3.2.10). Any palaeo-channels identified during this coring will be subject to a further programme of coring and assessment (see section 3.3 Palaeo-channel contingency coring and assessment).

3.2.2 ***Cable coring environmental walkover***: in addition the OA North Environmental Archaeologist will undertake a rapid walkover survey of a 200 metres easement along the length of the sub-sea and terrestrial cable to identify and record any possible palaeo-channels. This will be augmented by examination of AP's, OS maps including the 1st edition, and offshore charts.

3.2.3 ***Cable coring analysis:*** the field data together will be inputted into the specialist computer programme ROCKWORKS. The data will be correlated and a terrain model of the transect will be produced which will illustrate possible mechanisms for sediment formation along the cable corridor. The stratigraphy of the deposits is likely to be complex in nature because of the modern dynamics of Morecambe Bay and because the Lancashire coast is known to have been greatly influenced by changing sea-level in the Holocene following the retreat of the ice after the last glaciation (Tooley 1978, Sea Level changes, Oxford).

3.2.4 ***Cable coring report***: the data will be presented as a written report in which the development of the sediments will be described and the possible implications for the archaeological record of the present inter-tidal zone will be discussed.

3.2.5 ***Cable assessment fieldwork methods***: if it is demonstrated that the changes in stratigraphy in the individual cores is uniform along the length of the cable route, two sites will be selected for the retrieval of cores for environmental assessment and possible analysis. If, however, there is considerable variation between these two cores, an additional two cores will be taken (totalling four cores in all). The coring method will be dependent on the nature of the deposits but it is hoped to use a Russian-type peat borer.

3.2.6 ***Cable assessment laboratory methods:*** the cores will be cleaned, photographed and the stratigraphy and lithology recorded by an OA technician and environmental specialist. The cores will be subsampled for the assessment of pollen, plant macrofossils, diatoms, foraminifera and ostracods. Assuming a sediment depth of four metres, it is proposed to take from the two cores a total of 24 subsamples for each of the fossil types, (a total of 120 subsamples); if, however, it is necessary to core to a greater depth, additional subsamples will be required.

3.2.7 ***Pollen methodology***: the subsamples will be prepared for pollen analysis using the standard techniques of potassium hydroxide, hot hydrofluoric acid treatment or zinc chloride, and acetolysis (Faegri and Iversen 1989). The residues will be mounted in silicone oil and examined with an Olympus BH-2 microscope. The pollen will be counted and rapidly identified and the data will be presented in tabular form. The pollen assessment will be undertaken in house by an OA North environmental archaeologist or by an appropriate specialist.

3.2.8 ***Assessment of plant macrofossils***: the subsamples will be soaked in water and sieved through a 250 micron mesh. The residues will be examined microscopically and all plant material recorded and provisionally identified.

3.2.9 ***Assessment of diatoms, foraminifera and ostracods:*** the samples will be sent to the appropriate specialists for assessment and they will provide a written report of each assessment type.

3.2.10 ***Dating***: material, if available, will be selected for scientific dating. The dating methods will be dependent on the sediment type as marine deposits are unsuitable for radiocarbon dating.

Radiocarbon dating will be used to date organic terrestrial sediments unless no suitable material for radiocarbon assay is identified, in which case other means of dating will be investigated.

3.3 PALAEOENVIRONMENTAL SAMPLING - PALAEO-CHANNEL CONTINGENCY CABLE CORING

3.3.1 ***Fieldwork***: if a palaeo-channel is identified, the stratigraphy will be recorded by a series of profiles at right angles to the channel. Assuming a length of 500 metres by 7.0 metres wide, a series of 10 profiles each with five sampling points will be cored. For methodology see methods for cable coring.

3.3.2 ***Palaeo-channel contingency cable coring analysis***: the data from the palaeo-channel contingency coring will be analysed in the same way as that from the cable coring.

3.3.3 ***Palaeo-channel contingency assessment fieldwork***: if it is demonstrated that the changes in stratigraphy of the palaeo-channel are uniform along the length and breadth of the channel, two sites will be selected for the retrieval of cores for environmental assessment and possible analysis. If, however, there is considerable variation in the stratigraphy, two additional cores will be taken. The coring method will be dependent on the nature of the deposits but it is hoped to use a Russian-type peat borer.

3.3.4 ***Palaeo-channel contingency assessment laboratory methods****:* for the laboratory methods see those for the cable coring, paragraphs 3.2.6 - 3.2.10. *A similar suite of environmental indicators will be assessed by the appropriate specialists.*

4. REPORT AND ARCHIVE

4.1 ***Interim Statement***: in the event that further work is recommended an interim statement will be issued. In this instance, or in the event that the client specifically requests an interim statement, it should be noted that the statement would not be fully illustrated.

