

TRIAL PITS, DRIGG, CUMBRIA

Archaeological Watching Brief



Client: The Nuclear
Decommissioning Agency

NGR: 306740 496113
(centre)

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Contents

| | |
|--|----|
| Illustrations..... | 2 |
| List of Figures..... | 2 |
| List of Plates..... | 2 |
| Non-Technical Summary..... | 3 |
| Acknowledgements..... | 3 |
| 1. Introduction..... | 4 |
| 1.1 Circumstances of the Project..... | 4 |
| 1.2 Location, Topography and Geology..... | 4 |
| 2. Methodology..... | 6 |
| 2.1 Introduction..... | 6 |
| 2.2 Desk-Based Assessment..... | 6 |
| 2.3 Walk-Over Survey..... | 6 |
| 2.4 Watching Brief..... | 6 |
| 2.5 Finds..... | 7 |
| 2.6 Environmental samples..... | 7 |
| 2.7 Archive..... | 7 |
| 3. Desk-Based Assessment..... | 8 |
| 3.1 Results..... | 8 |
| 3.2 Background History..... | 8 |
| 3.3 Previous Archaeological Investigation..... | 9 |
| 3.4 Map Regression..... | 10 |
| 3.5 Discussion..... | 13 |
| 4. Watching brief..... | 14 |
| 4.1 Introduction..... | 14 |
| 4.2 Results..... | 14 |
| 4.3 Additional observations..... | 15 |
| 4.4 Finds..... | 17 |
| 5. Conclusion..... | 18 |
| 5.1 Introduction..... | 18 |
| 5.2 Discussion..... | 18 |
| 6. Bibliography..... | 19 |
| 6.1 Primary and Cartographic Sources..... | 19 |
| 6.2 Secondary Sources..... | 19 |
| Appendix 1: Site Gazetteer..... | 22 |
| Appendix 2: Project Design..... | 34 |
| Appendix 3: Trial Pit/Borehole Logs..... | 40 |
| Appendix 4: Radio carbon dates..... | 79 |

Illustrations

List of Figures

| | |
|--|---|
| Figure 1: Site location and gazetteer plan | 5 |
|--|---|

List of Plates

| | |
|--|----|
| Plate 1: Extract from the Drigg Inclosure Award map of 1828 | 11 |
| Plate 2: Extract from the Ordnance Survey map of 1867 | 12 |
| Plate 3 (left): Dark grey silts present in trial pit/borehole 03 | 14 |
| Plate 4 (right): Trial pit 30A2 which contained buried peat deposit | 14 |
| Plate 5: Typical observation during the excavation of a toad scrape in dune area | 15 |
| Plate 6 (left): Stake from fishtrap/weir | 16 |
| Plate 7 (right): Stakes <i>in situ</i> on gravel bank | 16 |
| Plate 8: Surveying of gravel bank on west side of Esk, Ravenglass in distance | 16 |

Non-Technical Summary

Following the discovery that trial pits had been excavated as part of exploratory work, carried out on behalf of the Nuclear Decommissioning Authority to assess the structure and stability of the spit of land and the sand dunes west of Drigg, Cumbria, without archaeological monitoring, a request was made by the Senior Archaeology and Heritage Advisor at the Lake District National Park Authority that the remaining pits and an area to be landscaped to improve the site for natterjack toads be monitored by watching brief. The previous trial pits had been excavated both within the National Park and immediately over its northern boundary, the remaining trial pits were largely to be excavated within the National Park. The entire area is known to have extensive evidence for prehistoric and later activity, as evidenced by numerous scatters of flint artefacts and other features revealed during field walking and examination of the eroding cliff line. The watching brief was therefore requested in order that any further remains of this type that might be uncovered can be recorded and where possible avoided by the ground works.

The area around the Esk Estuary has been known to have evidence for archaeological remains since the 1930s, when material eroding from sand dunes and cliffs along the shore was first recorded. Extensive remains were found at Drigg in the 1950s, and investigative work was continued by members of the Cherry family throughout the remainder of the 20th century, with the result that a large amount of material was recovered over an extensive area of the shoreline around the point where the River Irt meets the ocean. The material discovered spanned a large period of time, from the Mesolithic and into the Bronze Age, with remains of later date also being represented.

A total of eight pits were monitored by an archaeologist and the spoil was examined for artefacts. In most cases the depth and instability of the excavated pit meant that more detailed recording was not possible but geotechnical logs were made available and these are included in the report. The majority of the pits did not reveal any deposits of archaeological interest, although marine peat was discovered in one trial pit, and no artefacts were discovered. However, timber stakes, probably forming a fish trap, were observed on a shingle bank on the north side of the Esk estuary, at some distance from the area of the trial pits. Three shallow toad scrapes were also excavated in the sand dunes, but no archaeological finds or features were recorded from any of these interventions either. Despite the results of the watching brief being essentially negative, the project provided a further opportunity to collate data about the site, including some valuable excavation logs and radiocarbon dates from a number of samples, including some extremely early examples, which indicate that the area was perhaps inhabitable from a much earlier date than previously thought.

Acknowledgements

Greenlane Archaeology would like to thank George Reeves of Low Level Waste Repository (LLWR) Ltd, the staff of the British Geological Society who carried out the pitting and supplied the pit logs and other useful information. Particular thanks are due to John Hodgson, Senior Archaeology and Heritage Advisor at the Lake District National Park Authority, for instigating the project and providing useful advice and information about it. Further thanks are also due to Eleanor Kingston, Archaeology and Heritage Advisor at the Lake District National Park Authority, and Jo Macintosh, Historic Environment Officer at Cumbria County Council, for supplying the Historic Environment Record information used to compile the gazetteer. In addition, thanks are due to the staff of the Cumbria Record Office in Whitehaven (CRO(W)) for their help in accessing early maps of the site.

The watching brief was undertaken by Sam Whitehead, who also wrote the report, together with Dan Elsworth, who also managed the project. The figure was produced by Sam Whitehead and Tom Mace, and the report was edited by Jo Dawson.

1. Introduction

1.1 Circumstances of the Project

1.1.1 Greenlane Archaeology was approached by John Hodgson, Senior Heritage Advisor at the Lake District National Park Authority, following the discovery that geotechnical trial pits and boreholes were being excavated on the dunes at Drigg, Cumbria (centred on NGR 306740 496113) on behalf of the Nuclear Decommissioning Authority (hereafter 'the client') as part of a programme of work to characterise the development and stability of the dune structures. A series of trial pits and boreholes had already been excavated without archaeological monitoring in both the half of the site within the Lake District National Park and that part monitored by Cumbria County Council to the north. After discussions with John Hodgson a brief was agreed verbally and Greenlane Archaeology produced a project design (see *Appendix 2*) for the monitoring of the remaining trial pit excavation and excavation for the creation and improvement of ponds for natterjack toads, which was being undertaken at the same time, all of which was to take place within the Lake District National Park. The on-site recording was undertaken between the 23rd and the 26th of February 2010, following the compilation of a gazetteer of known sites of archaeological interest within the site environs.

1.2 Location, Topography and Geology

1.2.1 Drigg dunes are located on a spit of land on the west coast of Cumbria, and are separated from the town of Ravenglass by the river Irt and the Esk estuary (Ordnance Survey 2004; Figure 1).

1.2.2 The local topography comprises a mixture of sandy beach, sand dunes and estuarine mud flats. The dunes were stabilised by low grassy vegetation and low boulder clay cliffs were apparent in the northern part of the area investigated. The majority of the area examined was below the 10m contour, with many of the excavated areas being directly on or adjacent to the beach and so at effectively 0m above sea level.

1.2.3 The underlying geology largely comprises Triassic red sandstones of the Sherwood group (Moseley 78, Plate 1). There are considerable deposits of glacial till overlying the solid geology, this in turn is overlain by peat deposits in places and windblown sand in the dune areas.

2. Methodology

2.1 Introduction

2.1.1 The project comprised two separate elements intended to establish the extent, nature and, where possible, date of any buried deposits of archaeological interest present on the site. The first element was the completion of a rapid desk-based assessment in order to establish the extent of the known archaeological resource in the area and produce an outline history of the site environs. The second part was a rapid walk-over survey of those areas where trial pits had already been excavated in order to establish whether any remains of archaeological interest had been uncovered or disturbed. The third part was the watching brief carried out during the excavation of trial pits and alteration/creation of toad scrapes at the site, which aimed to record any archaeological features that might be revealed.

2.1.2 All aspects of the desk-based assessment and watching brief were carried out according to the standards and guidance of the Institute for Archaeologists (IfA 2008a; IfA 2008b).

2.2 Desk-Based Assessment

2.2.1 A study area comprising the entire Drigg Dunes from the southern end of Seascale at the north to the River Esk at the south extending 500m inland (approximately to the line of the railway) was examined in order to identify known sites of archaeological interest in the proximity of the area of work. Three main sources were used to access this information and re-construct a history of the site and assess the likelihood of remains of historical or archaeological significance:

- **Cumbria County Council Historic Environment Record (HER):** this is a list of all the known sites of archaeological interest within the county, which is maintained by Cumbria County Council and is the primary source of information for an investigation of this kind. This covered approximately the northern half of the study area. Each identified site comes with a grid reference, description, and sources and any additional information referenced was also examined as necessary;
- **Lake District National Park Authority HER:** this is a similar list of known sites of archaeological interest within the Lake District National Park, which covered approximately the southern half of the study area. Again, each identified comes with a grid reference, description, and sources;
- **Cumbria Record Office Whitehaven (CRO(W)):** the record office was visited in order to examine early maps of the site and establish whether these provided any relevant information such as the nature of field boundaries, land ownership and use, and the presence of any sites of potential archaeological interest;
- **Greenlane Archaeology Library:** secondary sources both published and unpublished, specifically those referenced in the two HERs, were examined to provide information for the site background.

2.3 Walk-Over Survey

2.3.1 A rapid walk-over survey of the entire area in which the previous trial pits and boreholes had been excavated was carried out. In addition, a rapid examination of each area where a pit was to be excavated and monitored was carried out during the watching brief phase, under similar conditions. In each case the area was walked in as systematic a manner as the topography allowed, in regular transects where possible, although the steep cliff and thick overgrowth made this difficult. No finds or features of archaeological interest were discovered so no further recording was required.

2.4 Watching Brief

2.4.1 The excavation of trial pits and the creation/modification of three toad scrapes, each of which was excavated with a wheeled, backhoe JCB excavator, was monitored throughout. Initially a number of

boreholes were to be excavated but the unstable nature of the deposits and depth of investigation meant that these were also excavated as trial pits (these are referred to as trial pit/borehole where necessary and tp/bh in Figure 1). In most cases the depth and small size of the trial pits and the fact that they soon became unstable and collapsed or filled with water meant that detailed monitoring was difficult, and typically only the spoil could be examined for finds before the pit was refilled. The nature of the toad scrapes, which were intended to hold surface water and in many cases already were, meant that they too tended to fill with water and so recording was hampered. By contrast with the trial pits they were typically quite shallow, although they covered a much larger area.

2.4.2 The location of each trial pit and toad scrape was plotted using GPS by the British Geological Survey contractors on site and they are shown in Figure 1.

2.5 Finds

2.5.1 **Processing:** the artefact removed from site was washed then naturally air-dried and packaged appropriately in a self-seal bag with a white write-on panel.

2.5.2 **Assessment and recording:** a catalogue of the finds was produced although as this only comprises a single piece of pottery this is included with the fieldwork results (see *Section 4*).

2.6 Environmental samples

2.6.1 No environmental samples were taken as no appropriate deposits were encountered. However, samples of peat were taken by the British Geological Survey contractors on site for radiocarbon dating as part of the project, and the details of the results are included in *Appendix 4*.

2.7 Archive

2.7.1 A comprehensive archive of the project has been produced in accordance with the project design (*Appendix 2*), and current IfA and English Heritage guidelines (Brown 2007; English Heritage 1991). A copy of this report will be deposited with the Cumbria HER and Lake District National Park HER, one with the client, one will be deposited in the Cumbria Record Office in Whitehaven with the paper and digital archive for the project, and one will be retained by Greenlane Archaeology. A record of the project, together with a digital copy of the report, will be added to the *Online Access to Index of Archaeological Investigations* (OASIS) scheme (English Heritage 2007).

3. Desk-Based Assessment

3.1 Results

3.1.1 A total of 57 findspots or archaeological sites were identified through examination of the HER data (see *Appendix 1*). Of these only two comprised excavations, which both focused on the same site, where timber and a possible hearth had been seen eroding out from the cliff face in 1967 (**Site 35**). A more limited excavation was also represented by **Site 34**.

3.1.2 The majority of the findspots were also prehistoric with many flint artefacts of a Bronze Age or Mesolithic date having been found, occasionally in association with hearths and pottery (Cherry 1965, 66-85). There was no evidence for Roman occupation at the site, although a number of finds of that date have been recovered from the general area. There were also numerous Second World War defensive structures and installations recorded, along with 19th century farm buildings. A gazetteer of all the sites identified is presented in *Appendix 1* and their locations are shown in Figure 1. Where relevant, specific sites have been referenced in the background history for the study area that follows.

3.2 Background History

3.2.1 **Introduction:** the background history of the site is intended to place the results of the watching brief in context and provide information about specific archaeological discoveries within the study area. As the area has been extensively examined since at least the late 1930s, and subject to a number of archaeological investigations, details of these are included in this section, but a summary of the previous work is also contained in *Section 3.3* below.

3.2.2 **Early Prehistoric – Late Upper Palaeolithic to Mesolithic (c11,000 BC- 8,000 BC):** there is no specific evidence for activity in the area in the period immediately following the last Ice Age, but remains belonging to this period have been found in the southern part of the county, around the north side of Morecambe Bay (Young 2002). Harpoon heads of possible Palaeolithic or early Mesolithic date have also been found at Crosby-on-Eden (Hodgson 1895), although the context is uncertain and they may not even be British. Mesolithic artefacts, particularly from the later part of the period, have been found in large numbers eroding from the cliffs and dunes on either side of the estuary of the River Esk, some perhaps reported as early as the 1930s, although little detail is given and it is apparent that finds of various periods were present (Fair 1936). Subsequent investigation in the 1950s and 1960s identified numerous scatters of Mesolithic material (Nickson and McDonald 1955; Cherry 1965; **Site 35**). Continued work in the area, particularly by John Cherry, identified sites of numerous periods, but his Mesolithic finds were the basis of a large excavation carried out by Clive Bonsall in the late 1970s and early 1980s on the south side of the Esk, at Eskmeals (Bonsall 1981). This identified large quantities of flint artefacts of late Mesolithic type and timber thought to represent structural remains, although this has been called into question (Croft *et al* 2003). Needless to say, there is certainly evidence of substantial occupation around the mouth of the river, although the nature of the occupation is still somewhat uncertain. Studies into the regional sea level and changes in the local topography brought about by the erosion and accumulation of deposits have also indicated that as the last of the ice retreated following the end of the Ice Age, the sea level was around 20m lower than at present by around 8,000 BC (LUAU 1996, 11). A relative sea level rise then eroded the existing glacial deposits before the level again dropped and shingle ridges were deposited, the development of which has been examined in detail in the area around Eskmeals (Bonsall *et al* 1994).

3.2.3 **Late Prehistoric – Neolithic to Iron Age (8,000 BC – 1st Century AD):** the numerous flint and other artefacts discovered during fieldwalking on the Drigg Dunes in the wider area by John Cherry and others include material that is clearly later prehistoric in date. It includes not only more flint artefacts but also stone axes (Cherry 1966, 474, Cherry and Cherry 1984, 255; Richardson 1990, 6), a possible stone mace head (Cherry 1966, 476), an arrowhead (Richardson 1990, 6), a saddle quern (Cherry 1988, 239-240; Richardson 1998, 6), and pottery (**Site 08**). More recently features associated with one of the sites previously identified (**Site 35** – an area of burnt material and possible timber structure identified by John Cherry (1982)) was subject to two phases of excavation following severe erosion, the first of which

identified the burnt feature as a burnt mound, which was subsequently radiocarbon dated to the Late Neolithic or Early Bronze Age (**Site 38**; LUAU 2001; although Cherry and Cherry mention a radiocarbon date of 3957 BP having been obtained from what is presumably the same layer at some point (2001, 194)). The pieces of timber recorded during the excavation appeared to have been artificially modified, although their exact function was uncertain; they were preserved in a layer of peat above the natural boulder clay sealed by wind-blown sand. Subsequent excavation revealed little of additional interest, although the published account considered it likely that the timber represented an entirely natural deposition (Croft *et al* 2003). The definition of when the Iron Age ends in this part of the country is uncertain, as the Roman invasion and occupation seems to have had little impact in some areas of rural North-West England (Philpott 2006, 73-74). There is no specific evidence for activity in the Iron Age, although some material considered to be Roman, such as a presumed bloomery (Cherry 1968; **Site 08**), could potentially belong to this period.

3.2.4 Romano-British to Early Medieval (1st century AD – 11th century AD): the period following the Roman Conquest and their gradual advance north in the later 1st century AD initially provides very visible remains of activity, in the form of the string of Roman forts running up the west coast of Cumbria from Ravenglass to the south of the site. However, only further stray finds have been identified from this period within the study area, in one case associated with a presumed bloomery. It is apparent that activity was taking place in the area during the Roman period, some of it perhaps industrial in nature. The purpose of such activity in such a remote location is uncertain, however, although it is possible that the beaches in the area were used as convenient stopping points for boats travelling along the coast and that trading points might have been established, like that at Moels in the Wirral (Griffiths *et al* 2007). Evidence from the period following the disintegration of Roman control is considerably rarer, but it is noteworthy in consideration of the previous point, that a single coin of Canute was discovered somewhere in the dunes, which shows distinct connections to Chester (Sugden 1992; **Site 11** and **53**).

3.2.5 Medieval (11th century – 16th century AD): there is little relevant information about the area during the medieval period, and very little in the way of archaeological remains, although a coin of Richard I was found in approximate association with the earlier bloomery (**Site 08**) and a well is recorded in Drigg that is thought to have medieval origins (**Site 37**). Drigg is recorded in documentary sources as early as the 12th century, the name thought to relate to its use as a place of access to the sea, in a sense somewhere that boats could be dragged ashore (Armstrong *et al* 1950, 377), something that may be relevant in relation to the suggestion that it was used a point for trading. Land in Drigg was held, apart from by individual families, by the Priory of St Bees, Calder Abbey, Conishead Priory, and Furness Abbey through a variety of grants and the area in general has a complex manorial history (Fair 1950).

3.2.6 Post-medieval to Modern (16th century AD – present): in many ways the area probably saw relatively little change in the post-medieval period, although the coming of the railway and increased industrialisation of the west coast of Cumbria on account of its rich iron and coal reserves, clearly had a noticeable affect (see Marshall and Davies-Sheil 1969, 105-134). The most notable archaeological sites within the study area dating from this period are the various military installations established during the Second World War that still remain (**Sites 14, 17, 51** and **52**). The even more recent establishment of a depot and facilities connected to the nuclear power station at Sellafield has further affected the local topography, although much of this has been landscaped and hidden so its impact is not always obvious.

3.3 Previous Archaeological Investigation

3.3.1 As has already been mentioned, the area has seen extensive field walking and investigation of surface finds, but no excavation of any size was carried out until the very end of the 20th century (LUAU 2001). A small-scale excavation of a bloomery site was carried out by John Cherry prior to this (Cherry 1974), but its scope was quite limited and so its conclusions perhaps questionable. Those excavations that were carried out more recently were essentially concerned with the same site, and were again relatively limited in size and were not able to provide many definite conclusions regarding their discoveries as a result (LUAU 2001; Croft *et al* 2003). Nevertheless, a layer of burnt stone was shown to be a probable burnt mound and dated to the late Neolithic or early Bronze Age, while the timbers were more contentious, and may represent an artificial structure or a natural deposition. An assessment was

also carried out to evaluate the impact on archaeological remains of the proposed drilling of bore holes in 1996 but it is not apparent whether any subsequent work was carried out (LUAU 1996).

3.4 Map Regression

3.4.1 In addition to the information gathered from the HERs a rapid examination of early maps of the site was also carried out, primarily to determine the previous land use of the area but also to identify any additional sites of archaeological interest and other relevant information. A range of maps was examined, the earliest being that accompanying the enclosure award of 1828, with the majority being Ordnance Survey maps of the 19th and early 20th centuries; there is no tithe map for Drigg. The detail of what was depicted on each of these maps is outlined below.

