Celtic Interconnector

Volume 4 – Appendix 16B
Geoarchaeological Assessment

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Le réseau de transport d'électricité

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EIRGRID

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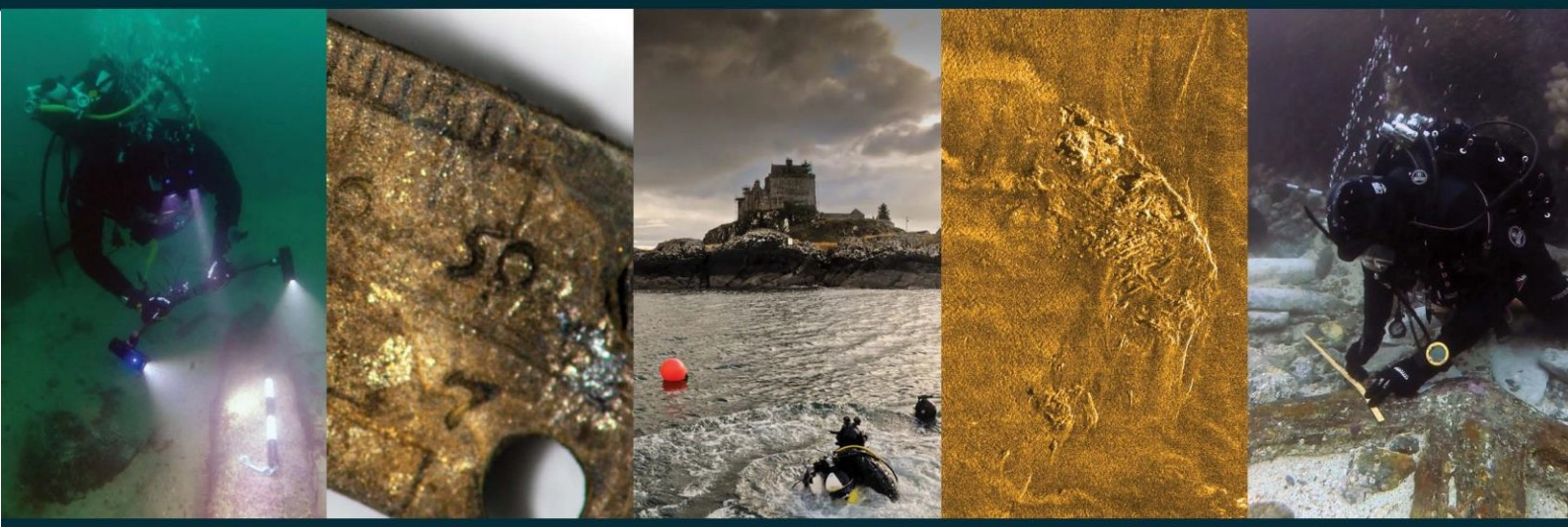
Cotswold Archaeology marine

Celtic Interconnector Project

Geoarchaeological Assessment



for

EirGrid plc

CA Project: 770617

CA Report: 19017

January 2019

Andover Cirencester Exeter Milton Keynes

Celtic Interconnector project
Geoarchaeological Assessment

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SUMMARY

Project name: Celtic Interconnector project

Cotswold Archaeology was commissioned by EirGrid plc to undertake a geoarchaeological assessment in association with the 2018 Geotechnical Site Investigations for the Celtic Interconnector project.

Recent studies indicate that there is good potential for the presence of submerged landscapes containing archaeological evidence from the early Mesolithic through to the Iron Age, and palaeo-environmentally important deposits in and around Ballinwilling Strand, Redbarn Beach and Claycastle Beach.

In 2018, 85 separate site investigations were undertaken along the three proposed routes, comprising test pits and boreholes on the landfall and nearshore locations, and vibrocores in deeper water. The site investigations confirmed the presence of extensive Late Pleistocene glacial deposits overlain by marine deposits. At the nearshore locations, however, some estuarine deposits were also encountered, including the remains of a submerged forest at Claycastle beach. A preliminary desk-based assessment of the geotechnical survey data identified cores with geoarchaeological potential, with four cores selected for geoarchaeological recording.

