KWNL11/005.2

KEADBY WIND FARM, NORTH LINCOLNSHIRE

Report on audit of the construction stage of individual turbines and recording of peat deposits and presence of fossil wood encountered during construction

commissioned by SSE Renewables

May 2013

HEADLAND ARCHAEOLOGY Ltd

REGISTERED ORGANISATION IfA

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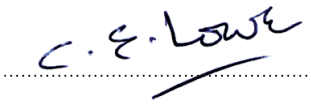

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Report on audit of the construction stage of individual turbines and recording of peat deposits and presence of fossil wood encountered during construction

An audit of the construction stage of individual turbines at Keadby Wind Farm identified several locations where deep peaty deposits had not yet been excavated as part of the construction work. It is clear, as a result of earlier work (Dalland & Timpany 2013), that these peat deposits correspond to 'Peat 3', a peat horizon that is of Neolithic to Iron Age date. These deposits may contain prehistoric burning events and evidence of prehistoric wood working.

1. INTRODUCTION

Keadby Wind Farm is located on the western side of the River Trent, between the villages of Keadby and Crowle. The scheme comprises 34 turbines located within an area of around 9.5km^2 centred on NGR SE 818 133. The site comprises large arable fields bounded by ditches and tracks. The southern half of the site is bisected by the Doncaster to Scunthorpe railway and the Stainforth and Keadby Canal; to the north, the site is crossed by the Pauper's and Warping Drains, which drain into the River Trent (*Illus 1*). The site is generally very flat and low-lying, roughly 0–2m OD and is a product of historic land reclamation.

Planning permission was granted for the construction of the Keadby Wind Farm subject to a number of archaeological conditions. In order to meet the terms of the archaeological conditions to the satisfaction of the planning authority, an Archaeological Mitigation Plan (Headland Archaeology 2012) was drawn up, to mitigate the impacts of the wind farm development on the cultural heritage resource of the development area.

Phases I and 2 of the mitigation work identified four chronologically distinct layers of peat in the development area. The earliest peat dates to the Early Holocene, approximately 11,500 years ago; the overlying peat horizons could be assigned to the Mesolithic, Neolithic to Iron Age and Roman or medieval periods.

Based on these results Alison Williams, the Historic Environment Record Officer at North Lincolnshire Council, identified four questions that could be addressed in connection with the excavation of the turbine and hard standing foundations that included:

- identify and investigate any burning events associated with Neolithic/Bronze Age peat;
- identification of any evidence for wood working;
- retrieval of tree trunk samples for dendrochronological assessment and dating to add to national chronologies;
- date range for fourth and final peat to tie in with previous data from the area.

She suggested that there should be a programme of targeted mitigation work during the excavation of the turbine foundations in order to retrieve evidence that could answer the questions listed above.