3.4.2 **Drigg Inclosure Award (CRO(W) YSPC/16/7 1828)**: this is the earliest detailed map of the area although it is primarily concerned with detailing land ownership rather than giving exact information about the local topography. It does, however, show the layout of the field system, both the existing areas (in green) and the proposed (blank), as well as give details of the ownership. The south end of the dunes is entirely marked as belonging to Lord Muncaster as is much of the central section (Plate 1), and the majority of the enclosures shown are named 'Drigghowsand' ('how' from the Norse word 'haugr' meaning hill), with those in the central part of the dunes named 'Low Moor'. However, plots 116 and 117 belong to Revd N Singleton and John Singleton respectively, while and the north end has a wide variety of owners, with many of the plots known as 'Herding Nab'. The entire area seems to have been largely used as rough grazing at this time.



Plate 1: Extract from the Drigg Inclosure Award map of 1828

3.4.3 **Ordnance Survey 1867:** the first edition Ordnance Survey map at a scale of 1: 10,560 demonstrates that there are very few features present on the dunes area. Of interest is the descriptions of different sections of the dunes; much of the south end and part of the north end are labelled 'Rabbit Warren' while the central section is labelled 'Drigg Common'. In addition 'Drigg Well (Chalybeate Spring)' is also labelled, which corresponds to **Site 37**.



Plate 2: Extract from the Ordnance Survey map of 1867

3.4.4 **Ordnance Survey n.d.:** the corresponding 1st edition 1: 2,500 map sheets of the area (Ordnance Survey n.d.a; n.d.b; n.d.c) show much of the same information as the previous map (they are not dated but are presumably also from 1867 or slightly later).

3.4.5 **Ordnance Survey 1899:** the one available map sheet for this date has one noticeable difference; the area previously labelled 'Drigg Common' is now labelled 'Rabbit Warren'. Presumably this means that by this date the dunes were no longer common land.

3.5 Discussion

3.5.1 The desk-based assessment clearly indicates a strong prehistoric presence in the area, with finds of Mesolithic to Bronze Age date. There is also evidence for occupation at the site during the Bronze Age as indicated by the burnt mound and various possible hearths and pottery. Finds from the Roman, early medieval, and medieval periods have also been discovered in the vicinity, suggesting that it was utilised or at least visited over a long period, although the extensive evidence is arguably a result of the continuous investigation of the area by John Cherry throughout the late 20th century.

3.5.2 The site of the burnt mound and the quantities of lithics recovered from the vicinity show a strong prehistoric presence in the area. It seems apparent that the prevalence of Mesolithic sites is probably concentrated slightly further inland on account of past marine transgressions, with the *in situ* Bronze Age activity closer to the shoreline (LUAU 1996, 11).

3.5.3 The map evidence provided little additional information although it did demonstrate that until the early 19th century much of the dunes area was unenclosed and at least some was common land. The apparent presence of rabbit warrens, recorded on the Ordnance Survey maps during the late 19th century, is perhaps significant as it suggests that the area would have seen considerable disturbance during this period, which might call into question the validity of the surface finds that have been made in the area.

3.5.4 It would appear, however, that from the results of the desk-based assessment that there is potential for the disturbance and recovery of lithic artefacts at the site during the excavation of the trial pits and other features.

4. Watching brief

4.1 Introduction

4.1.1 As described in the methodology section (*Section 2.3*) there were three elements to the fieldwork phase, initial checking of the completed and backfilled pits, observation of the remaining eight trial pits, and the observation of the excavation of three toad scrapes.

4.2 Results

4.2.1 **Walk-Over Survey:** the previously excavated and backfilled pits were impossible to accurately locate since any disturbance on the surface had been erased by the action of natural processes such as the wind and tides. The areas of the monitored trial pits and toad scrapes, which were all rapidly assessed before excavation commenced, also revealed no finds or features of archaeological interest from their environs. It was noticeable that the ground cover comprised thick dune grass, heather, and gorse and that there was little exposed sand apart from that on the beach. This would appear to be direct in contrast to earlier accounts of discoveries in the area, where artefacts and features of archaeological interest were discovered in eroding sand and areas disturbed by vehicles. This suggests that the vegetation cover has changed quite dramatically in the last 30 years, although it is not clear why this might be.

4.2.2 **Watching Brief:** the observation of the eight trial pits also proved them to be archaeologically sterile, typically comprising wind blown sands over beach sands, although occasionally beach cobbles, gravels, and silts (Plate 3) were observed at deeper levels. Only trial pit 30A2 revealed any buried deposits of interest, which comprised estuarine clays over a dense peat layer (see *Appendix 3*), however no artefacts or anthropogenic deposits were associated with these layers (Plate 4).



Plate 3 (left): Dark grey silts present in trial pit/borehole 03



Plate 4 (right): Trial pit 30A2 which contained buried peat deposit

4.2.3 The excavation for the toad scrapes also revealed no archaeological artefacts or features with waterlogged wind blown sand and silt being the most common deposit encountered (Plate 5).



Plate 5: Typical observation during the excavation of a toad scrape in dune area

4.3 Additional observations

4.3.1 Numerous timber stakes were observed on a gravel bank just off the west bank of the river Esk, whilst not part of the trial pitting area these were briefly recorded by photograph, and located by GPS (Figure 1). The stakes appeared to be in rows, and projected from the gravels by approximately 0.10m, a loose stake was found and had an overall length of around 0.80m. The stakes were fashioned from square sectioned hand finished timber that had the pointed or sharpened end poking out of the ground. The date of these stakes is assumed to be post-medieval, and they are thought to represent fish traps or perhaps a weir. The majority of the stakes appear to be seated in a bed of marine peat that underlies the gravel bank, various other horizontal timbers thought to be natural were also evident at the top of this layer where it had been exposed. The rows of stakes ran down the length of the gravel bar and were aligned with the flow of water rather than perpendicular to the flow of the river. The recording of this feature was somewhat hampered by the tides which only allowed very short periods of access to the gravel bank, a visit during the spring tide would allow more time for observation and recording of this feature.

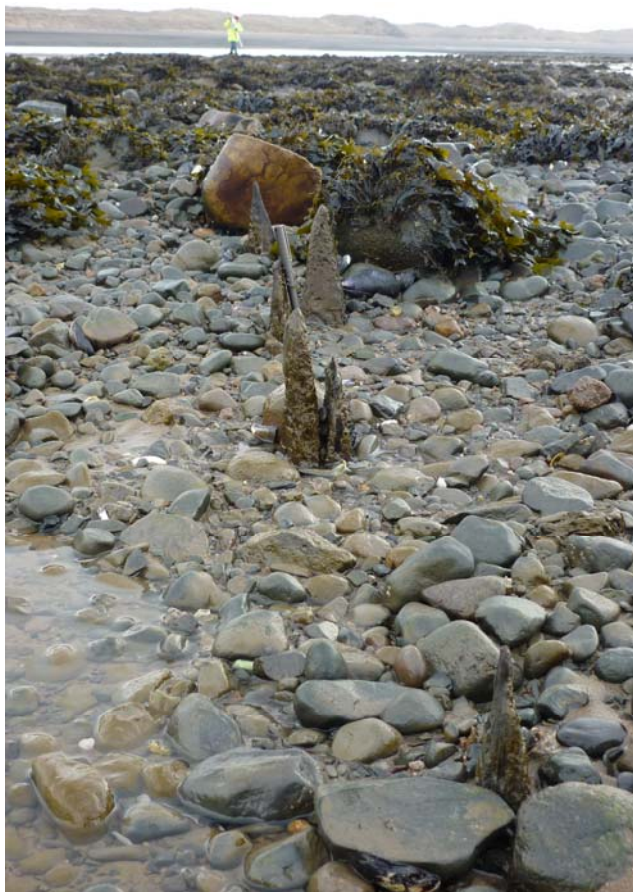


Plate 6 (left): Stake from fishtrap/weir

Plate 7 (right): Stakes *in situ* on gravel bank



Plate 8: Surveying of gravel bank on west side of Esk, Ravenglass in distance

4.4 Finds

4.4.1 No finds were recovered from either the walk-over survey or the monitoring of any of the excavation. However, pottery and glass was identified on the gravel bar on which the possible fish trap was located. This was all of probable 19th century date, with the exception of a single piece of Cistercian ware pottery, of probable 16th century date, comprising a rim fragment with part of a spout. Due to the potential significance of this latter piece only it was retained.

5. Conclusion

5.1 Introduction

5.1.1 Although the results of the walk-over survey and watching brief were essentially negative and the previously excavated trial pits and boreholes were not monitored, the resulting logs and radiocarbon dates are of interest in showing where deposits of clay and peat were located, and these will provide a valuable record for future researchers.

5.2 Discussion

5.2.1 Of particular interest is the deep deposit of peat present in TP30A and TP30A2, the former of which was observed during the watching brief although the depth meant that it could not be examined in detail. The three radiocarbon dates from of this deposit all give a date in the later Mesolithic (c8,500 BC), which coincides with the point at which the sea level was considered to have been considerably lower prior to its large increase (see *Section 3.2.2*); the overlying clays were presumably deposited during the subsequent marine transgressions and later settlement thus occurred further inland along the beach that formed at that time. Other samples that were radiocarbon dated are also of interest, although the manner in which they relate to later deposits is not as clear because of the manner in which they were retrieved (see *Appendix 4*) and interpretation in terms of the wider archaeological evidence is perhaps tentative at best. The sample from the Esk Estuary (B3/1) is similar to that from TP30A and so may represent the same formation episode. The three samples from 'Drigg Cliff' (DC1-3) are presumably from the peat deposit below the burnt mound previously examined and dated to the late Neolithic or early Bronze Age (LUAU 2001; Cherry 2001). They give dates from the early and late Mesolithic or perhaps early Neolithic, perhaps suggesting that the peat deposits in that area built up over a considerable period of time, essentially throughout the Mesolithic and Neolithic periods. The burnt mound was then presumably formed on top of this following the end of this event; a similar sequence was observed during the excavation of a burnt mound at Aldingham (The Morecambe Bay Archaeological Society 2006) and may be represented in the recent excavations carried out by OA North at Stainton near Carlisle (Clark 2010).

5.2.2 The potentially most significant dates are the two from Barn Scar (B2/1 and B2/2) from peat considered to have formed in a kettle hole. The calibrated dates are both c13,000-12,000 BC; this potentially makes them one of the earliest dated deposits in the county, and indicates that even this far north the glaciers of the last Ice Age had retreated enough for vegetation to develop and peat to form by this date, considerably earlier than it is generally thought to have (Hodgson and Brennand 2006, 23). The earliest dated artefacts in the county and from the very southern end of the county at that, are from only c11,000 BC (Salisbury 1992). The closest evidence for human activity at a similar date is the so called Poulton Elk, discovered in north Lancashire, which has been dated to maximum of 13,500-11,500 BC, although this is likely to be at the later end of that range (Hodgson and Brennand 2006, 25).

5.2.3 In addition, the incidental discovery of a possible fish trap in the estuary at the south end of the dunes, with possible associated dating evidence indicating that it could have its origins in the 16th century, is of some interest. It also ties into recent work carried out as part of the North West Rapid Coastal Zone Assessment (NWRCA), which recorded a fish trap in a similar location (although not necessarily the same structure) through the analysis of aerial photographs (Johnson 2009, 178, fig 8.11).

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Appendix 1: Site Gazetteer

Site Number: 01**Site Name:** Saltcoats Boat Find**NGR:** 307800 496900**Sources:** LDNPA HER: Hyam 1958, 14; Crawford and George 1983**HER No:** 1377**Designation:** none**Description:** Remains of an "ancient" wooden boat found here, date unknown.

Site Number: 02**Site Name:** Saltings, Drigg Barrow**NGR:** 306900 496400**Sources:** LDNPA HER: Hyam 1958, 27**HER No:** 1390**Designation:** none**Description:** A possible tumulus/barrow (artificial mound of earth, turf and/or stone, normally constructed to contain or conceal burials) of Bronze Age date.

Site Number: 03**Site Name:** Drigg flint working site**NGR:** 305400 497300**Sources:** LDNPA HER: Cherry 1965, 68-69, 72-79; Hyam 1958, 26; Crawford and George 1983**HER No:** 1396**Designation:** none**Description:** Flint tools find of Late Mesolithic to Bronze Age date indicating a lithic working site (*in situ* working of stone predominantly for the production of tools and weapons).

Site Number: 04**Site Name:** Drigg flint working site**NGR:** 305900 496800**Sources:** LDNPA HER: Cherry 1965, 68-69, 72-79; Hyam 1958, 26; Crawford and George 1983**HER No:** 1397**Designation:** none**Description:** Flint tools find of Late Mesolithic to Bronze Age date indicating a lithic working site (*in situ* working of stone predominantly for the production of tools and weapons).

Site Number: 05**Site Name:** Drigg flint working site**NGR:** 306300 496400**Sources:** LDNPA HER: Cherry 1965, 68-69, 72-79; Hyam 1958, 26; Crawford and George 1983**HER No:** 1398**Designation:** none**Description:** Flint tools find of Late Mesolithic to Bronze Age date indicating a lithic working site (*in situ* working of stone predominantly for the production of tools and weapons).

Site Number: 06**Site Name:** Ravenglass Barrow**NGR:** 307200 496000**Sources:** LDNPA HER: Hyam 1958, 27**HER No:** 3969**Designation:** none**Description:** A possible tumulus/barrow (artificial mound of earth, turf and/or stone, normally constructed to contain or conceal burials) of Bronze Age date.**Site Number: 07****Site Name:** Eskmeals rubber, saddle quern finds, Bootle**NGR:** 308100 494980**Sources:** LDNPA HER: Cherry 1963, 36; Cherry 1986, 1-17**HER No:** 4424**Designation:** none**Description:** Broken saddle quern and rubber found on surface of raised beach in Eskmeals.**Site Number: 08****Site Name:** Drigg and Carleton Bloomery and settlement**NGR:** 306790 496600**Sources:** LDNPA HER: Cherry 1968, 27-30, Cherry and Cherry 1985, 3-5**HER No:** 4428**Designation:** none**Description:** Iron slag scattered over a wide area with no sign of a hearth, a carved stone in the form of a fish which is thought to be Romano British in date, and several finds including Roman-British spindle whorls, a jet ring, glass bangles, pottery, and rotary quern fragments were discovered. Early flint flakes including a petit tranchet derivative arrowhead have also been recovered from the same general area and a penny dated AD 1199-1247.**Site Number: 09****Site Name:** Drigg and Carleton Axe, stone implement Finds**NGR:** 307100 496000**Sources:** LDNPA HER: Hyam 1958, 27; Cherry 1965, 27**HER No:** 4429**Designation:** none**Description:** Stone implement finds of unknown date.**Site Number: 10****Site Name:** Saltings, Drigg flint find**NGR:** 306800 496400**Sources:** LDNPA HER: Hyam 1958, 26; Crawford and George 1983, 42**HER No:** 4430**Designation:** none**Description:** A spindle whorl find and fragments of a bangle of Roman date. There were also Romano-British pot sherds and flints found.

Site Number: 11**Site Name:** Drigg Dunes coin find**NGR:** 307000 497000**Sources:** LDNPA HER: Sugden 1992**HER No:** 6363**Designation:** none**Description:** An early medieval coin of Canute was found on the dunes and given to Whitehaven museum. Exact location unknown: the same find is located in the CCC HER at Site **53**.

Site Number: 12**Site Name:** Drigg worked pebble find**NGR:** 306000 498000**Sources:** LDNP HER**HER No:** 6498**Designation:** none**Description:** A stone find carved with human features, of unknown date and authenticity.

Site Number: 13**Site Name:** Drigg and Carleton Park**NGR:** 307000 498000**Sources:** LDNPA HER**HER No:** 6822**Designation:** none**Description:** Robert de Eaglesfield was given licence to empark at Drigg in 1338. Documentary evidence of a medieval date, park location unknown.

Site Number: 14**Site Name:** Drigg and Carleton bombing decoy**NGR:** 307300 496900**Sources:** LDNPA HER**HER No:** 15136**Designation:** none**Description:** Site of a bombing decoy comprises a system of lights, controlled fires or dummy constructions used during World War II to distract aircraft with a false target.

Site Number: 15**Site Name:** Flint working site Drigg and Carleton, dunes**NGR:** 305800 497100**Sources:** LDNPA HER: Cherry 1965, 68**HER No:** 15243**Designation:** none**Description:** A possible lithic working site of prehistoric date.

Site Number: 16**Site Name:** Flint finds, River Irt, Drigg and Carleton**NGR:** 306400 496600**Sources:** LDNPA HER: Cherry 1965, 68-69; Cherry 1985, 5**HER No:** 15244**Designation:** none**Description:** Both leaf shaped and petit tranchet derivative arrowheads were found in some numbers, along with a knife and a scraper. Site lies on edge of a raised beach.

Site Number: 17**Site Name:** Drigg and Carleton World War II pillbox Ravenglass reserve**NGR:** 305500 497000**Sources:** LDNPA HER**HER No:** 16876**Designation:** none**Description:** Site of a pillbox (often squat building with thick loopoled walls and a flat roof, designed to accommodate a variety of weapons, and usually strategically placed to cover a vulnerable point in a defensive system).

Site Number: 18**Site Name:** Drigg Beach rough-out axe find**NGR:** 306000 497000**Sources:** LDNPA HER: Richardson 1990, 6**HER No:** 16924**Designation:** none**Description:** Find spot of an axe rough-out of Neolithic date, there was also a barbed and tanged arrowhead from the same location.

Site Number: 19**Site Name:** Flint finds east of Hall Carleton, Drigg and Carleton**NGR:** 307500 497800**Sources:** LDNPA HER: Cherry and Cherry 1985, 5**HER No:** 17906**Designation:** none**Description:** Sixty one flint artefacts including blade cores, blades, awls, scrapers along with two flakes of tuff.

Site Number: 20**Site Name:** Re-touched blade find, Hall Carleton, Drigg and Carleton**NGR:** 307000 498000**Sources:** LDNPA HER: Cherry and Cherry 1985, 5**HER No:** 17907**Designation:** none**Description:** A flint blade of prehistoric date.

Site Number: 21**Site Name:** Flint find south of Hall Carleton, Drigg and Carleton**NGR:** 307100 497600**Sources:** LDNPA HER: Cherry and Cherry 1985, 5**HER No:** 17908**Designation:** none**Description:** A flint flake of prehistoric date.

Site Number: 22**Site Name:** Flint find north of Saltcoats, Drigg and Carleton**NGR:** 307700 497200**Sources:** LDNPA HER: Cherry 1965, 68-69; Cherry 1985, 5**HER No:** 17909**Designation:** none**Description:** A flint flake of Bronze Age date.

Site Number: 23**Site Name:** Flint finds west of Bell Hill Farm, Drigg and Carleton**NGR:** 307600 498100**Sources:** LDNPA HER: Cherry and Cherry 1985, 6**HER No:** 17910**Designation:** none**Description:** Location of three nondescript flint flakes, one of which was patinated.

Site Number: 24**Site Name:** Saddle quern, south end of Drigg peninsula, Drigg and Carleton**NGR:** 307000 495000**Sources:** LDNPA HER: Cherry 1988, 239-240**HER No:** 19090**Designation:** none**Description:** An Eskdale granite quernstone of unknown date was found eroding from the dunes in 1986.

Site Number: 25**Site Name:** Flint find**NGR:** 307000 495000**Sources:** LDNPA HER: Richardson 1998, 13-14**HER No:** 19642**Designation:** none**Description:** A struck flint prehistoric date.

Site Number: 26**Site Name:** Flint find**NGR:** 307000 495000**Sources:** LDNPA HER: Richardson 1998, 13-14

HER No: 19644
Designation: none
Description: A struck flint prehistoric date.

Site Number: 27
Site Name: Mesolithic flint find
NGR: 307000 495000
Sources: LDNPA HER: Richardson 1998, 13-14
HER No: 19645
Designation: none
Description: A microlith.

Site Number: 28
Site Name: Glass bangle find, Ravenglass, Eskdale
NGR: 308000 496000
Sources: LDNPA HER: Richardson 1998, 29
HER No: 19687
Designation: none
Description: A fragment from a Romano-British bangle in a pale translucent pale green glass decorated with a narrow band of white overlay. 1st-2nd century AD.

Site Number: 29
Site Name: Romano-British pottery collection, Ravenglass, Muncaster
NGR: 308000 496000
Sources: LDNPA HER: Richardson 1998, 30
HER No: 19745
Designation: none
Description: A collection of pottery finds, an iron nail, and slag and cinder of Romano-British date were found eroding from the cliff top face.