An assessment of palaeoenvironmental potential was made, resulting in recommendations for a palaeoenvironmental assessment, including preliminary dating, of estuarine deposits from three cores associated with the Claycastle area.

Recommendations are also made for additional site investigations at Claycastle where the submerged forest deposits are present, should this be the chosen landfall location for the project.

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1. INTRODUCTION

Outline

1.1. Cotswold Archaeology (CA) was appointed by EirGrid plc in July 2017, under the Specialist Public Planning, Ecology and Environmental Services Framework, to prepare a marine cultural heritage assessment for the Celtic Interconnector project (Cotswold Archaeology 2017). This included an assessment of marine and coastal cultural assets, up to mean high water springs (MHWS), potentially affected by this project. The baseline environmental assessment considered previous work done in the areas of the proposed revised cable routes and indicated good palaeo-environmental potential for understanding the submerged prehistoric landscapes of south-east Ireland, including contributing to studies of past sea level change.

Project background

1.2. In 2013, two national electricity transmission system operators, EirGrid plc in Ireland and Réseau de Transport d'Electricité (RTE) in France, signed a Memorandum of Understanding. The agreement was to commission further preliminary studies on the feasibility of installing a submarine electricity interconnector between the south coast of Ireland and the north-west coast of France, a distance of some 600 kilometres. EirGrid and RTE then conducted studies which indicated that an interconnector between Ireland and France could be beneficial for electricity customers in both countries. The project would involve the procurement and installation of a 700+MW High Voltage Direct Current (HVDC) interconnector which will include two HVDC converter stations, subsea cabling, and onshore lines/cables as appropriate.

1.3. EirGrid holds licences as independent electricity Transmission System Operator (TSO) and Market Operator (MO) in the wholesale trading system in Ireland and is the owner of the System Operator Northern Ireland (SONI Ltd), the licensed TSO and market operator in Northern Ireland. The EirGrid Group includes EirGrid plc, SEMO JV, EirGrid Interconnector Ltd, and EirGrid Telecoms Ltd.

1.4. RTE, an independent subsidiary of EDF, is a public service company responsible for operating, maintaining and developing the high and extra high voltage network in France. It guarantees the reliability and proper operation of the power network.

1.5. In 2013, EirGrid and RTE undertook the exploratory phase of this interconnector project with initial studies focussed on desktop analysis of the seabed to identify potential route corridors. Between 2014 and 2015 EirGrid completed a feasibility

study of the potential marine routes between Ireland and France, including geophysical and geotechnical / environmental marine surveys along the corridor between East Cork in Ireland and Brittany in France as well as investigations of two potential landfall sites. A desk-based assessment for this stage of the project was produced by Headland Archaeology (2014). An addendum was issued by Cotswold Archaeology (2017) to consider three revised/new potential cable routes within Irish territorial waters as well as three potential landfall locations; one revised and two new locations.

1.6. The revised / new cable routes run between three landfall options in Co. Cork (Ballinwilling Strand, Claycastle beach and Redbarn beach), and converge on the previously chosen route at the boundary of Irish territorial waters at 12 nautical miles (nm) (Figure 1). The revised routes were surveyed by Next Geosolutions in September to November 2017, and the data was passed to Cotswold Archaeology for a desk-based assessment in advance of the planned geotechnical site investigations.

Assessment of 2017 geophysical survey data

1.7. The 2018 geotechnical site investigations were planned to assess three potential landfall areas (Ballinwilling Strand, Claycastle beach and Redbarn beach) and the routes approaching them. In January 2018, Cotswold Archaeology commissioned Coastal and Offshore Archaeological Research Services (COARS), University of Southampton, to assess the marine geophysical survey data collected by Next Geosolutions.

1.8. The desk-based review of the geophysical data was undertaken to identify, locate and characterise features with possible archaeological potential, and to assess the sub-bottom profile data in order to establish the archaeological and palaeo-environmental potential of the sub-surface sediments that may be encountered (Cotswold Archaeology 2018a). Cotswold Archaeology (2018b) undertook an impact assessment of the landfall sites, mapping the submerged forest deposits at Claycastle and highlighting their palaeo-environmental potential, as well as identifying archaeological features at each of the foreshore locations. These reviews were undertaken in advance of site investigations which would use intrusive techniques, such as vibrocores and boreholes.