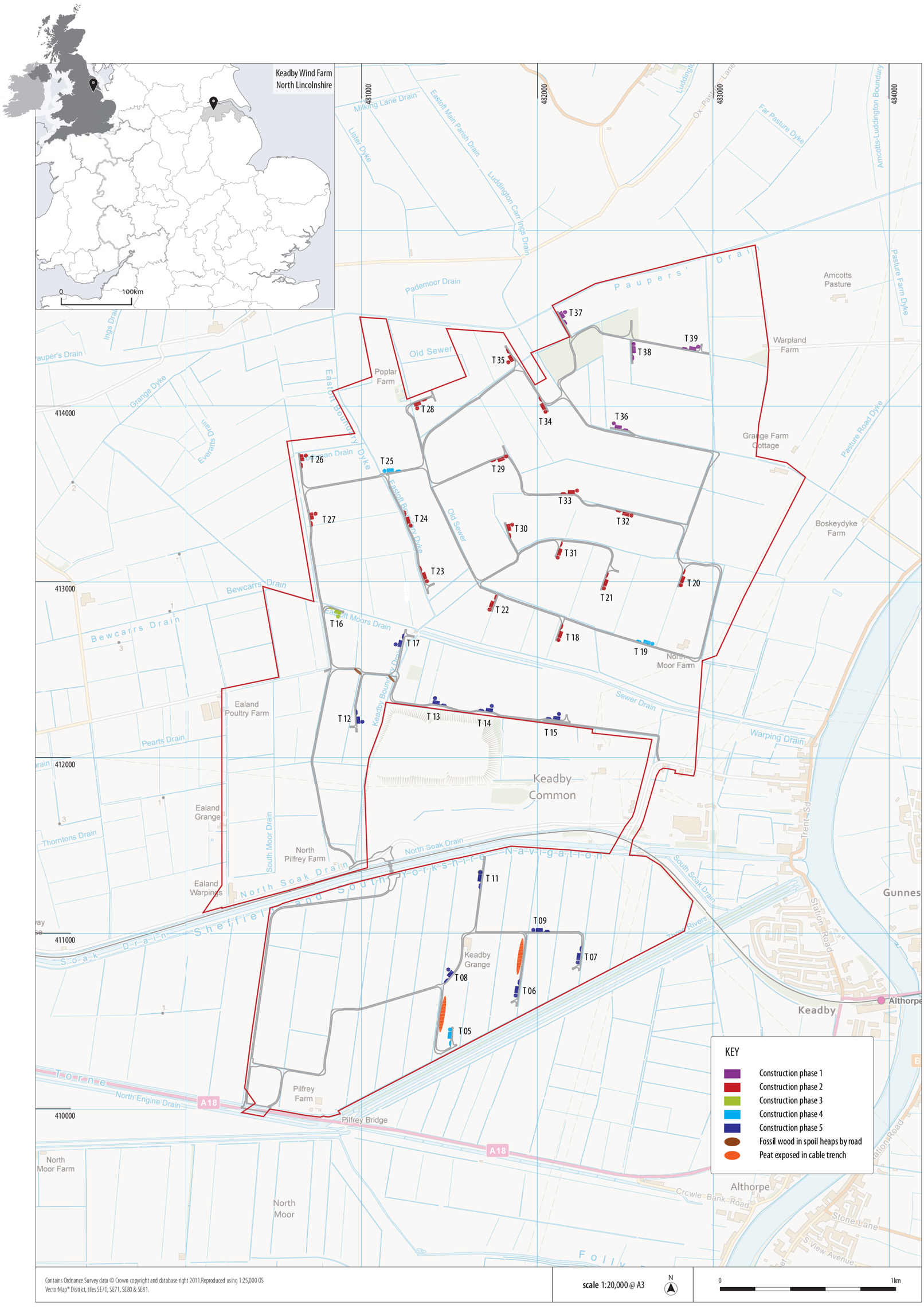
At a meeting with Alison Williams it was agreed that dendrochronological samples from Neolithic and later peats would not add significant new information to existing national chronologies. The thickness and extent of the fourth peat meant that it would not be possible to address the fourth question by examining the turbine locations. However, there would be a possibility to identify burning events associated with the Neolithic/Bronze Age peat and also the identification of any evidence for wood working.

As an initial step it was agreed to carry out an audit of the construction stage of individual turbines and, at the same time, record peat deposits and fossil wood encountered during construction.

2. OBJECTIVES

The principal aims of the audit were:

- to record the current stage of construction
- to evaluate the potential of identifying burning events and wood working associated with the peat deposits exposed during the construction



Illus 1
Site location

Illus 2
Different stages of turbine construction

3. METHODS

All turbine locations were visited during the 16th and 17th May. The stage of construction at each location was recorded, as well as the presence of peat and fossil wood in spoil heaps and/or exposed in situ in open cuts. A few samples of the fossil wood were taken from spoil heaps and in situ deposits.