Site Number: 30
Site Name: Possible site of military machine gunpost, Drigg dunes
NGR: 305520 497200
Sources: LDNPA HER
HER No: 32752
Designation: none
Description: A brick walled structure with a concrete roof, cubic structure on roof, semi-circular iron door facing the sea, semi-circular mounting inside possibly for machine gun or binoculars.

Site Number: 31
Site Name: Possible observation post at Drigg dunes, Drigg and Carleton
NGR: 305300 497510
Sources: LDNPA HER
HER No: 32753
Designation: none

Description: Rectangular observation post almost buried by sand with flat concrete roof, long slit along seaward side suggesting observation or firing position.

Site Number: 32

Site Name: Flint finds, Whitriggs Farm, Seascale

NGR: 304800 500300

Sources: CCC HER: Cherry 1967, 4; Cherry 1984, 13

HER No: 1303

Designation: none

Description: Flint flakes, scrapers and a flint knife were found in a field in 1964, a few more flints have been found subsequently.

Site Number: 33

Site Name: Axe and flint finds, seascale

NGR: 305000 500200

Sources: CCC HER: Cherry 1967, 4, 11

HER No: 1311

Designation: none

Description: Two flint blades, flint scrapers and a heavily patinated fragment of polished stone axe found 1965.

Site Number: 34

Site Name: Drigg settlement site

NGR: 305400 498500

Sources: CCC HER: Crawford and George 1983, 42

HER No: 1392

Designation: none

Description: A trial excavation on a scatter of boulders in a dune hollow revealed fragments of pottery and bone, along with a piece of Roman mortarium was carried out by John Cherry in 1971 and reported briefly in the CBA regional newsletter in 1974. Further excavation revealed a nearby hearth with the possibility of a wattle and daub windbreak and an area of charcoal, rough pottery, burnt bone and metal objects including a possible coin.

Site Number: 35

Site Name: Flint working site Drigg

NGR: 304700 498500

Sources: CCC HER: Fair 1936, 20; Nickson and Macdonald 1955, 17-29; Hyam 1958, 14, 26; Cherry 1982, 1-6; Crawford and George 1983, 41; LUAU 1996

HER No: 1394

Designation: none

Description: Mesolithic site comprising much debitage along with cores, scrapers, microliths, angle burins and arrowheads. In 1965 an organic layer was also exposed by cliff erosion, more flint flakes were found in this layer along with a quern fragment. Remains of a possible Bronze Age timber structure were also found, and close by a possible Bronze Age hearth, a small flint core was found in association with the timbers. Elements associated with this were subsequently excavated (see **Site 38**).

Site Number: 36**Site Name:** Flint and quern finds Drigg**NGR:** 304900 498300**Sources:** CCC HER: Hyam 1958, 14; Crawford and George 1983, 41; LUAU 1996**HER No:** 1461**Designation:** none**Description:** Flint flakes and quern fragment found in hollow of sandhills in 1932.**Site Number: 37****Site Name:** Drigg holy well**NGR:** 305680 497910**Sources:** CCC HER: McIntire 1945, 8; Crawford and George 1983, 42; LUAU 1996**HER No:** 3968**Designation:** none**Description:** Shown as 'Drigg Well' (Chalbeate spring) on 2nd edition Ordnance Survey map of 1900. Spring for curing ails.**Site Number: 38****Site Name:** Drigg burnt mound and lithic site**NGR:** 304500 498600**Sources:** CCC HER: Cherry 1982, 2-4; LUAU 2001; Croft *et al* 2003**HER No:** 4300**Designation:** none**Description:** A Mesolithic hearth containing several pieces of blackened timber located in the cliff face at Drigg. 1966 observations suggested it represented a rectangular or square structure that had been built on the peaty surface and perhaps stabilised by pegs. Lancaster University Archaeological Unit (LUAU) investigated the site in 1999 and suggested it represented a burnt mound rather than a hearth, and that it was Bronze Age. It was not certain if the timber element was man made or not. Further excavation work was undertaken by the south-west regional group of CWAAS but no further clarification was achieved.**Site Number: 39****Site Name:** Flint finds, stony How, Seascale**NGR:** 305100 500300**Sources:** CCC HER**HER No:** 6461**Designation:** none**Description:** Flints including blades, scrapers, knives, borers, utilised flakes and two struck flakes of volcanic tuff were found within a small area of a field south-west of Stony How. According to J Cherry the assemblage appears to be Neolithic.**Site Number: 40****Site Name:** Drigg sand pit**NGR:** 305610 498870**Sources:** CCC HER**HER No:** 12154**Designation:** none**Description:** Site of a sand pit, now built over by Drigg storage depot

Site Number: 41**Site Name:** Wray Head, Drigg**NGR:** 306120 499020**Sources:** CCC HER: LUAU 1996**HER No:** 12192**Designation:** none**Description:** Settlement site comprising two large buildings that were probably domestic. Site of farmstead on 1860 1st edition Ordnance survey map. Site now part of Drigg storage depot.

Site Number: 42**Site Name:** Sandford, Drigg**NGR:** 305960 498920**Sources:** CCC HER: LUAU 1996**HER No:** 12206**Designation:** none**Description:** Site of a farmstead shown on 1860 Ordnance Survey map, settlement site comprised two large buildings that probably formed several houses. Site now disappeared and superseded by Drigg storage depot.

Site Number: 43**Site Name:** Seascale dismantled railway**NGR:** 304570 500200**Sources:** CCC HER**HER No:** 12206**Designation:** none**Description:** Dismantled railway sidings just south of seascale

Site Number: 44**Site Name:** The Bungalow, Seascale**NGR:** 304630 498740**Sources:** CCC HER: LUAU 1996**HER No:** 12289**Designation:** none**Description:** Approximate location of domestic bungalow marked on 1899 Ordnance Survey map.

Site Number: 45**Site Name:** Bronze Age Hearths, Drigg dunes, Drigg and Carleton**NGR:** 305200 497900**Sources:** CCC HER: LUAU 1996; Cherry 1965, 69; Cherry 1985, 3**HER No:** 15246**Designation:** none**Description:** In a sandy hollow where boulder clay was partially exposed, a flint knife and arrowhead were found, small hearths associated with the artefacts had Bronze Age characteristics.

Site Number: 46**Site Name:** Flint finds, Barn Scar, Drigg and Carleton**NGR:** 304800 498600**Sources:** CCC HER: LUAU 1996; Cherry 1965, 66; Cherry 1985, 1**HER No:** 12192**Designation:** none**Description:** Settlement site comprising two large buildings that were probably domestic. Site of farmstead on 1860 1st edition Ordnance survey map. Site now part of Drigg storage depot.**Site Number: 47****Site Name:** Flint finds, Barn Scar, Drigg and Carleton**NGR:** 304800 498600**Sources:** CCC HER: LUAU 1996; Cherry 1965, 66; Cherry 1985, 1**HER No:** 15247**Designation:** none**Description:** Microliths and a re-used core found by J Cherry in 1965. Nearby in the adjacent cliff face is a buried land surface, dated to the elm decline of around 3,000 BC. Surface is covered by wind blown sand and was exposed due to erosion caused by vehicles.**Site Number: 48****Site Name:** Flint finds, Summer view, Drigg and Carleton**NGR:** 304700 499600**Sources:** CCC HER: LUAU 1996; Cherry 1965, 69**HER No:** 15248**Designation:** none**Description:** A few square yards of clay and gravel contained undiagnostic waste flakes and some scrapers.**Site Number: 49****Site Name:** Flint finds, Barn Scar, Drigg and Carleton**NGR:** 304700 498700**Sources:** CCC HER: LUAU 1996; Nickson and MacDonald 1955, 17-29**HER No:** 15249**Designation:** none**Description:** Material recovered from an area of 50x80 yards. The flint is worked from beach pebbles, although there was also some chert. Over 100 cores, some re-used as scrapers, 40 other scrapers, 30 microliths, some microburins, many blades and waste flakes.**Site Number: 50****Site Name:** Barn Scar Romano-British bloomery site, Drigg and Carleton**NGR:** 304630 498600**Sources:** CCC HER**HER No:** 15922**Designation:** none**Description:** Site of Romano-British bloomery.

Site Number: 51**Site Name:** Carl Crag World War II Observation Post**NGR:** 304800 499400**Sources:** CCC HER LUAU 1996; Wills 1985**HER No:** 16874**Designation:** none**Description:** Rectangular with a large aperture at the front. According to D Parkin it is a range observation post.

Site Number: 52**Site Name:** World War II Observation Post, Shore Road, Drigg**NGR:** 304800 498500**Sources:** CCC HER: LUAU 1996; Wills 1985**HER No:** 16875**Designation:** None**Description:** WWII pillbox in this location. According to D Parkin it is a gunnery range observation post, located at head of dune overlooking the shore

Site Number: 53**Site Name:** Coin find, Drigg and Carleton**NGR:** 305000 498000**Sources:** CCC HER: Sugden 1992**HER No:** 19156**Designation:** none**Description:** An Anglo-Saxon penny from 790, found by detectorist in the dunes. Exact location unknown: the same find is recorded at Site 11 in the LDNPA HER.

Site Number: 54**Site Name:** Drigg Boat House, Shore Road, Drigg**NGR:** 304850 498320**Sources:** CCC HER: LUAU 1996**HER No:** 43142**Designation:** none**Description:** A boat house and landing stage that appear only on the 1900 Ordnance Survey map.

Site Number: 55**Site Name:** Mireside, Drigg**NGR:** 305540 499280**Sources:** CCC HER: LUAU 1996**HER No:** 43143**Designation:** none**Description:** Farmstead shown on Ordnance Survey maps of 1860 and 1900. The farm is now gone and the land now forms part of the Drigg storage depot.

Site Number: 56**Site Name:** Town End, Drigg**NGR:** 305960 498960**Sources:** CCC HER: LUAU 1996

HER No: 43144

Designation: none

Description: Farmstead shown on the Ordnance Survey maps of 1860 and 1900, land now part of Drigg storage depot.

Site Number: 57

Site Name: Brown Knott, Drigg

NGR: 305190 499620

Sources: CCC HER: LUAU 1996

HER No: 43145

Designation: none

Description: Farmstead shown on the Ordnance Survey maps of 1860 and 1900, land now part of Drigg storage depot.

Appendix 2: Project Design

TEST PITS, DRIGG, CUMBRIA

Archaeological Watching Brief Project Design



Client: The Nuclear Decommissioning Authority

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February 2010

1. Introduction

1.1 Project Background

1.1.1 Following the discovery that test pits had been excavated as part of exploratory work, carried out on behalf of the Nuclear Decommissioning Authority (hereafter 'the client') to assess the structure of the sand dunes west of Drigg, Cumbria (centred on NGR 306740 496113), without archaeological monitoring, a request was made by the Senior Archaeology and Heritage Advisor at the Lake District National Park Authority that the remaining pits and an area to be landscaped to improve the site for natterjack toads be monitored by watching brief. The previous test pits had been excavated both within the National Park and immediately over its northern boundary, but the remaining test pits are anticipated to be excavated only within the National Park. The entire area is known to have extensive evidence for prehistoric and later activity, as evidenced by numerous scatters of flint artefacts and other features revealed during fieldwalking and examination of the eroding cliff line. The watching brief was therefore requested in order that any further remains of this type that might be uncovered can be recorded and where possible avoided by the ground works. A request was also made that the areas in which excavation had already been carried out also be examined to assess whether any remains of archaeological interest had been exposed and for the report on the watching brief to incorporate information from the previous excavations, which included C14 dating of peat deposits.

1.1.2 The area around Drigg has been known to have evidence for archaeological remains since the 1950s, when material eroding from sand dunes and cliffs along the shore was first recorded (Nickson and MacDonald 1956). This work was continued by members of the Cherry family throughout the remainder of the 20th century (Cherry 1965; and summarised in Cherry and Cherry 2002), with the result that a large amount of material was recovered over an extensive area of the shoreline around the point where the River Irt meets the ocean. The material discovered spanned a large period of time, from the Mesolithic and into the Bronze Age.

1.2 Greenlane Archaeology

1.2.1 Greenlane Archaeology is a private limited company based in Ulverston, Cumbria, and was established in 2005 (Company No. 05580819). Its directors, Jo Dawson and Daniel Elsworth, have a combined total of over 18 years continuous professional experience working in commercial archaeology, principally in the north of England and Scotland. Greenlane Archaeology is committed to a high standard of work, and abides by the Institute for Archaeologists' (IfA) Code of Conduct. The desk-based assessment and watching brief will be carried out according to the Standards and Guidance of the Institute for Archaeologists (IfA 2008a; 2008b).

1.3 Project Staffing

1.3.1 The project will be managed by **Dan Elsworth (MA (Hons), AIfA)**. Daniel graduated from the University of Edinburgh in 1998 with an honours degree in Archaeology, and began working for the Lancaster University Archaeological Unit, which became Oxford Archaeology North (OA North) in 2001. Daniel ultimately became a project officer, and for over six and a half years worked on excavations and surveys, building investigations, desk-based assessments, and conservation and management plans. These have principally taken place in the North West, and Daniel has a particular interest in the archaeology of the area. He carried out research into prehistoric coastal assemblages while at university (Elsworth 1998) and has retained a strong interest in the period ever since. Professionally, he has recently managed a wide variety of projects including building recordings of various sizes, watching briefs, evaluations, and excavations.

1.3.2 The watching brief will be carried out by **Sam Whitehead (BSc (Hons), MA)**. Sam graduated from the University of Liverpool in 1994 with an honours degree in Archaeology, and has more than 10 years professional experience in commercial archaeology, much of which in a supervisory capacity. He has extensive experience of excavations, evaluations, and watching briefs, as well as report writing and illustration production.

1.3.3 All artefacts will be processed by Greenlane Archaeology, and it is envisaged that they will initially be examined by **Jo Dawson (MA (Hons), AIfA)**, who will fully assess any of post-medieval date. Prehistoric lithic material will be assessed by Dan Elsworth at Greenlane Archaeology. Other finds will be assessed by specialist sub-contractors as appropriate, and in this case it is envisaged that prehistoric pottery will be examined by Carol Allen, and medieval pottery will be examined by Ian Miller at Oxford Archaeology North. The Lake District National Park Archaeology Service (LDNPAS) will be notified of any other specialists, other than those named, who Greenlane Archaeology wishes to engage, before any specialist contracts are awarded, and their approval will be sought.

1.3.4 Environmental samples and faunal remains, should significant deposits of these be recovered, will be processed by Greenlane Archaeology. It is envisaged that charred plant remains will be assessed by Scott Timpany of Headland Archaeology Ltd, and faunal remains by Auli Tourunen, also at Headland Archaeology. Should any human remains be recovered it is envisaged that these will be assessed by Malin Horst at York Osteoarchaeology, following appropriate advice on initial processing. The LDNPAS will be notified of any other specialists, other than those named, who Greenlane Archaeology wishes to engage, before any specialist contracts are awarded, and their approval will be sought.

2. Objectives

2.1 Rapid Desk-Based Assessment

2.1.1 To examine available sources in order to acquire information relating to previous archaeological discoveries in the area and local land use order to better understand the sites development, set it in its historic context, and assess the significance of any existing and potential archaeological remains.

2.2 Rapid Walk-Over Survey

2.2.1 To examine the areas previously affected by test pits and bore holes in order to identify whether any remains of archaeological interest have been exposed.

2.3 Watching Brief

2.3.1 To identify any surviving archaeological remains and to investigate and record any revealed archaeological remains or deposits.

2.4 Report

2.4.1 To produce a report detailing the results of the desk-based assessment, walk-over survey, and watching brief and incorporating information obtained during the previous excavation of test pits and boreholes.

2.5 Archive

2.5.1 Produce a full archive of the results of the watching brief.

3. Methodology

3.1 Rapid Desk-Based Assessment

3.1.1 An examination of both primary and secondary sources, particularly maps, but also published and unpublished local histories, pieces of research, articles and studies relating to the proposed development site and a suitable area around it (the 'study area') will be carried out. These sources will be consulted at the following locations:

- **Lake District National Park Authority Historic Environment Record (HER):** this is a list of all of the recorded sites of archaeological interest recorded in the Lake District National Park, and is the primary source of information for a study of this kind. Each site is recorded with any relevant references, a brief description and location related to the National Grid. All of the references relating to sites identified in the HER will be examined in order to verify them and add any necessary background information. In addition, relevant secondary sources, particularly the results of previous archaeological investigations in the immediate area, will also be examined;
- **Cumbria Historic Environment Record (HER):** this is a list of all of the recorded sites of archaeological interest recorded in the county excluding the Lake District National Park, and it contains the same form of information. As with the LDNPA HER details relating to known sites of archaeological interest will be acquired and available reports consulted;
- **Cumbria Record Office (Whitehaven):** the majority of original and secondary sources relating to the site are deposited in the Cumbria Record Office in Whitehaven. Particularly useful are early maps of the area such as the tithe map and those produced by the Ordnance Survey. These will be examined in order to provide information about the land use and development of the site in order to establish whether this has had any affect on the archaeological record, as well as identify any structures of historic interest. In addition, information relating to the general history and archaeology will also be consulted, in order

establish the context of the sites identified within the study area, and the potential for further, as yet unknown, sites of archaeological interest;

- **Greenlane Archaeology:** a number of copies of maps, local histories, unpublished reports, and journals are held in Greenlane Archaeology's library. These will be consulted in order to provide further information about the development of the site, and any other elements of archaeological interest.

3.1.2 The results of this assessment will be used to establish the location, extent, date, and development of any sites of archaeological interest demonstrated to be present within the proposed development area and its environs. The extent of all of the sites identified will be shown on an appropriately scaled maps and areas of archaeological interest or significance will be shown and the extent or level of their potential expressed as considered necessary.

3.1.3 Recommendations for areas to be avoided by the test pitting will be presented based on the results of the desk-based assessment. This will take into consideration the areas in which there is evidence for the presence of archaeological remains, the significance of known remains, areas of high potential, or areas that are likely to have been disturbed by subsequent activity on the site.

3.2 Rapid Walk-Over Survey

3.2.1 A rapid examination of the areas in which the previous test pits and boreholes were excavated will be carried out. This will be done in as systematic a manner as practicably possible with the areas walked in transects. Any finds or remains of archaeological interest encountered will be collected or recorded, photographs will be taken and written records made as appropriate and their location recorded relative to local topography (see 3.3.2 below).

3.3 Watching Brief

3.3.1 The groundworks are to be monitored, with one archaeologist on site assuming a single machine is working at any given time (see 3.3.2 below).

3.3.2 The watching brief methodology will be as follows:

- It is anticipated that the test pits will be excavated by machine under supervision by staff from Greenlane Archaeology;
- All deposits of archaeological significance will be examined by hand if possible in a stratigraphic manner, using shovels, mattocks, or trowels as appropriate for the scale;
- The position of any features, such as ditches, pits, or walls, will be recorded and where necessary these will be investigated in order to establish their full extent, date, and relationship to any other features. If possible, negative features such as ditches or pits will be examined by sample excavation, typically half of a pit or similar feature and approximately 10% of a linear feature;
- The position of the test pits and areas of excavation will be located with reference to local topography, assuming they are not being located by contractors on site via GPS. Given the size of the area within which the test pits are being excavated and relative lack of topographic features it is envisaged that the areas of excavation will be located utilising a total station;
- All recording of features will include detailed plans and sections at a scale of 1:20 or 1:10 where practicable or sketches where it is not, and photographs in both colour print and colour digital format;
- All deposits, drawings and photographs will be recorded on Greenlane Archaeology *pro forma* record sheets;
- All finds will be recovered during the watching brief for further assessment as far as is practically and safely possible. Should significant amounts of finds be encountered an appropriate sampling strategy will be devised;
- All faunal remains will also be recovered by hand during the watching brief as far as is practically and safely possible, but where it is considered likely that there is potential for the bones of fish or small mammals to be present appropriate volumes of samples will be taken for sieving;
- Deposits that are considered likely to have preserved environmental remains will be sampled. Bulk samples of between 10 and 40 litres in volume, depending on the size and potential of the deposit, will be collected from stratified undisturbed deposits and will particularly target negative features (gullies, pits and ditches) and occupation deposits such as hearths and floors although in this case it is anticipated that palaeoenvironmental deposits such as peat might also be worth sampling. An assessment of the environmental potential of the site will be undertaken through the examination of samples of suitable

deposits by specialist sub-contractors (see *Section 1.3.4* above), who will examine the potential for further analysis. All samples will be processed using methods appropriate to the preservation conditions and the remains present;

- Any human remains discovered during the watching brief will be left *in situ*, and, if possible, covered. English Heritage will be immediately informed as will the local coroner. Should it be considered necessary to remove the remains this will require a Home Office licence, under Section 25 of the Burial Act of 1857, which will be applied for should the need arise;
- Any objects defined as 'treasure' by the Treasure Act of 1996 (HMSO 1996) will be immediately reported to the local coroner and secured stored off-site, or covered and protected on site if immediate removal is not possible;
- Should any significant archaeological deposits be encountered during the watching brief these will immediately be brought to the attention of the LDNPAS so that the need for further work can be confirmed. Any additional work and ensuing costs will be agreed with the client and according to the requirements of the LDNPAS, and subject to a variation to this project design.