1.9. The assessment of the marine geophysical data revealed a series of palaeo-channels along all three route options. Along the Claycastle route there appears to be a series of deep fills between KP0.5 and KP5.0 where there is high potential for a nearshore submerged channel system. These may contain deposits with archaeological potential, such as submerged peats or estuarine deposits, corresponding with the onshore submerged forest peat deposits found at the Claycastle landfall site. By contrast the nearshore landfalls at Redbarn and Ballinwilling cross exposed bedrock where there is no archaeological potential for palaeo-environmental evidence unless it is located in the small channel seen meandering through the exposed bedrock. Previous coring associated with the offshore palaeo-channels has suggested that the channels may contain glacio-marine deposits at the near-surface, which would have low archaeological potential.

2. AIMS AND OBJECTIVES

2.1. The geo-archaeological assessment had the following aims:

- To undertake a desk-based assessment of the geotechnical data to identify samples with geo-archaeological potential;
- To inspect the core samples visually and describe samples identified as having geoarchaeological potential; and
- To assess the archaeological potential of the core samples and make recommendations for any further geo-archaeological investigations of these samples.

3. DESK-BASED ASSESSMENT OF GEOTECHNICAL DATA

3.1. A total of 85 interventions, ranging in elevation height from 11m to -83m lowest astronomical tide (LAT), were undertaken during the 2018 geotechnical site investigation phase (Fig. 1, Table 1). Onshore archaeological monitoring during the geotechnical investigations at Ballinwilling Strand, Redbarn beach and Claycastle beach was undertaken by IAC Archaeology (2018). This focused on 12 locations consisting of boreholes and test pits (indicated (*) in Table 1).

3.2. This assessment will consider the palaeo-environmental importance of the submerged forest deposits present at Claycastle beach that had been previously recorded during by Cotswold Archaeology (2018b; Figure 2).

3.3. Geotechnical samples were collected with the purpose of informing the engineering design, with recording and laboratory testing undertaken by Next GeoSolutions. All samples were split longitudinally and photographed prior to recording of the deposits by the geotechnical specialists, prior to sub-sampling with respect to both the stratigraphy encountered and the testing scheduled. The destructive laboratory testing included:

- Moisture content – at least 50g (fine grained soil), 3kg (coarse grained);
- Atterberg Limits – at least 600g passing 425µm sieve;
- Particle size distribution – at least 500g (for samples with grain sizes <10mm), 35kg (for samples with grain sizes <50mm);
- Minimum/maximum density – at least 6kg (sand), 16kg (gravelly soil);
- Oedometer – undisturbed sample at least 1 x diameter in length;
- Unconsolidated undrained triaxial – undisturbed sample at least 2 x diameter in length; and
- Consolidated triaxial – undisturbed sample at least 2 x diameter in length.

3.4. Core sections not subjected to destructive testing were retained by Next GeoSolutions and were made available to Cotswold Archaeology. Core photographs and descriptions were provided to enable Cotswold Archaeology to undertake a desk-based assessment of the geo-archaeological potential of the samples.

3.5. The assessment of the offshore vibrocore logs identified the following broad stratigraphic units within the cores:

- Marine sand with shell;
- Gravels and sand; and
- Compacted, probably over-consolidated, glacially-derived deposits including diamictons, clays and sub-glacial/outwash sand horizons.