The stages of construction were grouped into five levels (*Illus 2*):

Stage 1 Turbine base pit excavated and levelled. Construction of concrete turbine base not started
Stage 2 Turbine base pit excavated and levelled. Concrete turbine base at various stages of construction
Stage 3 Turbine base built and pit backfilled
Stage 4 Turbine base built and pit backfilled, hard standing excavated
Stage 5 Turbine base built and pit backfilled, hard standing backfilled

4. RESULTS

Table 1

*Table showing construction stage of individual turbines (**T**) and evidence of peat and fossil wood encountered during construction*

T	Visited	Stage	Photos	Samples	Comments
T05	16/05/2013, 12:05	4	71–75	7	Band of peat 0.9m to 1.1m thick, 0.8m below ground surface, exposed in cut for hard standing
T06	16/05/2013, 10:45	4-5	63–67	6	Peat spoilheap containing fossil wood
T07	16/05/2013, 10:20	5	60–61	5	Peat spoilheap containing fossil wood. One sample taken
T08	16/05/2013, 11:50	5	70	–	No visible peat spoilheap or fossil wood
T09	16/05/2013, 10:35	5	62	–	No visible peat spoilheap or fossil wood
T11	16/05/2013, 11:40	5	69	–	No visible peat spoilheap or fossil wood
T12	16/05/2013, 14:10	5	83	–	No visible peat spoilheap or fossil wood
T13	16/05/2013, 13:50	5	79	–	No visible peat spoilheap or fossil wood
T14	16/05/2013, 13:40	5	78	–	Spoilheap containing sandy peat with a few pieces of fossil wood
T15	16/05/2013, 13:35	5	77	–	No visible peat spoilheap or fossil wood
T16	16/05/2013, 14:30	3	85	8	Band of peat, 0.6m below ground surface and 0.6m thick exposed in cut for hard standing
T17	16/05/2013, 14:00	5	82	–	No visible peat spoilheap or fossil wood
T18	17/05/2013, 10:05	2	–	–	Thin band of peat 0.2m thick, 0.9m below ground surface exposed in cut for turbine base. Little evidence of fossil wood
T19	17/05/2013, 10:15	3-4	106	–	Band of peat 0.4m thick, 1.4m below ground surface, exposed in cut for hard standing. The peat lay below a 0.2m thick band of grey sandy clay. The peat contains pieces of fossil wood.
T20	17/05/2013, 11:30	1-2	–	–	Thin band of peat up to 0.25m thick exposed in cut for turbine base. Little evidence of fossil wood
T21	17/05/2013, 08:55	1-2	–	–	Band of peat 0.6m thick, 1.1m below ground surface, exposed in cut for turbine base. The peat contains a few pieces of fossil wood.
T22	17/05/2013, 10:00	2	–	–	Peat band visible in cut for turbine base. No access due to construction work
T23	16/05/2013, 15:55	2	96–97	–	Thin band of peat 0.15m thick, 0.6m – 0.7m below ground surface exposed in cut for turbine base. Little evidence of fossil wood
T24	16/05/2013, 16:15	2	99–100	9–10	Two bands of peat 1.3m below ground surface exposed in cut for turbine base. The upper peat is 0.35m thick overlying a 7cm thick band of grey sand on top of a 7cm thick layer of preat. The upper peat contains most fossil wood.
T25	17/05/2013, 08:25	4	103–104	–	Band of peat 0.45m thick, 0.8m below ground surface, exposed in cut for hard standing. The peat contains a few fragments of fossil wood.
T26	16/05/2013, 15:20	2	92–95	–	Thin band of peat 0.3m thick, 0.4m below ground surface exposed in cut for turbine base. Little evidence of fossil wood
T27	16/05/2013, 15:10	2	90–91	–	Small pile of fossil wood on the north side of the spoilheap
T28	16/05/2013, 16:55	2	–	–	Band of peat 0.5m thick, 0.4m below ground surface, exposed in cut for turbine base. The peat contains fossil wood.
T29	17/05/2013, 10:45	2	–	–	Band of peat 0.8m thick, 1.2m below ground surface, exposed in cut for turbine base. The peat spoilheap contains some pieces of fossil wood.
T30	17/05/2013, 09:30	2	105	–	Band of peat exposed in cut for turbine base 0.5m to 0.8m below ground surface. The peat increases in thickness from 0.2m on the west side to 1.1m on the east side. Numerous fragments of fossil wood are present in the spoilheap and in the exposed peat deposits.