3.4 Report

3.4.1 The results of watching brief will be compiled into a report, which will include the following sections:

- Results of the rapid walk-over survey and watching brief including descriptions of any deposits identified, their extent, form and potential date, and an assessment of any finds or environmental remains recovered during the watching brief;
- Incorporation of the results from the previously excavated test pits and bore holes such as logs and records, and particularly C14 dates obtained for any deposits encountered;
- Discussion of the results, with specific reference to their relationship with previously recorded archaeological remains from the area;
- Illustrations at appropriate scales including:
 - a plan showing the location of the ground works;
 - plans and sections of the watching brief ground works, as appropriate, showing any features of archaeological interest;
 - photographs of the watching brief, including both detailed and general shots of features of archaeological interest and the trenches;
 - photographs of individual artefacts as appropriate.

3.5 Archive

3.5.1 The archive, comprising the drawn, written, and photographic record of the watching brief, formed during the project, will be stored by Greenlane Archaeology until it is completed. Upon completion it will be deposited with the Cumbria Record Office in Whitehaven (CRO(W)). The archive will be compiled according to the standards and guidelines of the IfA (Brown 2007), and in accordance with English Heritage guidelines (English Heritage 1991). In addition details of the project will be submitted to the Online Access to the Index of archaeological investigations (OASIS) scheme. This is an internet-based project intended to improve the flow of information between contractors, local authority heritage managers and the general public.

3.5.2 A copy of the report will be deposited with the archive at the Cumbria Record Office in Whitehaven, one will be supplied to the client, and within six months of the completion of fieldwork, a copy will be provided for the LDNPA Historic Environment Record (HER) and Cumbria HER. In addition, Greenlane Archaeology Ltd will retain one copy, and digital copies will be deposited with the NMR and OASIS scheme as required.

3.5.3 The client will be encouraged to transfer ownership of the finds to a suitable museum. If no suitable repository can be found the finds may have to be discarded, and in this case as full a record as possible would be made of them beforehand.

4. Work timetable

4.1 Greenlane Archaeology will be available to commence the project on **18th February 2010**, or at another date convenient to the client. It is envisaged that the project will involve tasks in the following order:

- **Task 1:** desk-based assessment;
- **Task 2:** watching brief;
- **Task 3:** post-excavation work on archaeological watching brief, including processing of finds and production of draft report and illustrations;
- **Task 4:** feedback, editing and production of final report, completion of archive.

5. Other matters

5.1 Access

5.1.1 Access to the site will be organised through co-ordination with the client and/or their agent(s).

5.2 Health and Safety

5.2.1 Greenlane Archaeology carries out risk assessments for all of its projects and abides by its internal health and safety policy and relevant legislation. Health and safety is always the foremost consideration in any decision-making process.

5.3 Insurance

5.3.1 Greenlane Archaeology has professional indemnity insurance to the value of **£500,000**. Details of this can be supplied if requested.

5.4 Environmental and Ethical Policy

5.4.1 Greenlane Archaeology has a strong commitment to environmentally- and ethically-sound working practices. Its office is supplied with 100% renewable energy by Good Energy, uses ethical telephone and internet services supplied by the Phone Co-op, is even decorated with organic paint, and has floors finished with recycled vinyl tiles. In addition, the company uses the services of The Co-operative Bank for ethical banking, Naturesave for environmentally-conscious insurance, and utilises public transport wherever possible. Greenlane Archaeology is also committed to using local businesses for services and materials, thus benefiting the local economy, reducing unnecessary transportation, and improving the sustainability of small and rural businesses.

6. Bibliography

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Elsworth, DW, 1998 *The Mesolithic Around Morecambe Bay*, unpublished dissertation, University of Edinburgh

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Appendix 3: Trial Pit/Borehole Logs



Site

Drigg

Trial Pit Number
TP014

Excavation Method
Wheeled Backhoe Excavator

Dimensions
1x4 m

Ground Level (mOD)
1.67

Client
LLW Repository Ltd

Job Number
E3521R

Location
304466.14, 498747.92

Dates
08/01/2010

Engineer
British Geological Survey

Sheet
1/1

| Depth (m) | Sample / Tests | Water Depth (m) | Field Records | Level (mOD) | Depth (m) (Thickness) | Description | Legend | Water |
|-----------|----------------|-----------------|-----------------------|-------------|-----------------------|---|--------|-------|
| 0.30-0.30 | B1 | | Moderate(1) at 1.80m. | 1.17 | 0.50 | Loose yellowish brown (10YR 5/4) fine to medium SAND. | | |
| | | | | | 0.50 | Loose dark brown (7.5 YR 3/3) coarse SAND and fine to coarse subrounded to rounded GRAVEL with a little cobbles. Cobbles are subrounded and up to 100mm. A 50mm thick lense of gravel-sized coal fragments is present within the layer in the northern part of the trial pit. | | |
| | | | | | 1.20 | | | |
| | | | | | 1.70 | Loose dark brown (7.5YR 3/3) COBBLES and BOULDERS with some sand and gravel. Cobbles and boulders are subrounded to rounded up to 400mm (Generally cobble-sized). Some sand-sized fragments of coal present at the base of the cobble and boulder layer. | | ∇1 |
| | | | | -0.63 | 2.30 | Complete at 2.30m | | |

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Remarks
Excavating from 0.00m.
Trial pit collapsed.

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| Scale (approx) 1:20 | Logged By MRD | Figure No. E3521R.TP14 |
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Site

Drigg

Trial Pit Number
TP014B

Excavation Method
Wheeled Backhoe Excavator

Dimensions
1x4 m

Ground Level (mOD)
0.37

Client
LLW Repository Ltd

Job Number
E3521R

Location
304352.34, 498628.16

Dates
08/01/2010

Engineer
British Geological Survey

Sheet
1/1

| Depth (m) | Sample / Tests | Water Depth (m) | Field Records | Level (mOD) | Depth (m) (Thickness) | Description | Legend | Water |
|-----------|----------------|-----------------|-------------------|-------------|-----------------------|--|--------|-------|
| 0.10-0.10 | B1 | | | 0.22 | (0.15) 0.15 | Soft to firm black (GLE Y1 2.5/N) very organic clayey SILT with numerous plant fragments. NB large cobbles and boulders lying on surface not seen in excavation. | | |
| | | | | -0.28 | (0.50) 0.65 | Very soft dark brown (7.5YR 3/3) CLAY with occasional closely spaced thin laminations of black organic material and fine sand partings. | | |
| | | | Slow(1) at 1.40m. | -1.73 | (1.45) 2.10 | Loose brown (7.5YR 4/3) slightly silty fine to medium SAND. | | ∇1 |
| | | | | | | Complete at 2.10m | | |

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Remarks

Trial pit collapsed.

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| Scale (approx) 1:20 | Logged By MRD | Figure No. E3521R.TP014B |
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Site

Drigg

Trial Pit Number
TP015

Excavation Method
Wheeled Backhoe Excavator

Dimensions
1x4 m

Ground Level (mOD)
1.38

Client
LLW Repository Ltd

Job Number
E3521R

Location
304406.87, 498937.14

Dates
01/01/2010

Engineer
British Geological Survey

Sheet
1/1

| Depth (m) | Sample / Tests | Water Depth (m) | Field Records | Level (mOD) | Depth (m) (Thickness) | Description | Legend | Water |
|-----------|----------------|-----------------|---------------|-------------|-----------------------|---|--------|-------|
| | | | | | 0.40 | Loose brown (7.5 YR 4/4) shelly sandy fine to coarse subrounded to rounded GRAVEL with some cobbles. | | |
| | | | | 0.98 | 0.40 | Loose brown (7.5YR 5/4) gravelly fine to coarse SAND. Gravel is fine to coarse subrounded to rounded. | | |
| | | | | 0.38 | 1.00 | Complete at 1.00m | | |

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Remarks
Trial pit collapsed.

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| Scale (approx) 1:20 | Logged By MRD | Figure No. E3521R.TP015 |
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Site

Drigg

Trial Pit Number
TP016

Excavation Method
Wheeled Backhoe Excavator

Dimensions
1x4 m

Ground Level (mOD)
0.10

Client
LLW Repository Ltd

Job Number
E3521R

Location
304307.91, 498940.94

Dates
09/01/2010

Engineer
British Geological Survey

Sheet
1/1

| Depth (m) | Sample / Tests | Water Depth (m) | Field Records | Level (mOD) | Depth (m) (Thickness) | Description | Legend | Water |
|-----------|----------------|-----------------|-------------------|-------------|-----------------------|---|--------|-------|
| | | | | 0.00 | (0.10) | Loose yellow brown (10YR 6/6) shelly fine to medium SAND. | | |
| | | | | -0.10 | (0.10) | Loose yellowish brown (10YR 5/4) very shelly very sandy fine to coarse subrounded to rounded GRAVEL. | | |
| | | | fast(1) at 0.60m. | | (0.20) | Loose brown (7.5YR 4/4) fine to medium SAND. 20mm thick layer of orange/red oxidisation staining at top of layer. | | |
| | | | | | (1.70) | | | |
| | | | | -1.80 | 1.90 | Complete at 1.90m | | |

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Remarks

Scraping sound at base of trial pit, possibly cobbles. Not seen due to depth of water and trial pit collapse.
Trial pit collapsed.

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| Scale (approx) 1:20 | Logged By MRD | Figure No. E3521R.TP016 |
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Site

Drigg

Trial Pit Number
TP017

Excavation Method

Trial Pit

Dimensions

1x4 m

Ground Level (mOD)

1.12

Client

LLW Repository Ltd

Job Number
E3521R

Location

304386.08, 498996.65

Dates

09/01/2010

Engineer

British Geological Survey

Sheet

1/1

| Depth (m) | Sample / Tests | Water Depth (m) | Field Records | Level (mOD) | Depth (m) (Thickness) | Description | Legend | Water |
|-----------|----------------|-----------------|-------------------|-------------|-----------------------|--|--------|-------|
| | | | | | | Loose yellowish brown (10YR 6/6) fine to medium SAND. | | |
| | | | | 0.87 | 0.25 (0.10) | Loose black (GLE Y1 2.5/N) very shelly very gravelly fine to coarse SAND with a little cobbles. Gravel is fine to coarse subrounded to rounded. Cobbles are subrounded to rounded up to 100mm. | | |
| | | | Slow(1) at 0.75m. | 0.77 | 0.35 | Loose brown (7.5YR 4/4) fine to medium SAND. | | |
| | | | | | (1.40) | | | |
| | | | | -0.63 | 1.75 | Complete at 1.75m | | |

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Remarks

Trial pit collapsed.

Scale (approx)

1:20

Logged By

MRD

Figure No.

E3521R.TP017



Site

Drigg

Trial Pit Number
TP018

Excavation Method
Wheeled Backhoe Excavator

Dimensions
1x4 m

Ground Level (mOD)
0.59

Client
LLW Repository Ltd

Job Number
E3521R

Location
304315.28, 499010.39

Dates
09/01/2010

Engineer
British Geological Survey

Sheet
1/1

| Depth (m) | Sample / Tests | Water Depth (m) | Field Records | Level (mOD) | Depth (m) (Thickness) | Description | Legend | Water |
|-----------|----------------|-----------------|-------------------|-------------|-----------------------|---|--------|----------------|
| | | | Slow(1) at 0.30m. | 0.24 | (0.35) | Loose yellow brown (10YR 6/6) fine to medium SAND. | | ∇ ₁ |
| | | | | -0.16 | (0.40) | Loose very dark grey (10YR 3/1) slightly silty very sandy fine to coarse subrounded to rounded GRAVEL with many cobbles and boulders. Cobbles and boulders are subrounded to rounded up to 300mm. | | |
| | | | | -2.41 | (2.25) | Dense brown (7.5YR 4/4) slightly silty sandy fine to coarse subrounded to rounded GRAVEL with much cobbles and boulders. Cobbles and boulders are rounded up to 500mm. | | |
| | | | | | 3.00 | Complete at 3.00m | | |

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Remarks
Trial pit stable.

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| Scale (approx) 1:20 | Logged By MRD | Figure No. E3521R.TP018 |
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Site

Drigg

Trial Pit Number
TP026

Excavation Method
Wheeled Backhoe Excavator

Dimensions
1x4 m

Ground Level (mOD)
5.04

Client
LLW Repository Ltd

Job Number
E3521R

Location
306983.63, 495842.42

Dates
25/02/2010

Engineer
British Geological Survey

Sheet
1/1

| Depth (m) | Sample / Tests | Water Depth (m) | Field Records | Level (mOD) | Depth (m) (Thickness) | Description | Legend | Water |
|-----------|----------------|-----------------|-------------------|-------------|-----------------------|--|--------|-------|
| | | | Slow(1) at 0.40m. | | (1.60) | Loose yellowish brown (10YR 5/4) slightly gravelly fine to medium SAND. Gravel is fine to coarse subrounded to rounded. Colour changes to orange yellow at 0.8m. | | ∇1 |
| | | | | 3.44 | 1.60 | Complete at 1.60m | | |

Plan

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Remarks
Trial pit collapsed.

| | | |
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| Scale (approx) 1:20 | Logged By MRD | Figure No. E3521R.TP026 |
|-------------------------------|-------------------------|-----------------------------------|



Site

Drigg

Trial Pit Number
TP027

Excavation Method

Wheeled Backhoe Excavator

Dimensions

1x4 m

Ground Level (mOD)

4.57

Client

LLW Repository Ltd

Job Number
E3521R

Location

307734.89, 495794.46

Dates

24/02/2010

Engineer

British Geological Survey

Sheet

1/1

| Depth (m) | Sample / Tests | Water Depth (m) | Field Records | Level (mOD) | Depth (m) (Thickness) | Description | Legend | Water |
|-----------|----------------|-----------------|-------------------|-------------|-----------------------|---|--------|-------|
| 0.30-0.30 | B1 | | Slow(1) at 1.00m. | | (2.00) | Loose yellowish brown (10YR 5/4) fine to medium SAND with numerous rootlets in the top 400mm. Gravel and boulder lag present from 1.0-1.1m. | | ▽1 |
| | | | | 2.57 | 2.00 | Complete at 2.00m | | |

Plan

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Remarks

Trial pit collapsed.

Scale (approx)

1:20

Logged By

MRD

Figure No.

E3521R.TP027



Site

Drigg

Trial Pit Number
TP028

Excavation Method

Wheeled Backhoe Excavator

Dimensions

1x4 m

Ground Level (mOD)

3.85

Client

LLW Repository Ltd

Job Number
E3521R

Location

307314.99, 496233.31

Dates

25/02/2010

Engineer

British Geological Survey

Sheet

1/1

| Depth (m) | Sample / Tests | Water Depth (m) | Field Records | Level (mOD) | Depth (m) (Thickness) | Description | Legend | Water |
|-----------|----------------|-----------------|-------------------|-------------|-----------------------|---|--------|-------|
| 1.20-1.20 | B1 | | Slow(1) at 0.60m. | 2.95 | (0.90) | Loose yellowish brown (10YR 5/4) fine to medium SAND with numerous rootlets in the top 150mm. | | ▽1 |
| | | | | | 0.90 | Loose very dark grey (10YR 3/1) clayey silty fine to medium SAND grading to soft blue grey sandy silty CLAY with depth. | | |
| | | | | | 1.50 | Loose yellowish brown (10YR 5/4) fine to medium SAND. | | |
| | | | | | 2.50 | Complete at 2.50m | | |

Plan

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Remarks

Trial pit collapsed.

Scale (approx)

1:20

Logged By

MRD

Figure No.

E3521R.TP028



Site

Drigg

Trial Pit Number
TP029

Excavation Method

Wheeled Backhoe Excavator

Dimensions

1x4 m

Ground Level (mOD)

3.89

Client

LLW Repository Ltd

Job Number
E3521R

Location

306694.05, 495503.03

Dates

10/01/2010

Engineer

British Geological Survey

Sheet

1/1

| Depth (m) | Sample / Tests | Water Depth (m) | Field Records | Level (mOD) | Depth (m) (Thickness) | Description | Legend | Water |
|-----------|----------------|-----------------|---------------|-------------|-----------------------|---|--------|-------|
| | | | | | | Loose yellowish brown (10YR 5/4) very shelly slightly gravelly fine to coarse SAND. Gravel is fine to medium subrounded to rounded. Occasional iron concretions in the top 300mm. Gravel band at approx 2.0m. | | |
| | | | | 1.59 | 2.30 | Complete at 2.30m | | |

Plan

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Remarks

Trial pit collapsed.

Scale (approx)

1:20

Logged By

MRD

Figure No.

E3521R.TP029



Site

Drigg

Trial Pit Number
TP029A

Excavation Method

Wheeled Backhoe Excavator

Dimensions

1x4 m

Ground Level (mOD)

2.24

Client

LLW Repository Ltd

Job Number
E3521R

Location

306602.37, 495434.63

Dates

10/01/2010

Engineer

British Geological Survey

Sheet

1/1

| Depth (m) | Sample / Tests | Water Depth (m) | Field Records | Level (mOD) | Depth (m) (Thickness) | Description | Legend | Water |
|-----------|----------------|-----------------|---------------|-------------|-----------------------|---|--------|-------|
| | | | | | | Loose yellowish brown (10YR 5/4) very shelly slightly gravelly fine to coarse SAND. Gravel is fine to medium subrounded to rounded. Occasional iron concretions in the top 300mm. | | |
| | | | | 0.74 | 1.50 | Complete at 1.50m | | |

Plan

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Remarks

Trial pit collapsed.
Scraping at base of pit assumed to be gravel and cobble sized clasts. Not observed due to pit collapse.

Scale (approx)

1:20

Logged By

MRD

Figure No.

E3521R.TP029A



Site

Drigg

Trial Pit Number
TP030A

Excavation Method

Wheeled Backhoe Excavator

Dimensions

1x4 m

Ground Level (mOD)

1.22

Client

LLW Repository Ltd

Job Number
E3521R

Location

305905.95, 496427.37

Dates

10/01/2010

Engineer

British Geological Survey

Sheet
1/2

| Depth (m) | Sample / Tests | Water Depth (m) | Field Records | Level (mOD) | Depth (m) (Thickness) | Description | Legend | Water |
|-----------|----------------|-----------------|---------------|-------------|-----------------------|--|--------|-------|
| 0.45-0.45 | B1 | | | 1.12 | (0.10) 0.10 | Loose brown (7.5YR 5/3) very shelly slightly gravelly fine to coarse SAND. Gravel is fine subrounded to rounded. | | |
| | | | | 0.92 | (0.20) 0.30 | Loose dark grey (7.5YR 4/1) very shelly sandy fine to coarse subangular to subrounded GRAVEL with much cobbles and boulders. Cobbles and boulders are subrounded to rounded up to 300mm. | | |
| | | | | 0.62 | (0.30) 0.60 | Soft very dark grey (7.5YR 3/1) silty CLAY. | | |
| 1.10-1.10 | B2 | | | | (1.30) | Soft dark grey (10YR 4/1) sandy SILT. Sand is fine. Occasional articulated white bivalve shells. | | |
| 2.10-2.10 | B3 | | | -0.68 | 1.90 (0.40) | Soft to firm dark grey (10YR 4/1) slightly sandy clayey SILT. | | |
| 2.70-2.70 | B4 | | | -1.08 | 2.30 (0.90) | Firm dark bluish grey (GLE Y2 4/10B) clayey SILT. Strong smell of hydrogen sulphide. | | |
| | | | | -1.98 | 3.20 | | | |

Plan

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Remarks

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|------------------------|------------------|-----------------------------|
| Scale (approx) 1:20 | Logged By MRD | Figure No. E3521R.TP030A |
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Site

Drigg

Trial Pit Number
TP030A

Excavation Method

Wheeled Backhoe Excavator

Dimensions

1x4 m

Ground Level (mOD)

1.22

Client

LLW Repository Ltd

Job Number
E3521R

Location

305905.95, 496427.37

Dates

10/01/2010

Engineer

British Geological Survey

Sheet

2/2

| Depth (m) | Sample / Tests | Water Depth (m) | Field Records | Level (mOD) | Depth (m) (Thickness) | Description | Legend | Water |
|-----------|----------------|-----------------|---------------|-------------|-----------------------|---|--------|-------|
| 3.30-3.30 | B5 | | | -2.18 | (0.20) 3.40 | Firm very dark brown (7.5YR 2.5/3) dry fibrous PEAT. Strong smell of hydrogen sulphide. | | |
| | | | | | | Complete at 3.40m | | |

Plan

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Remarks

Trial pit stable.