4.2 ***Final Report:*** two copies of the final report will be submitted to the client. Both paper and digital copies will be provided on CD-ROM in pdf format. The report will present the following information:

(i) ***Summary:*** a summary statement of the findings;

(ii) ***Introduction:*** the background to the project including location details;

(iii) ***Methodology:*** an outline of the methodology of all elements of the programme of work;

(iv) ***Geological context:*** an outline of the topography, geology and brief sedimentary history of the study area;

(v) ***Results:*** any evidence for the remains of archaeological sites identified by the walkover;

The results palaeoenvironmental assessment for each of the sampled areas together with the results of the cable coring and of any contingency palaeo-channel coring;

(vi) ***Discussion:*** a discussion of the relative significance of the palaeoenvironmental results and of newly identified archaeological sites within the study area;

A description of the significance of the study area in its local and regional context;

(vii) ***Impact/Recommendations:*** the identification of areas where further development will impact upon the palaeoenvironmental and archaeological resource in addition to the impacts of the current development;

(viii) ***Illustrations:*** maps, plans, sections and copies of the site photographic archive;

(ix) ***Appendices:*** a copy of the brief and this project design, also a gazetteer of sites identified during the walkover survey and raw data pertaining to the assessment of the core samples;

4.3 Provision will be made for a summary report to be submitted to a suitable regional or national archaeological journal within one year of completion of fieldwork, if relevant results are obtained.

4.4 ***Confidentiality:*** all internal reports to the client are designed as documents for the specific use of the Client, for the particular purpose as defined in the project brief and project design, and should be treated as such. They are not suitable for publication as academic documents or otherwise without amendment or revision.

4.5 ***Archive:*** the results of all archaeological work carried out will form the basis for a full archive to professional standards, in accordance with current English Heritage guidelines (*Management of Archaeological Projects*, 2nd edition, 1991).

5. PROJECT MONITORING

5.1 Monitoring of this project will be undertaken through the auspices of the RSK Archaeologist, who will be informed of the start and end dates of the work.

6. WORK TIMETABLE AND STAFFING

6.1 The project will be under the direct management of **Alison Plummer BSc (Hons)** (OA North Senior Project Manager) to whom all correspondence should be addressed. The walkover survey and palaeoenvironmental coring will be undertaken by a team of archaeologists led by **Denise Druce PhD** whom as a result of extensive work experience and a doctorate studying intertidal sediments using pollen and plant macrofossils as palaeoenvironmental indicators, has vast practical and academic knowledge of coring in the intertidal zone. Palaeoenvironmental processing and assessment will be undertaken by a team led by **Elizabeth Huckerby MSc**, who has vast experience of palaeoenvironmental, particularly palaeobotanical, study and played a vital role in the North-West Wetlands survey, from Shropshire to Cumbria. Assessment of samples for diatoms, pollen, foramenifera and ostracods will be undertaken by recommended external specialists (see *Section 6.2* and Table 1).

6.2.1 ***Specialists:*** Dr Philip Barker and/or Dr Lydia King, Geography Department, University of Lancaster are both diatom specialists, who have worked in North West England.

6.2.2 Dr Sylvia Peglar is a very experienced palynologist, who has worked extensively in the United Kingdom, Scandinavia, the Falkland Islands and North Africa.

6.2.3 Dr John Whittaker, Natural History Museum, London is a specialist in micro-fossils including foraminifera and ostracods.

7. INSURANCE

7.1 OA North has a professional indemnity cover to a value of £2,000,000; proof of which can be supplied as required.

8. HEALTH AND SAFETY

8.1 The study area is located along the foreshore of Middleton Sands, Morecambe Bay. This is an intertidal zone renowned for soft pockets of sand and the extreme force of the tidal race. In the interests of health and safety a sand guide has been employed for the duration of the fieldwork and discussions have taken place as to safe working procedures. The field team has been instructed to comply with all instructions issued by the sand guide. A risk assessment has been compiled which all member of the field team are obliged to read.

BIBLIOGRAPHY

Faegri, K, and Iversen, J, 1989, *Textbook of modern pollen analysis*, 4th edn (Rev by K, Faegri, PE, Kaaland and K, Krzywinski), Chichester

Tooley, 1978, *Sea Level Changes*, Oxford

Wessex Archaeology 2002, *Barrow-in-Furness Offshore Wind Farm, Environmental Assessment: Archaeology*, unpubl client rep

Table1 Duration of proposed archaeological tasks to be carried out at Barrow Off-shore Windfarm. PM project manager, PO project officer, PS project supervisor, PA project assistant, PB Philip JW John Whitaker, CR Cedric Robinson

TASK	**Total Duration**	**Total Staff**
Walkover Inclusive of report.	2 days	PS/PA
Cable Coring: Stratigraphy (20 cores) including stratigraphic diagrams and report.	12 days	PM/PO/PA
Cable Assessment: Sampling of 2 cores unless stratigraphy is complex. (For complex stratigraphy see assessment day rate). Pollen sub-sampling 2 cores (12 samples /core). Diatoms - 24 samples Foraminifera - 24 samples (including ostracods).	10 days	PM/PO/PS/PA PB/LK JW
Palaeo-channel contingency coring Stratigraphy (assuming 500m x 7.0m): profile at 50m intervals. Total of 10 profiles x 5 sample points equals 50 samples. Inclusive of stratigraphic diagrams and report.	7 days	PM/PO/PA
Palaeo-channel contingency assessment: Sampling (2 cores unless stratigraphy is complex. For complex stratigraphy see assessment day rate). Pollen sub-sampling 2 cores (12 samples /core). Diatoms - 24 samples Foraminifera - 24 samples. (including ostracods).	10 days	PM/PO/PS/PA PB/LK JW