T	Visited	Stage	Photos	Samples	Comments
T31	17/05/2013, 09:15	2	–	–	Band of peat 0.8m thick, 0.8m below ground surface, exposed in cut for turbine base. The peat contains pieces of fossil wood.
T32	17/05/2013, 11:20	2	–	–	Thin band of peat up to 0.15m thick exposed in cut for turbine base. Little evidence of fossil wood
T33	17/05/2013, 11:05	2	107	–	Band of peat 0.4m thick, 1m below ground surface, exposed in cut for turbine base. The peat spoilheap contains some pieces of fossil wood.
T34	17/05/2013, 12:05	1-2	109–110	11	Band of peat 1.1m thick, 1.1m below ground surface, exposed in cut for turbine base. There is a distinct horizon of fossil wood 0.4m above the base of the peat.
T35	16/05/2013, 17:10	1-2	101–102	–	Peat deposit up to 1.9m thick, 1.3m below ground surface. The peat contains numerous pieces of fossil wood.
T36	17/05/2013, 11:45	1	108	–	Band of peat 0.4m thick, 1m below ground surface, exposed in cut for turbine base. The peat spoilheap and the exposed peat band contains pieces of fossil wood.
T37	17/05/2013, 12:40	1	114–115	–	Band of peat exposed in cut for turbine base. This peat deposit corresponds to the peat (C06) exposed in Trench 5 excavated in 2012.
T38	17/05/2013, 12:35	1	113	–	Band of peat exposed in cut for turbine base. This peat deposit corresponds to the peat (C09) exposed in Trench 6 excavated in 2012.
T39	17/05/2013, 12:30	1	112	–	Band of peat exposed in cut for turbine base. This peat deposit corresponds to the peat (C12) exposed in Trench 7 excavated in 2012.

The results of the audit are presented in *Table 1* above. The numbers of turbines at the different stages of construction were (*Illus 1*):

Stage 1 4 turbines
Stage 2 16 turbines
Stage 3 1 turbine
Stage 4 3 turbines
Stage 5 10 turbines

Layers of in situ peat were seen at 23 turbine locations. Some of these deposits were fairly thin but there is a clear trend of increasing thickness of the peat deposits towards the north of the site, confirming the peat depth projections based on the coring data. This peat corresponds to the previously identified 'Peat 3', identified as dating to the period ranging from the Neolithic to the Iron Age (Dalland & Timpany 2013). The deepest deposit was recorded at Turbine 34 where the peat was up to 1.9m thick.

Peat containing fossil wood was also noted in spoil heaps along the access roads at several locations indicating that peat deposits had been encountered during the road construction (*Illus 3*).

In addition to the construction of roads and turbines a network of cable trenches are required to lead the power from the turbines to the sub-station. These are generally excavated to a shallower level than the cuts for turbines and roads. Nonetheless, peat was exposed in open cable trenches seen during the visit (*Illus 4*).

5. CONCLUSION

In broad outline, the construction sequence comprises the following sequence of ground works. Firstly, the turbine base is excavated and the concrete foundation put in place. Secondly, once the base has been backfilled, the larger areas for the hard standing are then excavated and backfilled. This construction sequence has progressed from south to north. As a result of this most turbines located to the south of the Stainforth and Keadby Canal had reached Stage 5 with no opportunity to examine any exposed peat horizons. However, significant peat deposits with a high content of fossil wood were recorded in cuts for the turbine bases on the north side of the canal. In some places the fossil wood was concentrated forming a distinct horizon within the peat layer (*Illus 5*).

The thickest peat deposits were recorded towards the north end of the site (Turbines 21, 28–31, 34–39). At these locations the hard standings have not yet been excavated, presenting the opportunity to monitor the excavations of the deeper peat deposits to look for prehistoric burning events and examples of wood working.