Scale (approx)

1:20

Logged By

MRD

Figure No.

E3521R.TP030A



Site

Drigg

Trial Pit Number

TP30A2

Excavation Method

Wheeled Backhoe Excavator

Dimensions

1x6 m

Ground Level (mOD)

1.61

Client

LLW Repository Ltd

Job Number

E3521R

Location

305899.64, 496422.51

Dates

24/02/2010

Engineer

British Geological Survey

Sheet

2/2

| Depth (m) | Sample / Tests | Water Depth (m) | Field Records | Level (mOD) | Depth (m) (Thickness) | Description | Legend | Water |
|------------------------|----------------|-----------------|---------------|-------------|-----------------------|---|--------|-------|
| 3.80-4.00 3.85-3.95 | C1 P1 | | | -2.29 | (1.20) 3.90 | | | |
| 4.20-4.20 | B1 | | | -2.79 | (0.50) 4.40 | Firm very dark brown (7.5YR 2.5/3) dry fibrous PEAT. Strong smell of hydrogen sulphide. | | |
| | | | | | | Complete at 4.40m | | |

Plan

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Remarks

Trial pit stable.

Scale (approx)

1:20

Logged By

MRD

Figure No.

E3521R.TP030A2



Site

Drigg

Trial Pit Number
TP031

Excavation Method

Wheeled Backhoe Excavator

Dimensions

1x4 m

Ground Level (mOD)

4.09

Client

LLW Repository Ltd

Job Number
E3521R

Location

305340.61, 497405.13

Dates

10/01/2010

Engineer

British Geological Survey

Sheet

1/1

| Depth (m) | Sample / Tests | Water Depth (m) | Field Records | Level (mOD) | Depth (m) (Thickness) | Description | Legend | Water |
|-----------|----------------|-----------------|-------------------|-------------|-----------------------|--|--------|----------------|
| | | | Fast(1) at 0.95m. | | (0.75) | Loose yellowish brown (10YR 5/4) very shelly fine to coarse SAND and fine to coarse subrounded to rounded GRAVEL with a little cobbles. Cobbles are subrounded to rounded up to 200mm. | | |
| | | | | 3.34 | 0.75 | Loose brown (7.5YR 5/4) shelly sandy fine to coarse subangular to subrounded GRAVEL with a little cobbles. Cobbles are subrounded to rounded up to 150mm. | | ∇ ₁ |
| | | | | 2.84 | 1.25 | Complete at 1.25m | | |

Plan

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Remarks

Trial pit collapsed.

Scale (approx)

1:20

Logged By

MRD

Figure No.

E3521R.TP031



Site

Drigg

Trial Pit Number
TP031A

Excavation Method
Wheeled Backhoe Excavator

Dimensions
1x4 m

Ground Level (mOD)
1.95

Client
LLW Repository Ltd

Job Number
E3521R

Location
305271.93, 497358.62

Dates
10/01/2010

Engineer
British Geological Survey

Sheet
1/1

| Depth (m) | Sample / Tests | Water Depth (m) | Field Records | Level (mOD) | Depth (m) (Thickness) | Description | Legend | Water |
|-----------|----------------|-----------------|---------------|-------------|-----------------------|--|--------|-------|
| | | | | | (0.45) | Loose yellowish brown (10YR 5/4) shelly fine to coarse SAND. 20mm thick black layer present at 0.38m. Shell-rich layer 20mm thick present at 0.40m. | | |
| | | | | 1.50 | 0.45 (0.10) | Loose very dark grey (GLEY 1 3/N) shelly sandy fine to coarse subrounded to rounded GRAVEL with much cobbles and boulders. Cobbles and boulders are subrounded to rounded up to 300mm. | | |
| | | | | 1.40 | 0.55 | Loose brown (7.5YR 4/3) very silty fine SAND. | | |
| | | | | | (2.45) | | | |
| | | | | -1.05 | 3.00 | Complete at 3.00m | | |

Plan

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Remarks
Trial pit stable.

| | | |
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| Scale (approx) 1:20 | Logged By MRD | Figure No. E3521R.TP031A |
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Site

Drigg

Trial Pit Number

TP031B

Excavation Method

Wheeled Backhoe Excavator

Dimensions

1x4 m

Ground Level (mOD)

4.21

Client

LLW Repository Ltd

Job Number

E3521R

Location

305396.52, 497328.65

Dates

10/01/2010

Engineer

British Geological Survey

Sheet

1/1

| Depth (m) | Sample / Tests | Water Depth (m) | Field Records | Level (mOD) | Depth (m) (Thickness) | Description | Legend | Water |
|-----------|----------------|-----------------|-------------------|-------------|-----------------------|--|--------|----------------|
| | | | | | | Loose yellowish brown (10YR 5/4) very shelly fine to coarse SAND and fine to coarse subrounded to rounded GRAVEL with a little cobbles. Cobbles are subrounded to rounded up to 200mm. | | |
| | | | | 3.41 | 0.80 | Loose brown (7.5YR 5/4) shelly sandy fine to coarse subangular to subrounded GRAVEL with a little cobbles. Cobbles are subrounded to rounded up to 150mm. | | |
| | | | Slow(1) at 1.90m. | 2.11 | 2.10 (0.20) | Loose brown (7.5YR 4/3) very silty fine SAND. | | ∇ ₁ |
| | | | | 1.91 | 2.30 | Complete at 2.30m | | |

Plan

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Remarks

Trial pit collapsed.

Scale (approx)

1:20

Logged By

MRD

Figure No.

E3521R.TP031B



Site

Drigg

Trial Pit Number
TP033

Excavation Method
Wheeled Backhoe Excavator

Dimensions
1x4 m

Ground Level (mOD)
3.91

Client
LLW Repository Ltd

Job Number
E3521R

Location
304740.35, 498444.88

Dates
09/01/2010

Engineer
British Geological Survey

Sheet
1/1

| Depth (m) | Sample / Tests | Water Depth (m) | Field Records | Level (mOD) | Depth (m) (Thickness) | Description | Legend | Water |
|-----------|----------------|-----------------|-------------------|-------------|-----------------------|---|--------|-------|
| | | | | | 0.30 | Loose yellowish brown (10Y 5/4) very shelly gravelly SAND. Gravel is fine to coarse subrounded to rounded. | | |
| | | | | 3.61 | 0.30 | Loose grey brown shelly COBBLES and BOULDERS with some sand and gravel. Cobbles and boulders are subrounded to rounded up to 600mm. | | |
| | | | | 3.21 | 0.70 | Loose brown (7.5Y 4/4) shelly slightly silty very sandy fine to coarse subrounded to rounded GRAVEL with much cobbles and boulders. Cobbles and boulders are subrounded to rounded up to 400mm. | | |
| | | | | | (1.10) | | | |
| | | | Slow(1) at 1.75m. | 2.11 | 1.80 | Complete at 1.80m | | ∇1 |

Plan

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Remarks

Trial pit collapsed.

| | | |
|------------------------|------------------|----------------------------|
| Scale (approx) 1:20 | Logged By MRD | Figure No. E3521R.TP033 |
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Site

Drigg

Trial Pit Number

TP033A

Excavation Method
Wheeled Backhoe Excavator

Dimensions
1x4 m

Ground Level (mOD)
1.06

Client
LLW Repository Ltd

Job Number
E3521R

Location
304644.84, 498394.75

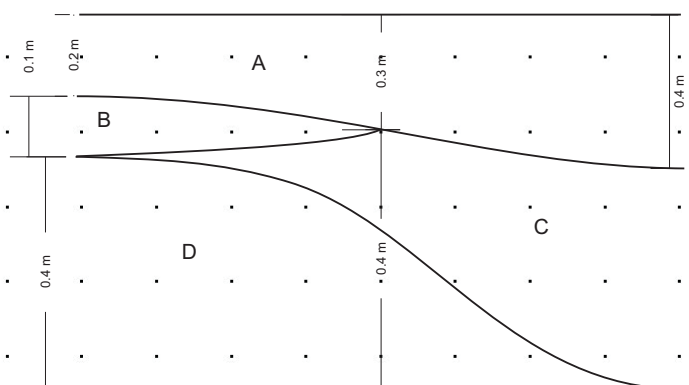
Dates
09/01/2010

Engineer
British Geological Survey

Sheet
1/1

| Depth (m) | Sample / Tests | Water Depth (m) | Field Records | Level (mOD) | Depth (m) (Thickness) | Description | Legend | Water |
|-----------|----------------|-----------------|-------------------|-------------|-----------------------|--|--------|----------------|
| | | | Slow(1) at 0.30m. | | A | Loose yellowish brown (10Y 5/4) shelly fine to medium SAND. | | ∇ ₁ |
| | | | | | B | Loose dark grey (GLE Y1 3/N) very shelly very sandy fine to coarse subrounded to rounded GRAVEL with much cobbles and boulders. Cobbles and boulders are subrounded to rounded up to 300mm | | |
| | | | | | C | Firm brown (7.5YR 4/3) slightly gravelly silty CLAY. Gravel is fine to coarse subrounded to rounded. | | |
| | | | | | D | Loose strong brown (7.5YR 4/6) fine to medium SAND. | | |
| | | | | | | Complete at 2.00m | | |

Plan NORTH SOUTH



Remarks

Trial trench collapsed.

Scale (approx)

1:20

Logged By

MRD

Figure No.

E3521R.TP033A



Site

Drigg

Trial Pit Number
TP034

Excavation Method
Wheeled Backhoe Excavator

Dimensions
1x4 m

Ground Level (mOD)
3.58

Client
LLW Repository Ltd

Job Number
E3521R

Location
304628.97, 498626.18

Dates
08/01/2010

Engineer
British Geological Survey

Sheet
1/1

| Depth (m) | Sample / Tests | Water Depth (m) | Field Records | Level (mOD) | Depth (m) (Thickness) | Description | Legend | Water |
|-----------|----------------|-----------------|---------------|-------------|-----------------------|---|--------|-------|
| | | | | 3.18 | 0.40 | Loose brown (7.5YR 4/4) shelly gravelly fine to coarse SAND. Gravel is fine to medium subrounded to rounded. | | |
| | | | | | 0.40 | Stiff dusky red (2.5YR 3/2) slightly gravelly clayey SILT becoming stiffer and more like a silty CLAY with depth. | | |
| | | | | | (2.20) | | | |
| | | | | 0.98 | 2.60 | Complete at 2.60m | | |

Plan

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Remarks

Trial pit stable.

| | | |
|-------------------------------|-------------------------|-----------------------------------|
| Scale (approx) 1:20 | Logged By MRD | Figure No. E3521R.TP034 |
|-------------------------------|-------------------------|-----------------------------------|



Site

Drigg

Trial Pit Number

TP034A

Excavation Method
Wheeled Backhoe Excavator

Dimensions
1x12 m

Ground Level (mOD)
1.34

Client
LLW Repository Ltd

Job Number
E3521R

Location
304552.17, 498578.95

Dates
09/01/2010

Engineer
British Geological Survey

Sheet
1 / 2

| Depth (m) | Sample / Tests | Water Depth (m) | Field Records | Level (mOD) | Depth (m) (Thickness) | Description | Legend | Water |
|-----------|----------------|-----------------|-------------------|-------------|-----------------------|---|--------|-------|
| 2.50-3.00 | B1 | | Slow(1) at 0.80m. | | A | Loose yellowish brown (10Y 5/4) shelly very gravelly fine to medium SAND. Gravel is fine to coarse subrounded to rounded. | | ∇1 |
| | | | | | B | Loose dark brown (7.5YR 3/3) silty fine to medium SAND. Rare coal patches. | | |
| | | | | | C | Dense yellowish brown (10Y 5/4) shelly very gravelly SAND with a little cobbles. Gravel is fine to coarse subrounded to rounded. Cobbles are subrounded to rounded up to 100mm. | | |
| | | | | | D | Loose dark grey (GLE Y1 3/N) very shelly very sandy fine to coarse subrounded to rounded GRAVEL with much cobbles and boulders. Cobbles and boulders are subrounded to rounded up to 300mm. | | |
| | | | | | E | Firm to stiff brown (7.5YR 4/3) slightly gravelly slightly silty CLAY. Gravel is fine to coarse subrounded. | | |
| | | | | | F | Loose brown (7.5Y 3/4) fine to coarse SAND. | | |
| | | | | | | Complete at 3.00m | | |

Plan

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Remarks

| | | |
|-------------------------------|-------------------------|------------------------------------|
| Scale (approx) 1:20 | Logged By MRD | Figure No. E3521R.TP034A |
|-------------------------------|-------------------------|------------------------------------|



British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Site
Drigg

Trial Pit
Number
TP034A

Excavation Method
Wheeled Backhoe Excavator

Dimensions
1x12 m

Ground Level (mOD)
1.34

Client
LLW Repository Ltd

Job
Number
E3521R

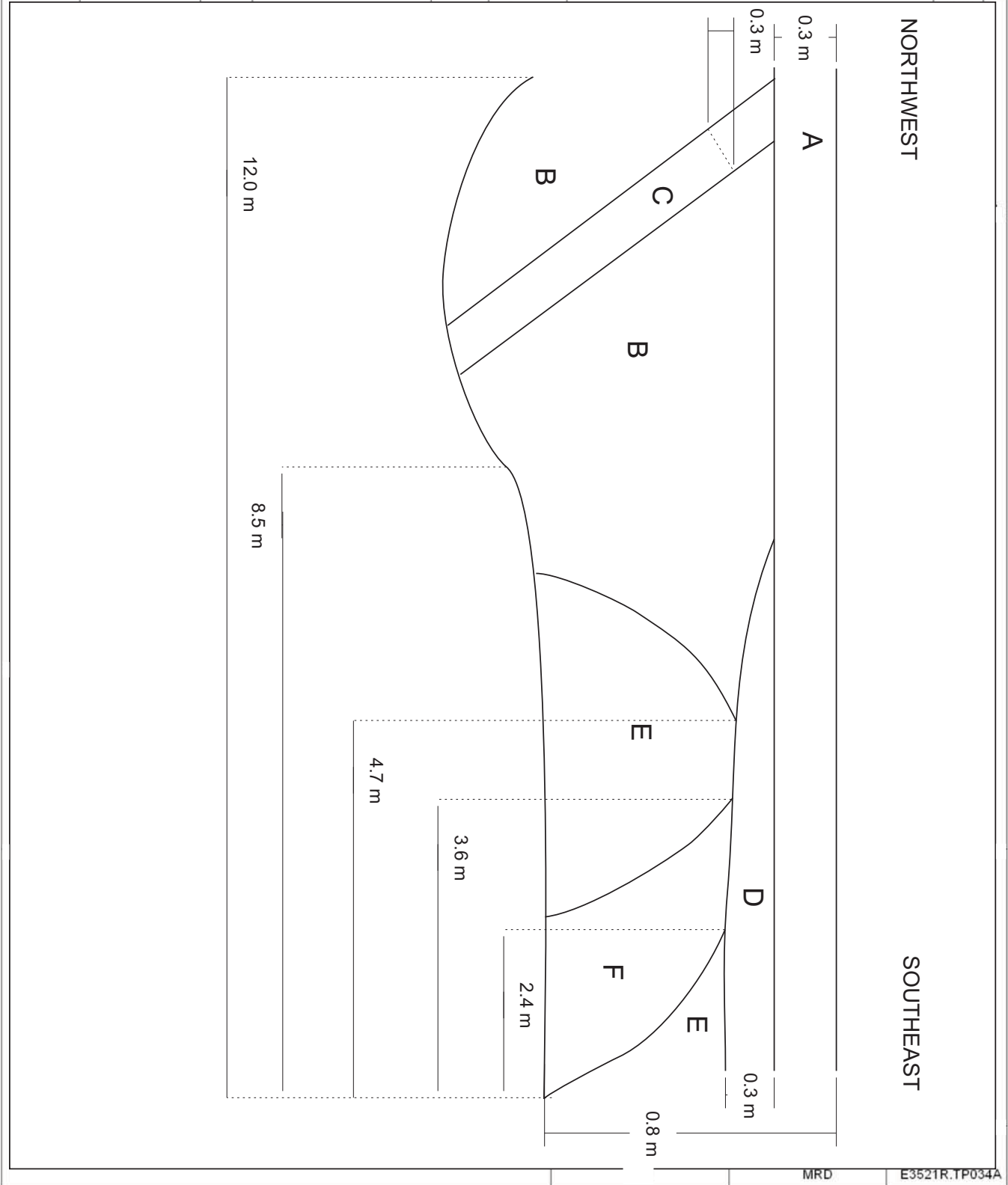
Location
304552.17, 498578.95

Dates
09/01/2010

Engineer
British Geological Survey

Sheet
2/2

| Depth (m) | Sample / Tests | Water Depth (m) | Field Records | Level (mOD) | Depth (m) (Thickness) | Description | Legend | Water |
|-----------|----------------|-----------------|---------------|-------------|-----------------------|-------------|--------|-------|
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MRD

E3521R.TP034A



Site

Drigg

Trial Pit Number
TPBH001

Excavation Method
Wheeled Backhoe Excavator

Dimensions
1x4 m

Ground Level (mOD)
4.29

Client
LLW Repository Ltd

Job Number
E3521R

Location
307321.71, 495314.88

Dates
23/02/2010

Engineer
British Geological Survey

Sheet
1/1

| Depth (m) | Sample / Tests | Water Depth (m) | Field Records | Level (mOD) | Depth (m) (Thickness) | Description | Legend | Water |
|-----------|----------------|-----------------|-------------------|-------------|-----------------------|---|--------|-------|
| 1.20-1.20 | B1 | | Slow(1) at 0.80m. | 4.14 | (0.15) 0.15 | Loose yellowish brown (10YR 5/4) shelly slightly gravelly fine to medium SAND. Gravel is fine to medium subrounded to rounded. | | |
| | | | | 3.79 | (0.35) 0.50 | Loose yellowish brown (10YR 5/4) shelly fine to medium SAND and fine to coarse subrounded to rounded GRAVEL with a little cobbles and boulders. Cobbles and boulders are rounded up to 250mm. | | |
| | | | | 3.29 | (0.50) 1.00 | Loose yellowish brown (10YR 5/4) shelly gravelly fine to coarse SAND with a little cobbles and boulders. Gravel is fine to coarse subrounded to rounded. Cobbles are subrounded to rounded up to 250mm. | | |
| | | | | 2.29 | (1.00) 2.00 | Loose dark yellowish brown (10YR 4/4) slightly silty fine to coarse SAND. | | |
| | | | | | | Complete at 2.00m | | |

Plan

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Remarks

Trial pit collapsed.

| | | |
|------------------------|------------------|------------------------------|
| Scale (approx) 1:20 | Logged By MRD | Figure No. E3521R.TPBH001 |
|------------------------|------------------|------------------------------|



Site

Drigg

Trial Pit Number
TPBH003

Excavation Method
Wheeled Backhoe Excavator

Dimensions
1x4 m

Ground Level (mOD)
3.38

Client
LLW Repository Ltd

Job Number
E3521R

Location
307209.68, 496286.42

Dates
26/02/2010

Engineer
British Geological Survey

Sheet
1/1

| Depth (m) | Sample / Tests | Water Depth (m) | Field Records | Level (mOD) | Depth (m) (Thickness) | Description | Legend | Water |
|-----------|----------------|-----------------|---------------|-------------|-----------------------|---|--------|-------|
| | | | | | 0.65 | Loose yellowish brown (10YR 5/4) fine to medium SAND with reddish brown streaks. | | |
| | | | | 2.73 | 0.65 | Loose very dark grey (10YR 3/1) clayey silty SAND becoming increasingly silty and clayey and more dark grey in colour with depth. | | |
| | | | | 1.58 | 1.80 | Complete at 1.80m | | |

Plan

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Remarks

Trial pit collapsed.

| | | |
|------------------------|------------------|------------------------------|
| Scale (approx) 1:20 | Logged By MRD | Figure No. E3521R.TPBH003 |
|------------------------|------------------|------------------------------|



Site

Drigg

Trial Pit Number
TPBH006

Excavation Method

Wheeled Backhoe Excavator

Dimensions

1x4 m

Ground Level (mOD)

4.27

Client

LLW Repository Ltd

Job Number
E3521R

Location

306612.90, 495611.77

Dates

23/02/2010

Engineer

British Geological Survey

Sheet
1/1

| Depth (m) | Sample / Tests | Water Depth (m) | Field Records | Level (mOD) | Depth (m) (Thickness) | Description | Legend | Water |
|-----------|----------------|-----------------|-------------------|-------------|-----------------------|---|--------|-------|
| | | | | | | Loose yellowish brown (10YR 5/4) shelly fine to medium SAND. | | |
| | | | | 3.82 | 0.45 (0.45) | Loose yellowish brown (10YR 5/4) shelly gravelly fine to coarse SAND. Gravel is fine to coarse subrounded to rounded. | | |
| | | | Slow(1) at 0.90m. | 3.42 | 0.85 (0.20) | Loose yellowish brown (10YR 5/4) shelly very sandy GRAVEL. Gravel is fine to medium subrounded to rounded. | | ∇1 |
| | | | | 3.22 | 1.05 (1.25) | Loose yellowish brown (10YR 5/4) fine to medium SAND. | | |
| | | | | 1.97 | 2.30 | Complete at 2.30m | | |

Plan

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| . | . | . | . | . | . | . | . | . | . | . | . |
| . | . | . | . | . | . | . | . | . | . | . | . |

Remarks

Trial pit collapsed.

Scale (approx)

1:20

Logged By

MRD

Figure No.

E3521R.TPBH006



Site

Drigg

Number
BH002

Excavation Method

Dando Terrier Windowless Sampler

Dimensions

87mm to 4.50m

Ground Level (mOD)

4.18

Client

LLW Repository Ltd

Job Number
E3521R

Location

307636.25, 495549.69

Dates

26/01/2010

Engineer

British Geological Survey

Sheet
1/2

| Depth (m) | Sample / Tests | Water Depth (m) | Field Records | Level (mOD) | Depth (m) (Thickness) | Description | Legend | Water |
|-----------|----------------|-----------------|---------------|-------------|-----------------------|--|--------|-------|
| | | | | | | Yellowish brown (7.5YR 5/4) shelly gravelly fine to coarse SAND. Gravel is fine to coarse subrounded to rounded. | | |
| | | | | 3.48 | 0.70 | Yellowish brown (7.5YR 5/4) fine to coarse SAND. 5mm mottle of black peat at 1.4m. | | |
| | | | | 2.43 | 1.75 | No sample recovery. | | |
| | | | | 1.58 | 2.60 | Yellowish brown (7.5YR 5/4) slightly shelly slightly gravelly fine to coarse SAND. Gravel is fine to coarse subrounded to rounded. | | |
| | | | | 1.18 | 3.00 | Dark yellowish brown (10YR 4/4) slightly shelly very gravelly fine to coarse SAND. Gravel is fine to coarse subrounded to rounded. | | |
| | | | | 0.68 | 3.50 | Dark yellowish brown (10YR 4/4) slightly shelly very sandy fine to coarse subrounded to rounded GRAVEL. | | |
| | | | | 0.38 | 3.80 | Dark yellowish brown (10YR 4/4) sandy fine to coarse subrounded to rounded GRAVEL. | | |
| | | | | 0.28 | 3.90 | | | |

Remarks

Scale (approx)

1:20

Logged By

MRD

Figure No.

E3521R.BH002



Site

Drigg

Number
BH002

Excavation Method

Dando Terrier Windowless Sampler

Dimensions

87mm to 4.50m

Ground Level (mOD)

4.18

Client

LLW Repository Ltd

Job Number
E3521R

Location

307636.25, 495549.69

Dates

26/01/2010

Engineer

British Geological Survey

Sheet
2/2

| Depth (m) | Sample / Tests | Water Depth (m) | Field Records | Level (mOD) | Depth (m) (Thickness) | Description | Legend | Water |
|-----------|----------------|-----------------|---------------|-------------|-----------------------|---|--------|-------|
| | | | | 0.08 | (0.20) 4.10 | Dark yellowish brown (10YR 4/4) slightly shelly gravelly fine to coarse SAND. Gravel is fine to coarse subrounded to rounded. | | |
| | | | | | (0.40) | Dark yellowish brown (10YR 4/4) slightly shelly sandy fine to coarse subrounded to rounded GRAVEL. | | |
| | | | | -0.32 | 4.50 | Complete at 4.50m | | |

Remarks

Brown (7.5YR 3/3) sandy silty CLAY observed in bottom 20mm of casing (approx 5.8m bgl) when removed from ground. Rest of casing contained dark yellowish brown (10YR 4/4) fine to coarse SAND and Gravel with some cobbles. Gravel is fine to coarse subrounded to rounded. Cobbles are rounded up to 100mm.
Effective refusal at 4.55m

Scale (approx)

1:20

Logged By

MRD

Figure No.

E3521R.BH002



Site

Drigg

Number
BH004

Excavation Method

Dando Terrier Windowless Sampler

Dimensions

117mm to 2.50m
87mm to 8.55m

Ground Level (mOD)

4.25

Client

LLW Repository Ltd

Job Number
E3521R

Location

305991.80, 496509.10

Dates

23/01/2010-
25/01/2010

Engineer

British Geological Survey

Sheet
1/5

| Depth (m) | Sample / Tests | Water Depth (m) | Field Records | Level (mOD) | Depth (m) (Thickness) | Description | Legend | Water |
|-----------|----------------|-----------------|---------------|-------------|-----------------------|---|--------|-------|
| | | | | | | Dark yellowish brown (10YR 4/4) shelly fine to coarse SAND and fine to coarse subrounded to rounded GRAVEL with some cobbles. Cobbles are rounded up to 100mm. | | |
| | | | | 3.85 | 0.40 (0.12) | Dark yellowish brown (10YR 4/4) very shelly coarse SAND and fine to medium subrounded to rounded GRAVEL. | | |
| | | | | 3.73 | 0.52 (0.38) | Yellowish brown (10YR 5/4) shelly slightly gravelly fine to coarse SAND. Gravel is fine to medium subrounded to rounded present as very closely spaced gravel partings. | | |
| | | | | 3.35 | 0.90 (0.10) | Yellowish brown (10YR 5/4) shelly sandy medium to coarse subrounded to rounded GRAVEL with much cobbles. Cobbles are rounded up to 120mm. | | |
| | | | | 3.25 | 1.00 (0.20) | Brown (7.5YR 4/4) slightly silty fine to medium SAND. Very rare fine subrounded to rounded gravel and sand-sized fragments of shell present throughout. | | |
| | | | | 3.05 | 1.20 (0.08) | Brown (7.5YR 4/4) slightly silty gravelly fine to medium SAND with very closely spaced partings of black silty fine sand-sized fragments of coal and rare shell fragments. | | |
| | | | | 2.97 | 1.28 (0.07) | Brown (7.5YR 4/4) slightly silty fine to medium SAND with extremely closely spaced lenses of dark brown (7.5YR 3/4) clay and mottles of black silty sand-sized fragments of coal. | | |
| | | | | 2.90 | 1.35 (0.02) | Brown (7.5YR 4/4) sandy fine to coarse subrounded to rounded GRAVEL. Possible gravel lag. | | |
| | | | | 2.88 | 1.37 (0.45) | Brown (7.5YR 4/3) slightly gravelly medium to coarse SAND. Gravel is medium to coarse subangular to subrounded. Coarsening downwards. | | |
| | | | | 2.43 | 1.82 (0.10) | Black (10Y 2/1) very organic silty very gravelly fine to coarse SAND. Gravel is fine to coarse subangular to rounded. Rare medium gravel-sized fragments of wood. | | |
| | | | | 2.33 | 1.92 | Brown (7.5YR 4/4) medium to coarse SAND. | | |

Remarks

Scale (approx)
1:10

Logged By
MRD

Figure No.
E3521R.BH004



Site

Drigg

Number
BH004

Excavation Method

Dando Terrier Windowless Sampler

Dimensions

117mm to 2.50m
87mm to 8.55m

Ground Level (mOD)

4.25

Client

LLW Repository Ltd

Job Number
E3521R

Location

305991.80, 496509.10

Dates

23/01/2010-
25/01/2010

Engineer

British Geological Survey

Sheet
2/5

| Depth (m) | Sample / Tests | Water Depth (m) | Field Records | Level (mOD) | Depth (m) (Thickness) | Description | Legend | Water |
|-----------|----------------|-----------------|---------------|-------------|-----------------------|--|--------|-------|
| | | | | | | | | |
| | | | | 1.93 | (0.40) 2.32 | Brown (7.5YR 4/4) very gravelly medium to coarse SAND. Gravel is fine to coarse subangular to rounded. | | |
| | | | | 1.75 | (0.18) 2.50 | Brown (7.5YR 4/4) slightly silty fine to coarse SAND. | | |
| | | | | 1.25 | (0.50) 3.00 | Very dark brown (7.5YR 2.5/3) slightly silty slightly gravelly fine to coarse SAND. Gravel is fine to medium subangular to subrounded. Increasingly gravelly towards the base. A 25mm x 25mm pocket of brown (7.5YR 4/3) silty fine to medium sand is present at the base. | | |
| | | | | 0.85 | (0.40) 3.40 | Dark reddish brown (5.0YR 3/3) fine to medium SAND with closely spaced black mottles and streaks of silty sand-sized fragments of coal. | | |

Remarks

Scale (approx)

1:10

Logged By

MRD

Figure No.
E3521R.BH004



Site

Drigg

Number
BH004

Excavation Method

Dando Terrier Windowless Sampler

Dimensions

117mm to 2.50m
87mm to 8.55m

Ground Level (mOD)

4.25

Client

LLW Repository Ltd

Job Number
E3521R

Location

305991.80, 496509.10

Dates

23/01/2010-
25/01/2010

Engineer

British Geological Survey

Sheet
3/5

| Depth (m) | Sample / Tests | Water Depth (m) | Field Records | Level (mOD) | Depth (m) (Thickness) | Description | Legend | Water |
|-----------|----------------|-----------------|---------------|-------------|-----------------------|-------------|------------------|-------|
| | | | | | | | [Dotted pattern] | |

Remarks

Scale (approx)

1:10

Logged By

MRD

Figure No.
E3521R.BH004



Site

Drigg

Number
BH004

Excavation Method

Dando Terrier Windowless Sampler

Dimensions

117mm to 2.50m
87mm to 8.55m

Ground Level (mOD)

4.25

Client

LLW Repository Ltd

Job Number
E3521R

Location

305991.80, 496509.10

Dates

23/01/2010-
25/01/2010

Engineer

British Geological Survey

Sheet
4/5

| Depth (m) | Sample / Tests | Water Depth (m) | Field Records | Level (mOD) | Depth (m) (Thickness) | Description | Legend | Water |
|-----------|----------------|-----------------|---------------|-------------|-----------------------|-------------|--------|-------|
| | | | | | (5.15) | | | |

Remarks

Scale (approx)

1:10

Logged By

MRD

Figure No.
E3521R.BH004



Site

Drigg

Number
BH004

Excavation Method

Dando Terrier Windowless Sampler

Dimensions

117mm to 2.50m
87mm to 8.55m

Ground Level (mOD)

4.25

Client

LLW Repository Ltd

Job Number
E3521R

Location

305991.80, 496509.10

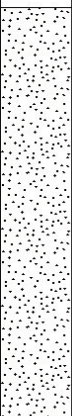
Dates

23/01/2010-
25/01/2010

Engineer

British Geological Survey

Sheet
5/5

| Depth (m) | Sample / Tests | Water Depth (m) | Field Records | Level (mOD) | Depth (m) (Thickness) | Description | Legend | Water |
|-----------|----------------|-----------------|---------------|-------------|-----------------------|-------------------|---|-------|
| | | | | | (5.15) | |  | |
| | | | | -4.30 | 8.55 | Complete at 8.55m | | |

Remarks

Scale (approx)

1:10

Logged By

MRD

Figure No.

E3521R.BH004



Site

Drigg

Number
BH005

Excavation Method

Dando Terrier Windowless Sampler

Dimensions

87mm to 3.80m

Ground Level (mOD)

4.72

Client

LLW Repository Ltd

Job Number
E3521R

Location

305402.65, 497333.31

Dates

27/01/2010

Engineer

British Geological Survey

Sheet
1/1

| Depth (m) | Sample / Tests | Water Depth (m) | Field Records | Level (mOD) | Depth (m) (Thickness) | Description | Legend | Water |
|-----------|----------------|-----------------|---------------|-------------|-----------------------|--|--------|-------|
| | | | | | | Yellowish brown (10YR 5/4) shelly fine to coarse SAND and fine to coarse subrounded to rounded GRAVEL with some cobbles. Cobbles are rounded up to 80mm. Increasingly cobbly towards the base. | | |
| | | | | 3.72 | 1.00 | Brown (7.5YR 4/3) slightly shelly sandy fine to coarse subangular to rounded GRAVEL. | | |
| | | | | 1.72 | 3.00 | Firm dark brown (7.5YR 3/3) slightly gravelly slightly sandy silty CLAY. Gravel is fine to coarse subangular to angular. | | |
| | | | | 0.92 | 3.80 | Complete at 3.80m | | |

Remarks
Effective refusal at 3.8 m.

Scale (approx)
1:20

Logged By
MRD

Figure No.
E3521R.BH005

Appendix 4: Radio carbon dates

5 Sample Testing

All samples were transported to BGS Keyworth and stored in a 'Cold Store' at 10°C prior to testing.

5.1 MOISTURE CONTENT ANALYSIS

Sixteen samples were tested for moisture content in accordance with BS1377:Part 2:1990. Test results are presented in Appendix 5.

5.2 PARTICLE SIZE DISTRIBUTION ANALYSIS

Sixteen samples were tested for particle size distribution in accordance with BS1377:Part 2:1990 and Eurocode 7: Part 2 at BGS Keyworth. The analysis was undertaken using the wet sieving method, as per BS1377:Part 2:1990. Where a significant fraction (>10%) of material <63 µm remained, further analysis was undertaken to analyse the silt and clay fractions. Fine particle analysis was undertaken, in accordance with Eurocode 7, by x-ray monitored gravity sedimentation using a Micromeritics SediGraph III. Test results for both wet sieving analysis and x-ray monitored gravity sedimentation results are presented in Appendix 5.

5.3 CARBON-14 ANALYSIS

Samples obtained by the BGS during the intrusive investigation and walkover surveys were prepared at BGS Keyworth prior to being despatched the laboratories of Beta Analytic in Miami, Florida. Carbon-14 sample information details are provided in table 5 below:

| Exploratory Hole/ Sample Location | Sample No. | Sub-sample No. | Easting (BNG) | Northing (BNG) | Sample Depth (m BGL) | Sample Depth (m AOD) |
|--------------------------------------|------------|----------------|---------------|----------------|----------------------|----------------------|
| TP30a-2 | B1 | B1/1 | 305899.6 | 496422.5 | 3.90 | -2.29 |
| Barn Scar | B2 | B2/1 | 304349.3 | 498628.3 | 0.0 | 0.37 |
| Barn Scar | B2 | B2/2 | 304349.3 | 498628.3 | 0.043 | 0.327 |
| Esk Estuary | B3 | B3/1 | 308130.4 | 495970.5 | 0.0908 | -1.0092 |
| TP30a-2 | PS1 | PS1 | 305899.6 | 496422.5 | 3.90 | -2.29 |
| TP30a-2 | S1 | S1 | 305899.6 | 496422.5 | 1.35 to 2.70 | 0.26 to -1.09 |
| Drigg cliff | DC1 | DC1 | 30470 | 49856 | 0.0 | 6.02 |
| Drigg Cliff | DC2 | DC2 | 30470 | 49856 | 0.0 | 6.39-6.44 |
| Drigg Cliff | DC3 | DC3 | 30470 | 49856 | 0.0 | 6.52-6.54 |

Table 5 - Summary of information for sub-samples sent for Carbon-14 analysis

A total of nine samples were sent to Beta Analytic for Carbon-14 analysis. Four samples were from the three block samples obtained during the intrusive investigation; one sample from the push sample obtained during the excavation of TP30a-2; one shell sample obtained during the excavation of TP30a-2; and three samples obtained from Drigg Cliff during the walkover by the BGS field geologist.

The block samples and push sample were prepared by removing all peripheral material so that only fresh surfaces would be sampled. Sub-samples of between 4.59 g and 21.15 g were then taken from these fresh faces. Photographs of the prepared block samples and push sample, with the subsample locations indicated, are presented in Appendix 3.



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REPORT OF RADIOCARBON DATING ANALYSES

Dr. Peter Balson

Report Date: 5/5/2010

British Geological Survey

** Comments/Logs Added by :-
LM Reeves 4/6/10*

Material Received: 3/31/2010

| Sample Data | Measured Radiocarbon Age | 13C/12C Ratio | Conventional Radiocarbon Age(*) |
|--|---|---------------|--|
| Beta - 277717 SAMPLE : BS1/1 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (peat): acid/alkali/acid 2 SIGMA CALIBRATION : Cal BC 6700 to 6500 (Cal BP 8650 to 8460) | B1/1 TP30a-2 7860 +/- 50 BP | -28.6 o/oo | 7800 +/- 50 BP NGR 305899.6 E 496422.5 N |
| Beta - 277718 SAMPLE : BS2/1 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (peat): acid/alkali/acid 2 SIGMA CALIBRATION : Cal BC 12970 to 12290 (Cal BP 14920 to 14240) | B2/1 BARN (KETTLE HOLE PEAT) SCAR 12460 +/- 60 BP | -22.6 o/oo | 12500 +/- 60 BP NGR 304349.3 498628.3 ['Verbal BGS' Cal BP 14670] |
| Beta - 277719 SAMPLE : BS2/2 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (peat): acid/alkali/acid 2 SIGMA CALIBRATION : Cal BC 13060 to 12670 (Cal BP 15010 to 14620) | B2/2 BARN (KETTLE HOLE PEAT) SCAR 12580 +/- 60 BP | -24.1 o/oo | 12590 +/- 60 BP NGR ↑ as above. ['Verbal BGS' Cal BP 14890] |
| Beta - 277720 SAMPLE : B3/1 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (peat): acid/alkali/acid 2 SIGMA CALIBRATION : Cal BC 6600 to 6440 (Cal BP 8550 to 8390) | B3/1 Esk Estuary 7720 +/- 50 BP | -28.1 o/oo | 7670 +/- 50 BP NGR : 308130.4 495970.5 ['Verbal BGS' Cal 8430 BP] |

Dates are reported as RCYBP (radiocarbon years before present, "present" = AD 1950). By international convention, the modern reference standard was 95% the 14C activity of the National Institute of Standards and Technology (NIST) Oxalic Acid (SRM 4990C) and calculated using the Libby 14C half-life (5568 years). Quoted errors represent 1 relative standard deviation statistics (68% probability) counting errors based on the combined measurements of the sample, background, and modern reference standards. Measured 13C/12C ratios (delta 13C) were calculated relative to the PDB-1 standard.

The Conventional Radiocarbon Age represents the Measured Radiocarbon Age corrected for isotopic fractionation, calculated using the delta 13C. On rare occasion where the Conventional Radiocarbon Age was calculated using an assumed delta 13C, the ratio and the Conventional Radiocarbon Age will be followed by ***. The Conventional Radiocarbon Age is not calendar calibrated. When available, the Calendar Calibrated result is calculated from the Conventional Radiocarbon Age and is listed as the "Two Sigma Calibrated Result" for each sample.