6. REFERENCES

Dalland & Timpany 2012 ***Keadby Wind Farm, North Lincolnshire: Report on Archaeological Evaluation of Compound 3.*** Unpublished client report for SSE Renewables (February 2012).

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Illus 3

Fossil wood within peat spoil heap on the west side of road leading south to Turbine 06, facing north

Illus 4

Peat deposit exposed in cable trench at T-junction to the south of Turbine 17, facing south

Illus 5

Horizon of fossil wood exposed within peat deposit in cut for Turbine 34, facing south

7. APPENDICES

Appendix 1 Site registers

Appendix 1.1 Photo register

Photo	Digital file	Facing	Description
01–19			Photos taken during evaluation of compound site (Job 003)
20–59			Photos taken during excavation of evaluation trenches (Job 005)
60	KWNL11-005-Pic060	S	Turbine 07. Backfilled turbine base and hard standing. Peat spoilheap to the right
61	KWNL11-005-Pic061	SW	Turbine 07. Fossil tree trunks and branches next to peat spoilheap
62	KWNL11-005-Pic062	W	Turbine 09. Backfilled turbine base and hard standing
63	KWNL11-005-Pic063	S	Turbine 06. D44+D50
64	KWNL11-005-Pic064	NE	Turbine 06. Peat layer exposed in cut for hard standing
65	KWNL11-005-Pic065	W	Turbine 06. Peat layer exposed in cut for hard standing
66	KWNL11-005-Pic066	SW	Turbine 06. Fossil tree trunk near spoilheap
67	KWNL11-005-Pic067	S	Turbine 06. Peat spoilheap containing fossil wood
68	KWNL11-005-Pic068	N	Peat spoilheap containing fossil wood along west side of road leading up to Turbine 06
69	KWNL11-005-Pic069	N	Turbine 11. Backfilled turbine base and hard standing
70	KWNL11-005-Pic070	S	Turbine 08. Backfilled turbine base and hard standing
71	KWNL11-005-Pic071	S	Turbine 05. Peat layer exposed in cut for hard standing
72	KWNL11-005-Pic072	NE	Turbine 05. Peat layer exposed in cut for hard standing
73	KWNL11-005-Pic073	NW	Turbine 05. Peat layer exposed in cut for hard standing
74	KWNL11-005-Pic074	W	Turbine 05. Peat layer exposed in cut for hard standing
75	KWNL11-005-Pic075	NW	Turbine 05. Backfilled turbine base
76	KWNL11-005-Pic076	NE	Peat spoilheap containing fossil wood along east side of road leading up to Turbine 05
77	KWNL11-005-Pic077	SW	Turbine 15. Backfilled turbine base and hard standing
78	KWNL11-005-Pic078	SW	Turbine 14. Backfilled turbine base and hard standing
79	KWNL11-005-Pic079	W	Turbine 13. Backfilled turbine base and hard standing
80	KWNL11-005-Pic080	SE	Peat band exposed in trench cut at T-junction between Turbines 13 and 17
81	KWNL11-005-Pic081	ESE	Peat band exposed in trench cut at T-junction between Turbines 13 and 17
82	KWNL11-005-Pic082	SW	Turbine 17. Backfilled turbine base and hard standing
83	KWNL11-005-Pic083	SE	Turbine 12. Backfilled turbine base and hard standing
84	KWNL11-005-Pic084	SE	Peat deposit exposed in trench cut at T-junction leading south to Turbines 12
85	KWNL11-005-Pic085	NW	Turbine 16. Backfilled turbine base
86	KWNL11-005-Pic086	WNW	Turbine 16. Peat layer exposed in cut for hard standing
87	KWNL11-005-Pic087	NW	Turbine 16. Peat layer exposed in cut for hard standing
88	KWNL11-005-Pic088	NNW	Turbine 16. Peat layer exposed in cut for hard standing
89	KWNL11-005-Pic089	WNW	Turbine 16. D45. Detail
90	KWNL11-005-Pic090	SW	Turbine 27. Concrete base for turbine in open cut
91	KWNL11-005-Pic091	SW	Turbine 27. Fossil trunks and branches on north side of spoilheap
92	KWNL11-005-Pic092	NNE	Turbine 26. Thin band of peat visible in cut for turbine base
93	KWNL11-005-Pic093	NE	Turbine 26. Thin band of peat visible in cut for turbine base
94	KWNL11-005-Pic094	ENE	Turbine 26. Thin band of peat visible in cut for turbine base
95	KWNL11-005-Pic095	E	Turbine 26. Thin band of peat visible in cut for turbine base
96	KWNL11-005-Pic096	SE	Turbine 23. Thin peat bands visible in cut for turbine bases
97	KWNL11-005-Pic097	NW	Turbine 23. Concrete base for turbine in open cut
98	KWNL11-005-Pic098	SSE	Turbine 24. Detail of bands of peat separated by grey sand layer
99	KWNL11-005-Pic099	SW	Turbine 24. Concrete base for turbine in open cut
100	KWNL11-005-Pic100	SE	Turbine 24. Bands of peat visible in cut for turbine base
101	KWNL11-005-Pic101	SE	Turbine 35. Thick band of peat visible in cut for turbine base
102	KWNL11-005-Pic102	S	Turbine 35. Piling in progress
103	KWNL11-005-Pic103	E	Turbine 25. Backfilled turbine base. Cut for hard standing in the background
104	KWNL11-005-Pic104	NE	Turbine 25. Peat layer exposed in cut for hard standing
105	KWNL11-005-Pic105	NE	Turbine 30. Variable thickness of peat layer visible in cut for turbine base