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REPORT OF RADIOCARBON DATING ANALYSES

Dr. Peter Balson

Report Date: 5/5/2010

| Sample Data | Measured Radiocarbon Age | 13C/12C Ratio | Conventional Radiocarbon Age(+) |
|---|---|---------------|--|
| Beta - 277721 SAMPLE: <u>DC1</u> ANALYSIS: AMS-Standard delivery MATERIAL/PRETREATMENT: (peat): acid/alkali/acid 2 SIGMA CALIBRATION: Cal BC 8700 to 8680 (Cal BP 10650 to 10620) AND Cal BC 8650 to 8420 (Cal BP 10600 to 10370) Cal BC 8400 to 8350 (Cal BP 10350 to 10300) | <i>Drigg Cliff #1</i> 9210 +/- 50 BP | -19.4 o/oo | 9300 +/- 50 BP <i>NGR 3047049856</i> |
| Beta - 277722 SAMPLE: <u>DC2</u> ANALYSIS: AMS-Standard delivery MATERIAL/PRETREATMENT: (peat): acid/alkali/acid 2 SIGMA CALIBRATION: Cal BC 5200 to 5170 (Cal BP 7150 to 7120) AND Cal BC 5070 to 4840 (Cal BP 7020 to 6790) | <i>Drigg Cliff #2</i> 6130 +/- 50 BP | -29.1 o/oo | 6060 +/- 50 BP <i>NGR ↑</i> |
| Beta - 277723 SAMPLE: <u>DC3</u> ANALYSIS: AMS-Standard delivery MATERIAL/PRETREATMENT: (peat): acid/alkali/acid 2 SIGMA CALIBRATION: Cal BC 4910 to 4690 (Cal BP 6860 to 6640) | <i>Drigg Cliff #3</i> 5980 +/- 50 BP | -29.2 o/oo | 5910 +/- 50 BP <i>NGR ↑</i> |
| Beta - 277724 SAMPLE: <u>PS1</u> ANALYSIS: AMS-Standard delivery MATERIAL/PRETREATMENT: (peat): acid/alkali/acid 2 SIGMA CALIBRATION: Cal BC 6580 to 6420 (Cal BP 8530 to 8370) | <u>TP30a-2</u> 7670 +/- 50 BP | -27.6 o/oo | 7630 +/- 50 BP <i>NGR as B#1</i> <i>[Verbal BSS Cal BP 8410]</i> |

Dates are reported as RCYBP (radiocarbon years before present, "present" = AD 1950). By international convention, the modern reference standard was 95% the 14C activity of the National Institute of Standards and Technology (NIST) Oxalic Acid (SRM 4990C) and calculated using the Libby 14C half-life (5568 years). Quoted errors represent 1 relative standard deviation statistics (68% probability) counting errors based on the combined measurements of the sample, background, and modern reference standards. Measured 13C/12C ratios (delta 13C) were calculated relative to the PDB-1 standard.

The Conventional Radiocarbon Age represents the Measured Radiocarbon Age corrected for isotopic fractionation, calculated using the delta 13C. On rare occasion where the Conventional Radiocarbon Age was calculated using an assumed delta 13C, the ratio and the Conventional Radiocarbon Age will be followed by "an". The Conventional Radiocarbon Age is not calendar calibrated. When available, the Calendar Calibrated result is calculated from the Conventional Radiocarbon Age and is listed as the "Two Sigma Calibrated Result" for each sample.



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REPORT OF RADIOCARBON DATING ANALYSES

Dr. Peter Balson

Report Date: 5/5/2010

| Sample Data | Measured Radiocarbon Age | 13C/12C Ratio | Conventional Radiocarbon Age(*) |
|---|---------------------------|----------------------------|---------------------------------|
| Beta - 277725 SAMPLE (S1) ANALYSIS: AMS-Standard delivery MATERIAL/PRETREATMENT: (shell): acid etch 2 SIGMA CALIBRATION : Cal BC 6360 to 6120 (Cal BP 8310 to 8070) | TP30a-2 7340 +/- 50 BP | -2.1 o/oo | 7720 +/- 50 BP |
| | SHELL SAMPLE- | Scrobicularia plana. | NGR ad B1/1 |
| | | [Verbal BGS : Cal BP 8180] | |

Dates are reported as RCYBP (radiocarbon years before present, "present" = AD 1950). By international convention, the modern reference standard was 95% the 14C activity of the National Institute of Standards and Technology (NIST) Oxalic Acid (SRM 4990C) and calculated using the Libby 14C half-life (5568 years). Quoted errors represent 1 relative standard deviation statistics (68% probability) counting errors based on the combined measurements of the sample, background, and modern reference standards. Measured 13C/12C ratios (delta 13C) were calculated relative to the PDB-1 standard.

The Conventional Radiocarbon Age represents the Measured Radiocarbon Age corrected for isotopic fractionation, calculated using the delta 13C. On rare occasion where the Conventional Radiocarbon Age was calculated using an assumed delta 13C, the ratio and the Conventional Radiocarbon Age will be followed by "ass". The Conventional Radiocarbon Age is not calendar calibrated. When available, the Calendar Calibrated result is calculated from the Conventional Radiocarbon Age and is listed as the "Two Sigma Calibrated Result" for each sample.

CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-28.6:lab. mult=1)

Laboratory number: Beta-277717

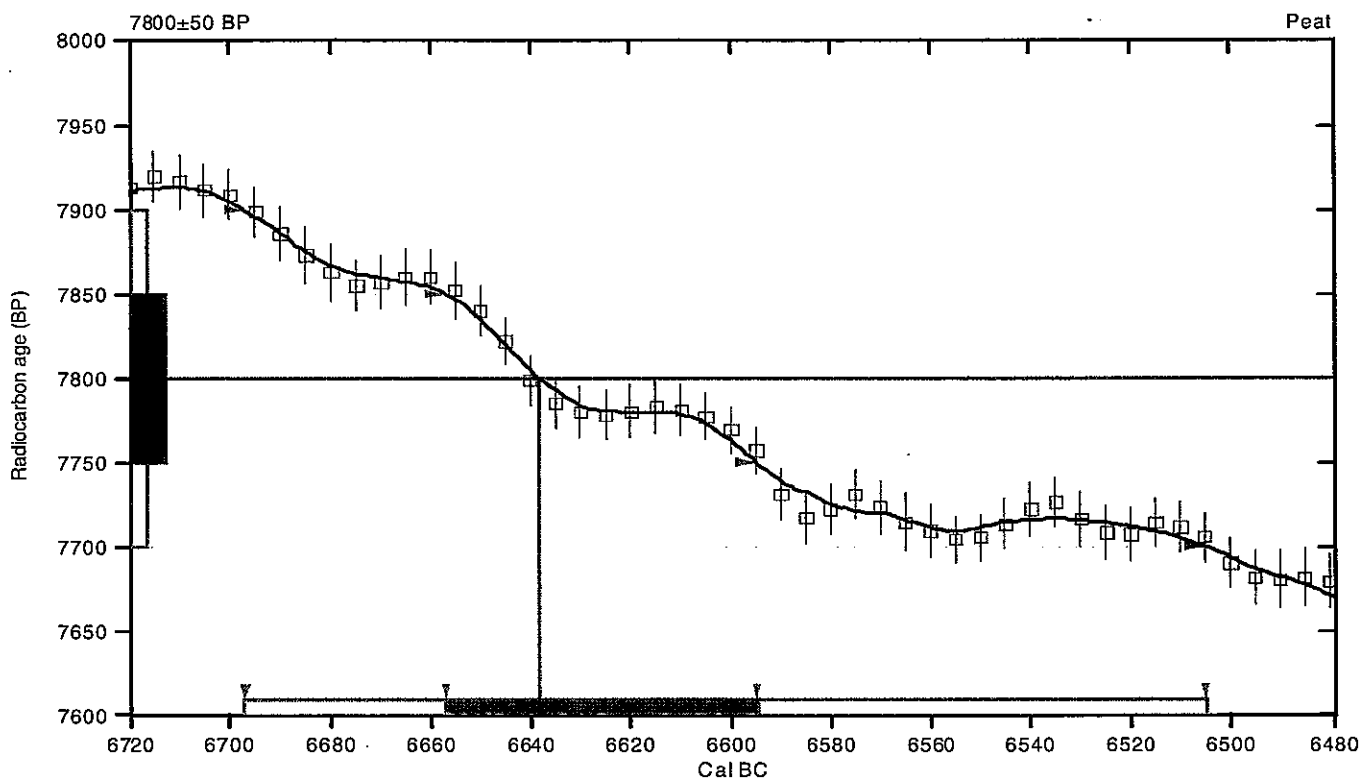
Conventional radiocarbon age: 7800±50 BP

2 Sigma calibrated result: Cal BC 6700 to 6500 (Cal BP 8650 to 8460)
(95% probability)

Intercept data

Intercept of radiocarbon age
with calibration curve: Cal BC 6640 (Cal BP 8590)

1 Sigma calibrated result: Cal BC 6660 to 6600 (Cal BP 8610 to 8540)
(68% probability)



References:

Database used

INTCAL04

Calibration Database

INTCAL04 Radiocarbon Age Calibration

IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).

Mathematics

A Simplified Approach to Calibrating C14 Dates

Talma, A. S., Vogel, J. C., 1993, Radiocarbon 35(2), p317-322

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-22.6:lab. mult=1)

Laboratory number: **Beta-277718**

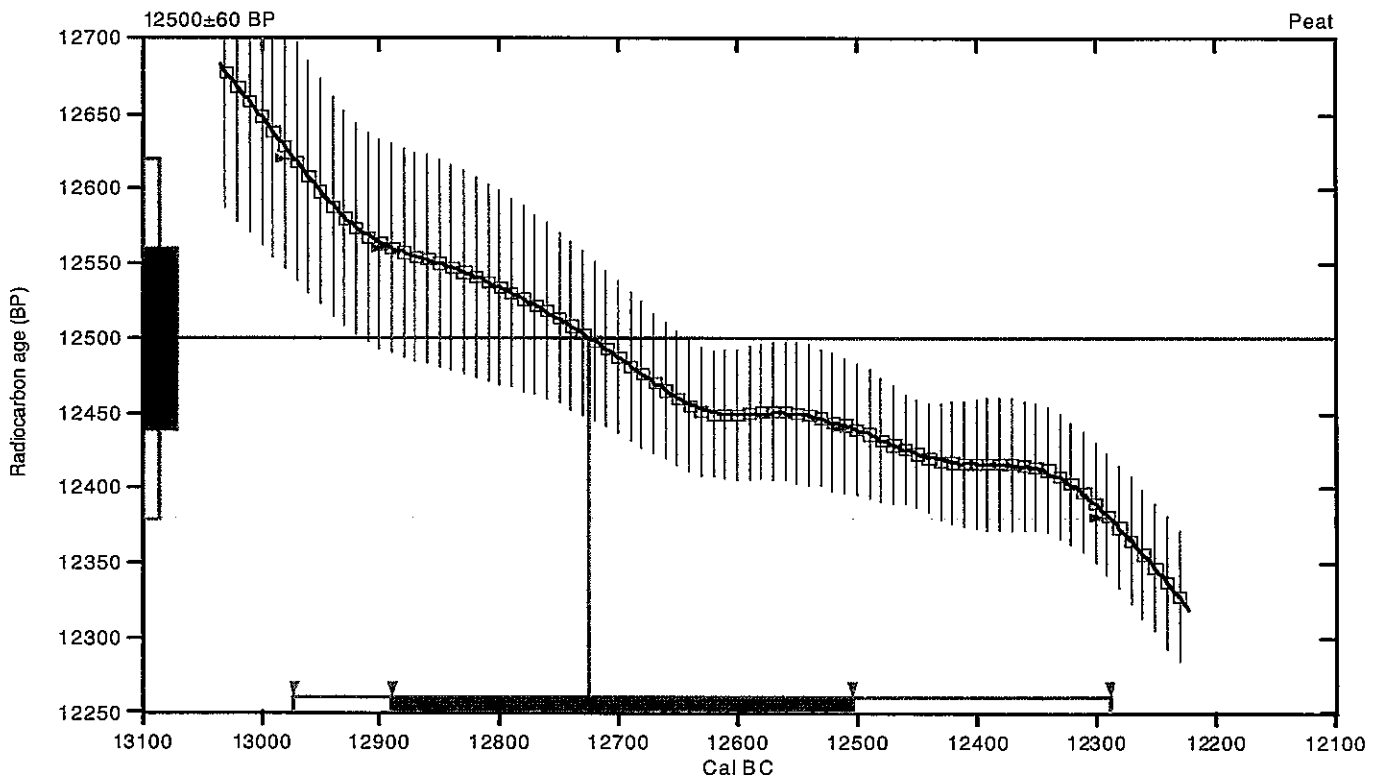
Conventional radiocarbon age: **12500±60 BP**

2 Sigma calibrated result: **Cal BC 12970 to 12290 (Cal BP 14920 to 14240)**
(95% probability)

Intercept data

Intercept of radiocarbon age
with calibration curve: **Cal BC 12720 (Cal BP 14670)**

1 Sigma calibrated result: **Cal BC 12890 to 12500 (Cal BP 14840 to 14450)**
(68% probability)



References:

Database used

INTCAL04

Calibration Database

INTCAL04 Radiocarbon Age Calibration

IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).

Mathematics

A Simplified Approach to Calibrating C14 Dates

Talma, A. S., Vogel, J. C., 1993, Radiocarbon 35(2), p317-322

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.1:lab. mult=1)

Laboratory number: **Beta-277719**

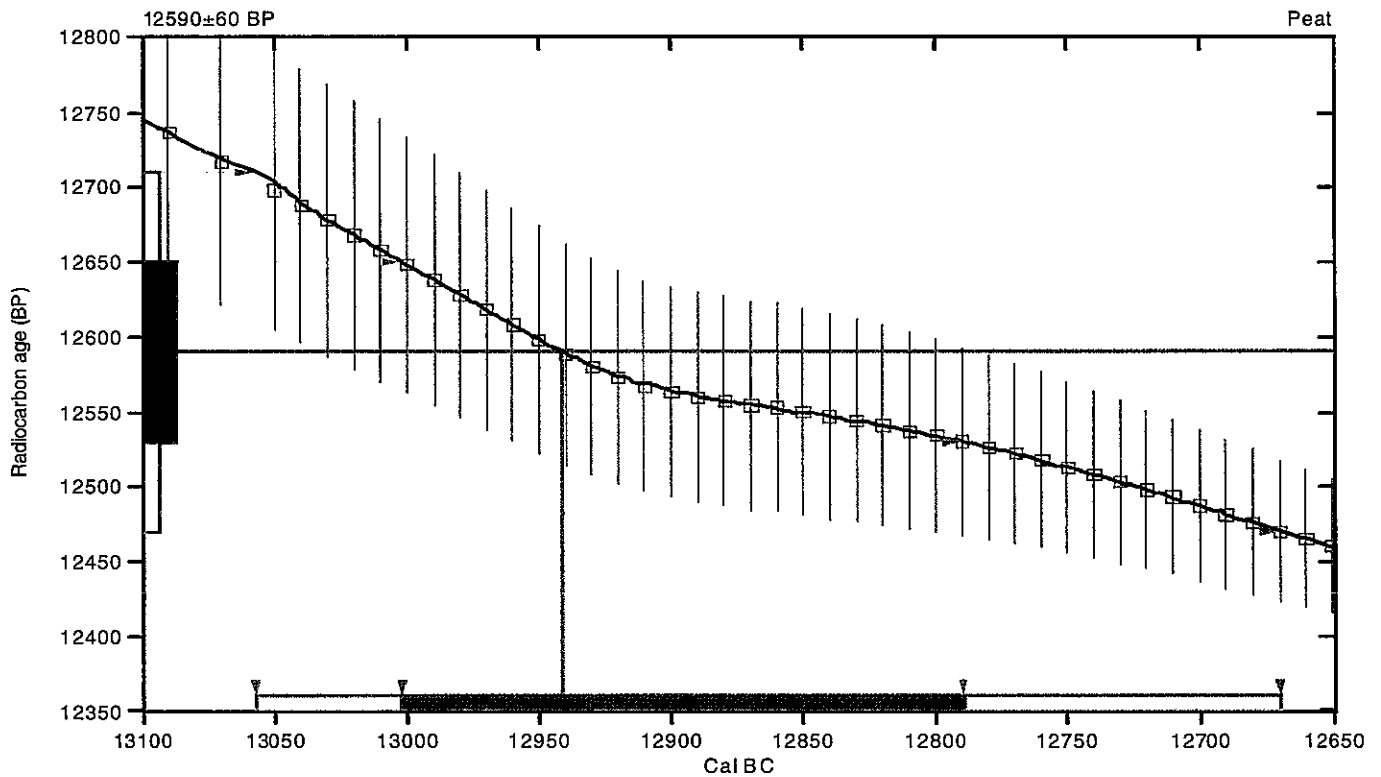
Conventional radiocarbon age: **12590±60 BP**

2 Sigma calibrated result: Cal BC 13060 to 12670 (Cal BP 15010 to 14620)
(95% probability)

Intercept data

Intercept of radiocarbon age
with calibration curve: **Cal BC 12940 (Cal BP 14890)**

1 Sigma calibrated result: Cal BC 13000 to 12790 (Cal BP 14950 to 14740)
(68% probability)



References:

Database used

INTCAL04

Calibration Database

INTCAL04 Radiocarbon Age Calibration

IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).

Mathematics

A Simplified Approach to Calibrating C14 Dates

Talma, A. S., Vogel, J. C., 1993, Radiocarbon 35(2), p317-322

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-28.1:lab. mult=1)

Laboratory number: **Beta-277720**

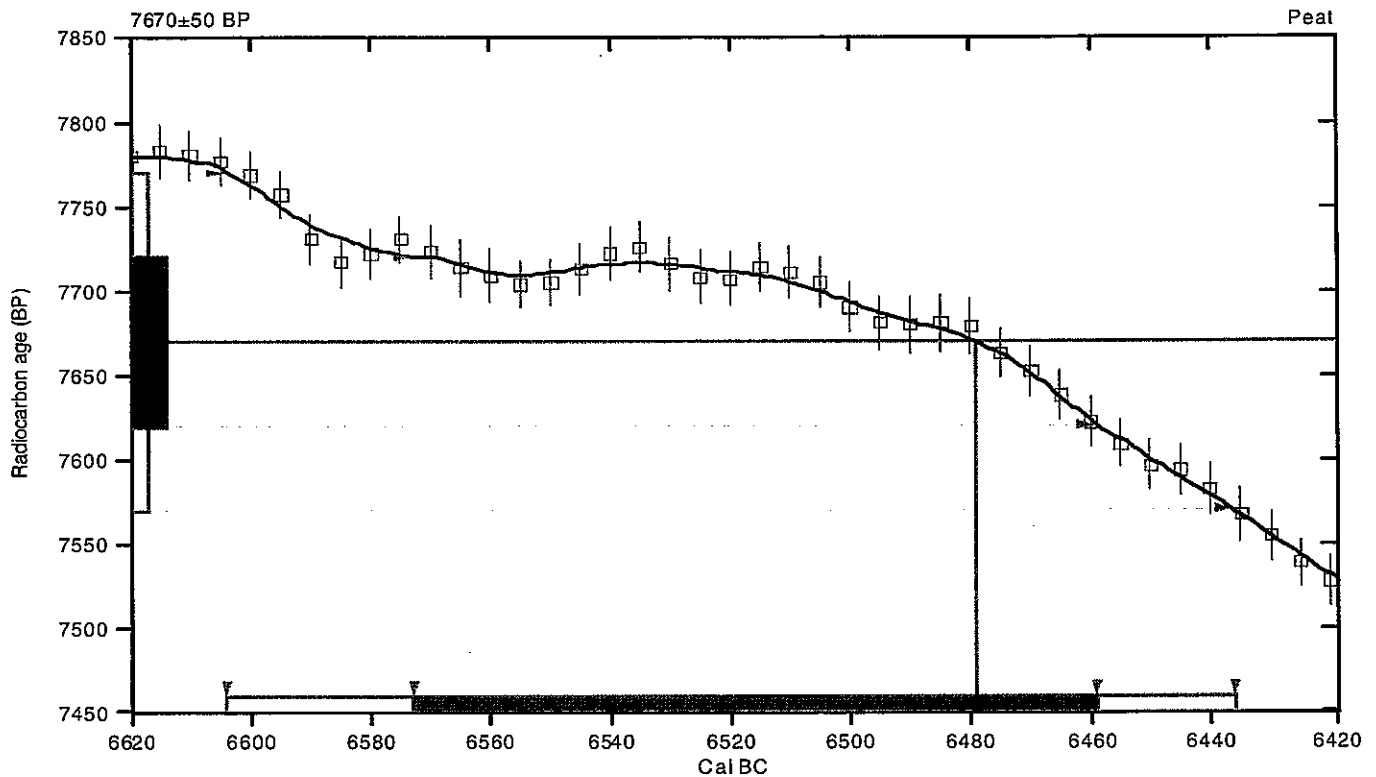
Conventional radiocarbon age: **7670±50 BP**

2 Sigma calibrated result: **Cal BC 6600 to 6440 (Cal BP 8550 to 8390)**
(95% probability)

Intercept data

Intercept of radiocarbon age
with calibration curve: **Cal BC 6480 (Cal BP 8430)**

1 Sigma calibrated result: **Cal BC 6570 to 6460 (Cal BP 8520 to 8410)**
(68% probability)



References:

Database used

INTCAL04

Calibration Database

INTCAL04 Radiocarbon Age Calibration

IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).