Photo	Digital file	Facing	Description
106	KWNL11-005-Pic106	E	Turbine 19. Backfilled turbine base, peat layer visible in cut for hard standing
107	KWNL11-005-Pic107	E	Turbine 33. Band of peat visible in cut for turbine base
108	KWNL11-005-Pic108	NW	Turbine 36. Band of peat visible in cut for turbine base
109	KWNL11-005-Pic109	SE	Turbine 34. Thick band of peat visible in cut for turbine base
110	KWNL11-005-Pic110	S	Turbine 34. Detail showing horizon of fossil wood within peat layer
111	KWNL11-005-Pic111	E	Turbine 39. Band of peat visible in cut for turbine base
112	KWNL11-005-Pic112	N	Turbine 39. Peat spoilheap with numerous pieces of fossil wood
113	KWNL11-005-Pic113	N	Turbine 38. Band of peat visible in cut for turbine base
114	KWNL11-005-Pic114	NE	Turbine 37. Thick band of peat visible in cut for turbine base
115	KWNL11-005-Pic115	N	Turbine 37. Detail showing horizon of fossil wood within peat layer
111	KWNL11-005-Pic111	E	Turbine 39. Band of peat visible in cut for turbine base
112	KWNL11-005-Pic112	N	Turbine 39. Peat spoilheap with numerous pieces of fossil wood
113	KWNL11-005-Pic113	N	Turbine 38. Band of peat visible in cut for turbine base
114	KWNL11-005-Pic114	NE	Turbine 37. Thick band of peat visible in cut for turbine base
115	KWNL11-005-Pic115	N	Turbine 37. Detail showing horizon of fossil wood within peat layer

Appendix 1.2 Sample register

Sample	Context	Description
001–002		Samples taken during evaluation of compound site (Job 003)
003–004		Samples taken during excavation of evaluation trenches (Job 005)
005	T07 spoilheap	Sample of fossil wood retrieved from peat spoilheap by T07
006	T06 spoilheap	Sample of fossil wood and bark retrieved from peat spoilheap by T06
007	T05	Sample of fossil wood retrieved from base of peat layer in cut for hard standing at T05
008	T16	Sample of fossil wood retrieved from base of peat layer in cut for hard standing at T16
009	T24	Sample of fossil wood retrieved from upper peat layer in cut for hard standing at T24
010	T24	Sample of fossil wood retrieved from lower peat layer in cut for hard standing at T24
011	T34	Sample taken from horizon of fossil wood within peat layer in cut for turbine base at T34

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