Mathematics

A Simplified Approach to Calibrating C14 Dates

Talma, A. S., Vogel, J. C., 1993, Radiocarbon 35(2), p317-322

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-19.4:lab. mult=1)

Laboratory number: Beta-277721

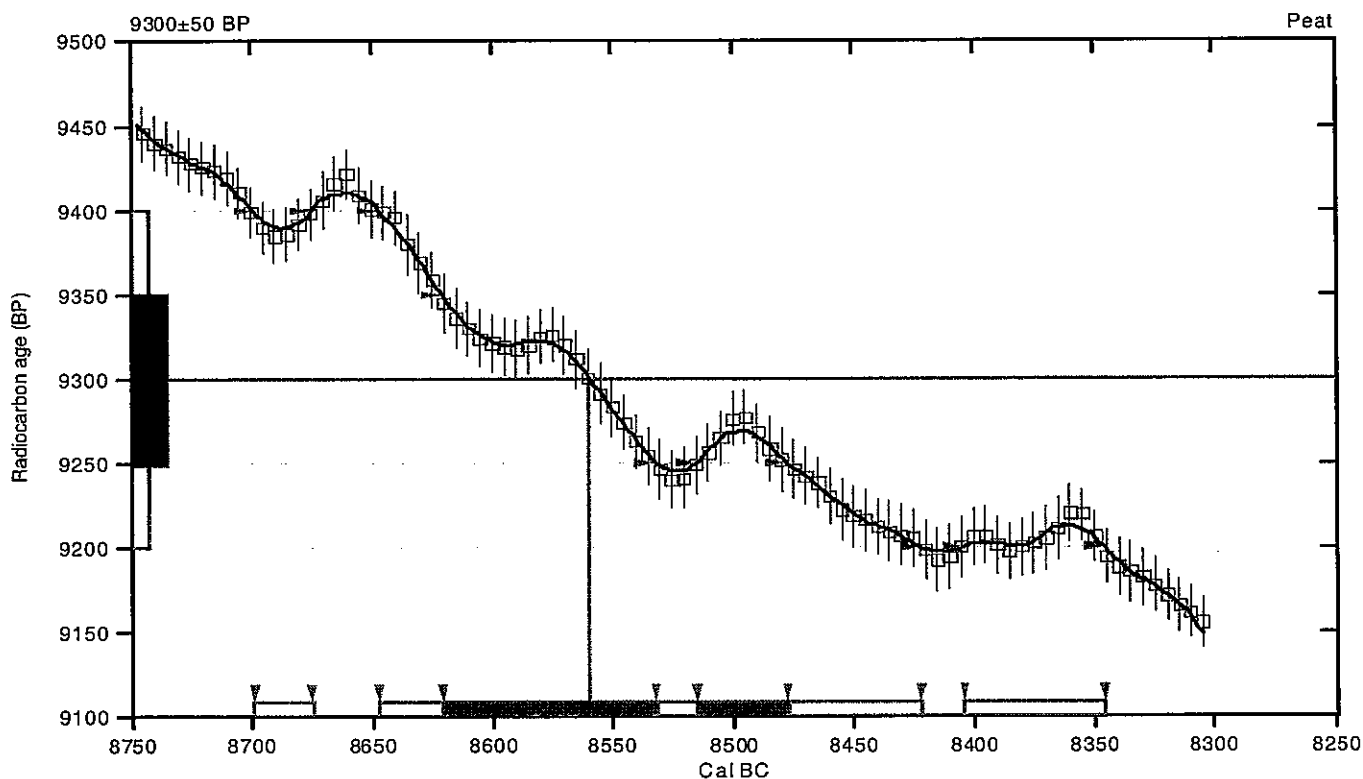
Conventional radiocarbon age: 9300±50 BP

2 Sigma calibrated results: Cal BC 8700 to 8680 (Cal BP 10650 to 10620) and
(95% probability) Cal BC 8650 to 8420 (Cal BP 10600 to 10370) and
Cal BC 8400 to 8350 (Cal BP 10350 to 10300)

Intercept data

Intercept of radiocarbon age
with calibration curve: Cal BC 8560 (Cal BP 10510)

1 Sigma calibrated results: Cal BC 8620 to 8530 (Cal BP 10570 to 10480) and
(68% probability) Cal BC 8520 to 8480 (Cal BP 10460 to 10430)



References:

Database used

INTCAL04

Calibration Database

INTCAL04 Radiocarbon Age Calibration

IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).

Mathematics

A Simplified Approach to Calibrating C14 Dates

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-29.1:lab. mult=1)

Laboratory number: **Beta-277722**

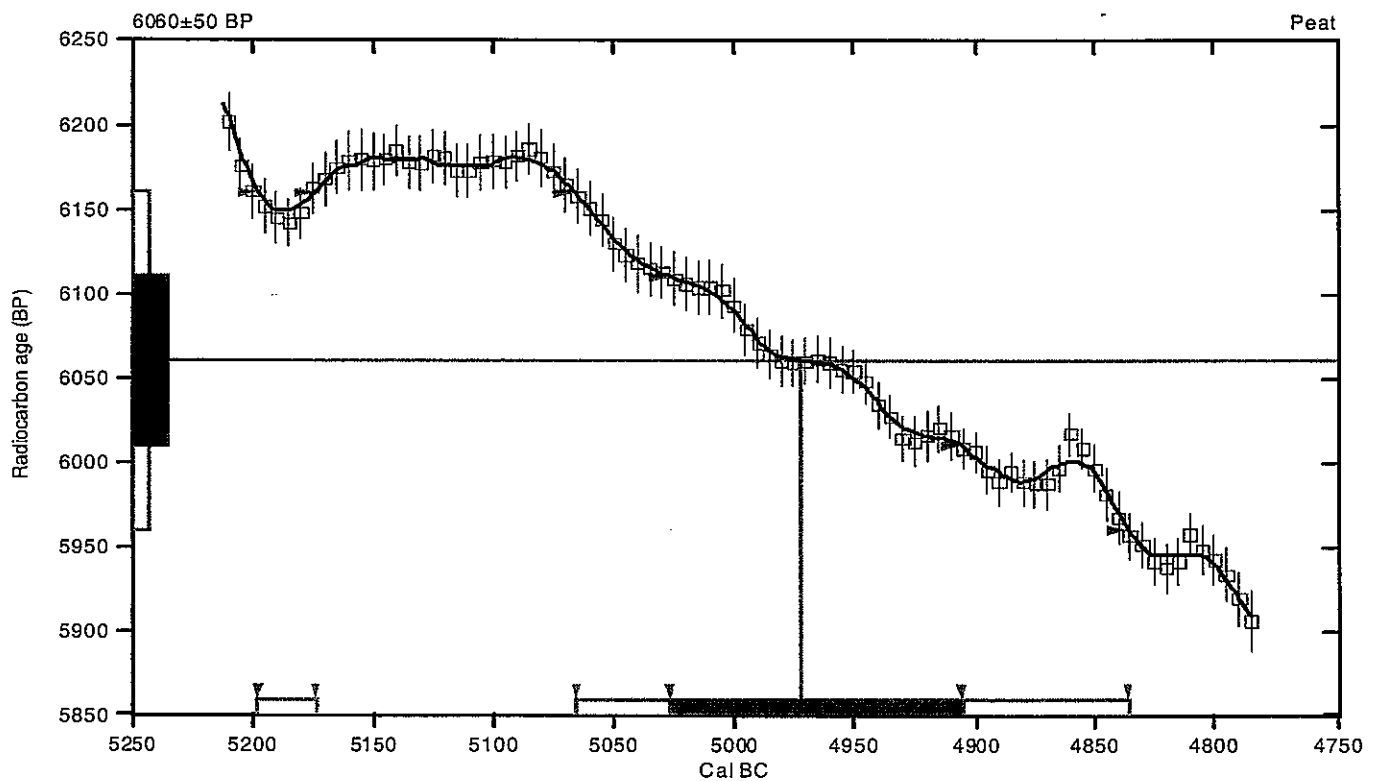
Conventional radiocarbon age: **6060±50 BP**

2 Sigma calibrated results: **Cal BC 5200 to 5170 (Cal BP 7150 to 7120) and
(95% probability) Cal BC 5070 to 4840 (Cal BP 7020 to 6790)**

Intercept data

Intercept of radiocarbon age
with calibration curve: **Cal BC 4970 (Cal BP 6920)**

1 Sigma calibrated result: **Cal BC 5030 to 4910 (Cal BP 6980 to 6860)**
(68% probability)



References:

Database used

INTCAL04

Calibration Database

INTCAL04 Radiocarbon Age Calibration

IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).

Mathematics

A Simplified Approach to Calibrating C14 Dates

Talma, A. S., Vogel, J. C., 1993, Radiocarbon 35(2), p317-322

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-29.2:lab. mult=1)

Laboratory number: **Beta-277723**

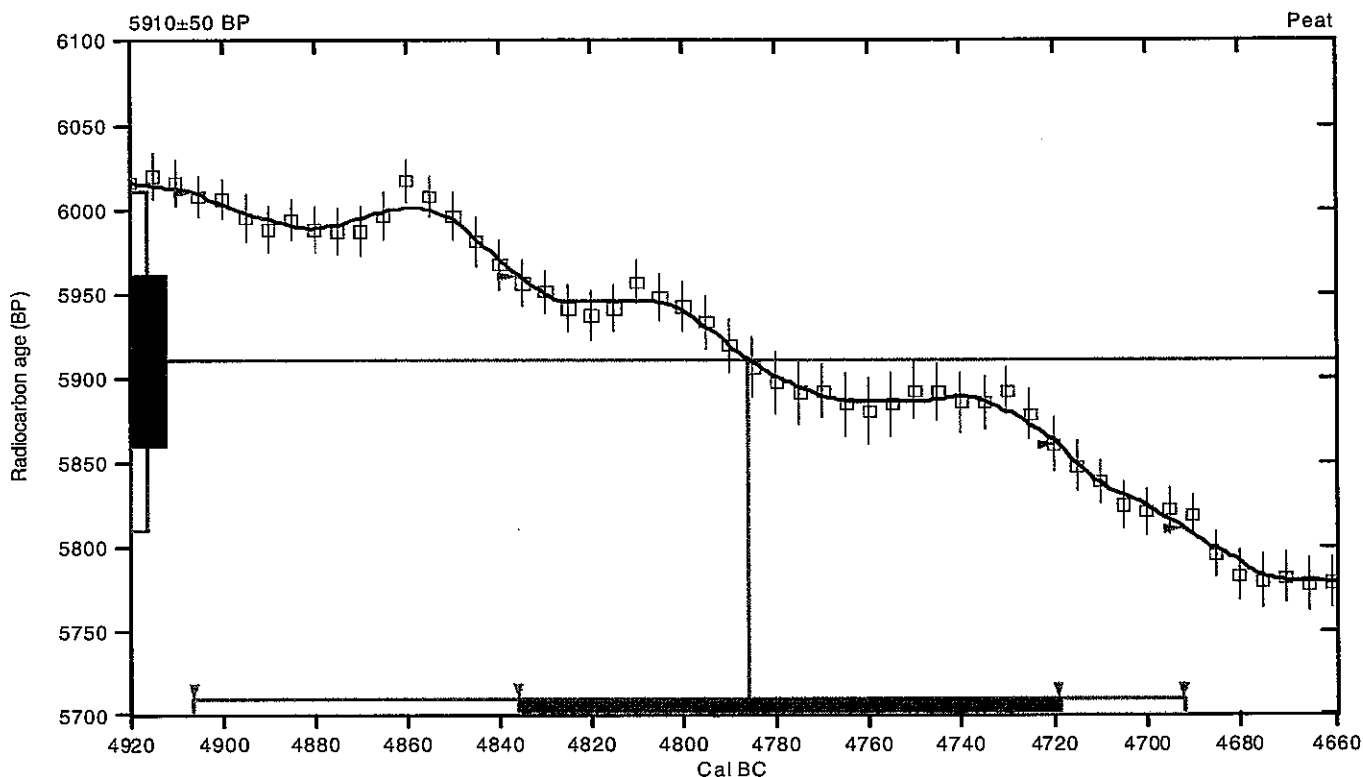
Conventional radiocarbon age: **5910±50 BP**

2 Sigma calibrated result: **Cal BC 4910 to 4690 (Cal BP 6860 to 6640)**
(95% probability)

Intercept data

Intercept of radiocarbon age
with calibration curve: **Cal BC 4790 (Cal BP 6740)**

1 Sigma calibrated result: **Cal BC 4840 to 4720 (Cal BP 6790 to 6670)**
(68% probability)



References:

Database used

INTCAL04

Calibration Database

INTCAL04 Radiocarbon Age Calibration

IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).

Mathematics

A Simplified Approach to Calibrating C14 Dates

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-27.6:lab. mult=1)

Laboratory number: **Beta-277724**

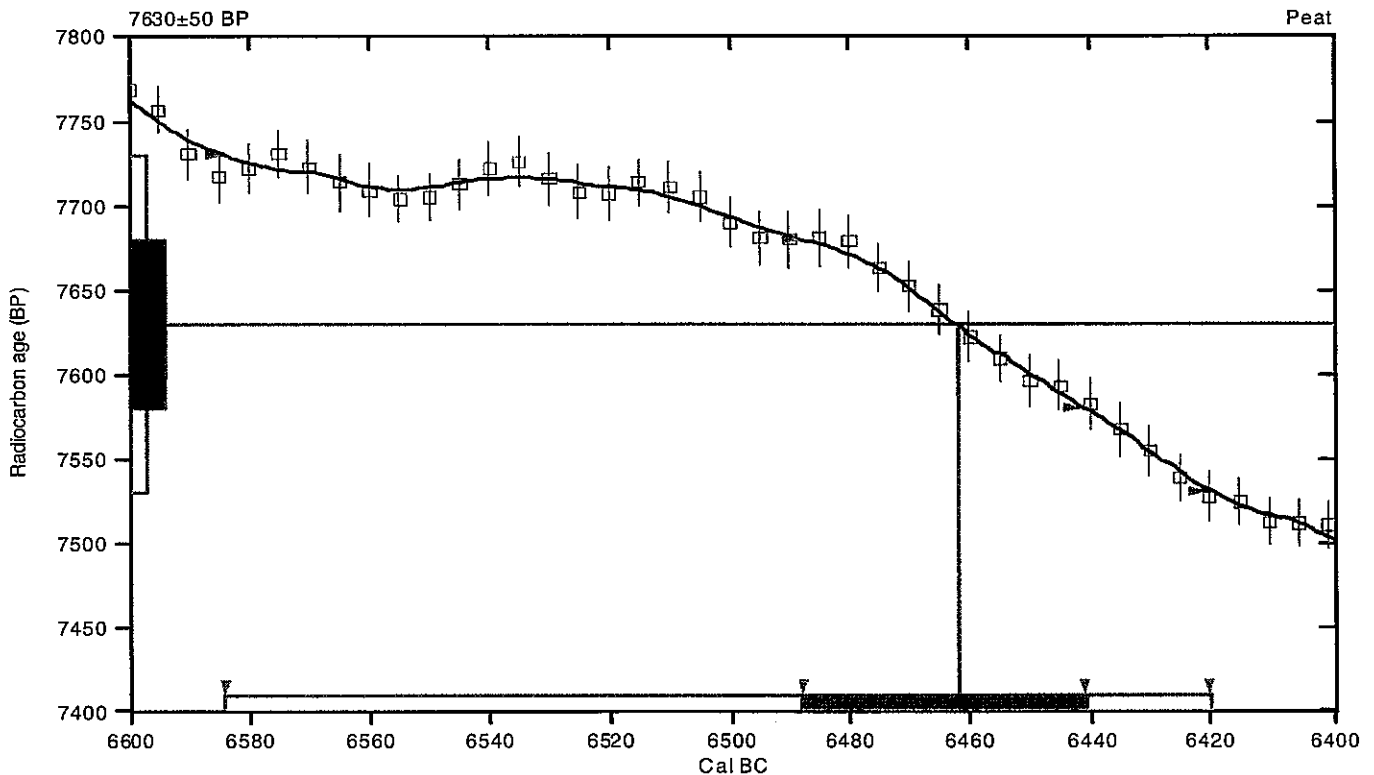
Conventional radiocarbon age: **7630±50 BP**

2 Sigma calibrated result: **Cal BC 6580 to 6420 (Cal BP 8530 to 8370)**
(95% probability)

Intercept data

Intercept of radiocarbon age
with calibration curve: **Cal BC 6460 (Cal BP 8410)**

1 Sigma calibrated result: **Cal BC 6490 to 6440 (Cal BP 8440 to 8390)**
(68% probability)



References:

Database used

INTCAL04

Calibration Database

INTCAL04 Radiocarbon Age Calibration

IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).

Mathematics

A Simplified Approach to Calibrating C14 Dates

Talma, A. S., Vogel, J. C., 1993, Radiocarbon 35(2), p317-322

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-2.1:Delta-R=0±0:Glob res=-200 to 500:lab. mult=1)

Laboratory number: **Beta-277725**

Conventional radiocarbon age: **7720±50 BP**

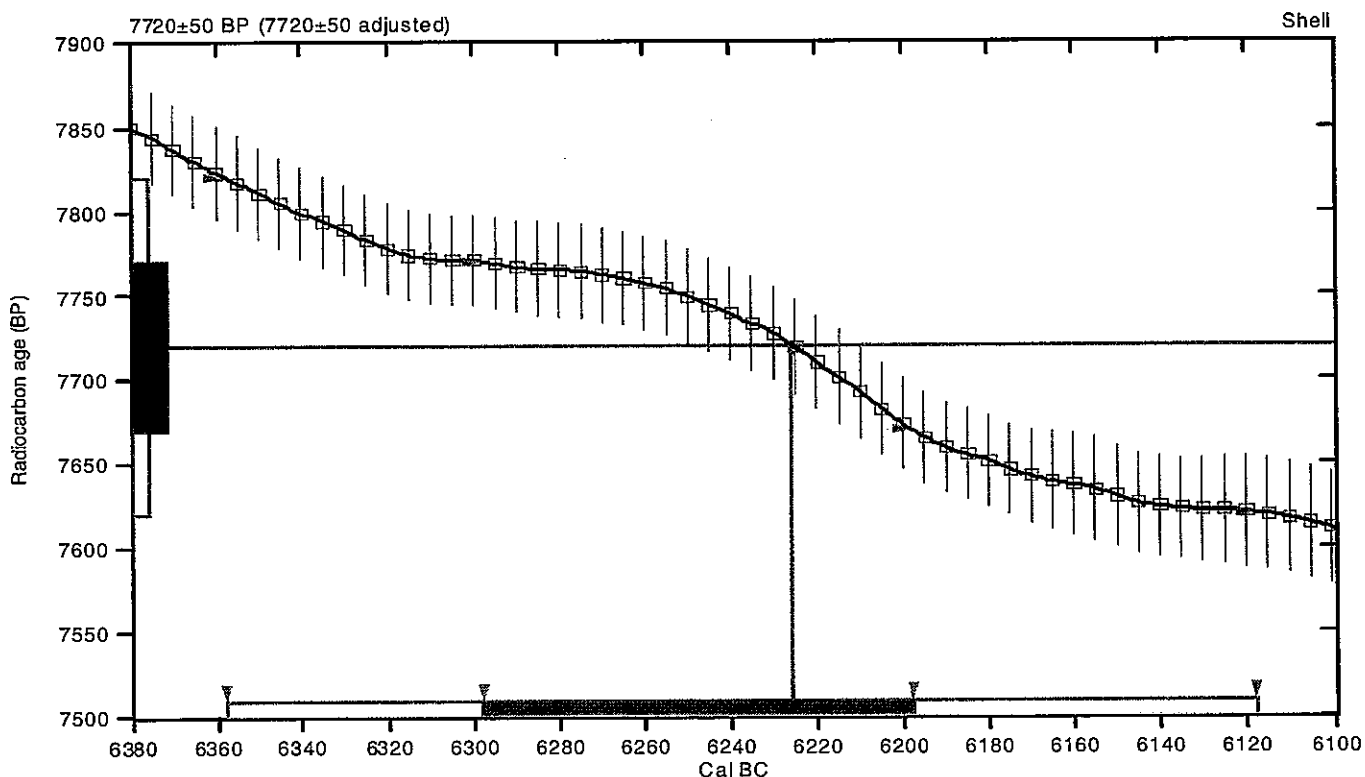
(local reservoir correction not applied)

2 Sigma calibrated result: Cal BC 6360 to 6120 (Cal BP 8310 to 8070)
(95% probability)

Intercept data

Intercept of radiocarbon age
with calibration curve: Cal BC 6230 (Cal BP 8180)

1 Sigma calibrated result: Cal BC 6300 to 6200 (Cal BP 8250 to 8150)
(68% probability)



References:

Database used

MARINE04

Calibration Database

INTCAL04 Radiocarbon Age Calibration

IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).

Mathematics

A Simplified Approach to Calibrating C14 Dates

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