Table 1 2018 Site investigation locations

Core ID	Easting (UTM29N)	Northing (UTM29N)	Elevation (m LAT)
BW2-BH-1 *	570265	5746647	6.73
BW2-BH-2 *	570282	5746588	-0.37
BW2-BH-3	570308	5746478	0.47
BW2-CPT _ VC-1	570565	5745468	-7.67
BW2-CPT _ VC-2	570861	5744335	-15.21
BW2-TP1 *	570276	5746622	0.67
BW2-TP2 *	5701291	5746565	-0.87
BW2-VC-03	571125	5742899	-22
BW2-VC-04	571384	5741478	-30
BW2-VC-04A	571370	5741484	-30
BW2-VC-05	571216	5740019	-37
BW2-VC-05A	571212	5740030	-37
BW2-VC-06	570672	6738649	-43
BW2-VC-07	569960	5737329	-44
BW2-VC-07A	569976	5737337	-45
BW2-VC-08	569690	5736341	-51
BW2-VC-08A	569697	5736346	-51
BW2-VC-09	569934	5735736	-56
BW2-VC-10	571694	5733975	-63
BW2-VC-10A	571696	5733990	-64
BW2-VC-11	572695	5732677	-67
BW2-VC-12	573710	5731495	-72
BW2-VC-12A	573696	5731498	-72
BW2-VC-13	574690	5730363	-76
BW2-VC-14	575680	5729235	-80
BW2-VC-14A	575667	5729236	-79
BW2-VC-15	576671	5728105	-80
BW2-VC-15A	576672	5728122	-81
BW2-VC-16	577661	5726978	-79

Core ID	Easting (UTM29N)	Northing (UTM29N)	Elevation (m LAT)
BW2-VC-16A	577661	5726991	-80
BW2-VC-17	578648	5725853	-80
BW2-VC-18A	579520	5724639	-83
CL-BH-1 *	578387	5754308	3.33
CL-BH-2 *	578432	5754258	0.57
CL-BH-3	578496	5754176	-0.37
CL-CPT _ VC-2	579848	5752527	-6.97
CL-CPT _ VC-3	580198	5752043	-9.99
CL-CPT_VC-1	579150	5753381	-2.41
CL-CPT_VC-1A	549145	5753381	-2.41
CL-TP1 *	578396	5754300	2.19
CL-TP2 *	578440	5754248	0.73
CL-VC-02	579850	5752523	-7
CL-VC-04	581068	5750805	-19
CL-VC-05	581605	5749403	-28
CL-VC-06	582128	5748005	-31
CL-VC-07	582686	5746622	-34
CL-VC-08	583224	5745213	-38
CL-VC-09	583876	5743864	-47
CL-VC-10	584605	5742559	-55
CL-VC-11	585334	5741240	-62
CL-VC-11A	585338	5741252	-62
CL-VC-12	585963	5739899	-70
CL-VC-12A	585985	5739902	-70
CL-VC-13	586010	5738424	-70
CL-VC-13A	586017	5738432	-70
CL-VC-14	585566	5736988	-71
CL-VC-14A	585582	5736997	-71
CL-VC-15	584999	5735629	-74
CL-VC-16	584413	5734225	-77

Core ID	Easting (UTM29N)	Northing (UTM29N)	Elevation (m LAT)
CL-VC-16A	584411	5734234	-77
CL-VC-17	583827	5732859	-75
CL-VC-17A	583849	5732857	-75
CL-VC-18	583306	5731435	-78
CL-VC-18A	583317	5731444	-79
CL-VC-19	582793	5730032	-80
CL-VC-19A	582807	5730041	-80
CL-VC-20	582268	5728624	-80
CL-VC-20A	582280	5728632	-80
CL-VC-21	581747	5727218	-80
CL-VC-21A	581739	5727227	-80
CL-VC-22	581231	5725809	-80
CL-VC-23	580710	5724399	-82
CL-VC-23A	580722	5724409	-82
CL-VC-23B	580709	5724399	-82
CL-VC-24	580359	5723405	-82
CL-VC-24A	580374	5723413	-83
RB-BH-1 *	577557	5753240	4.2
RB-BH-2 *	577621	5753202	-0.05
RB-BH-3	577819	5753080	-0.53
RB-BH-4	577795	5753003	-0.07
RB-CPT _ VC-1	578504	5752678	3.1
RB-CPT _ VC-2	580009	5751736	11.03
RB-TP1 *	577581	5753228	1.61
RB-TP2 *	577683	5753162	-1.56
RB-VC-02A	580027	5751726	-15

* monitored by IAC Archaeology

3.6. No peats or possible palaeosol horizons were identified in either the vibrocores or the core photos and were not alluded to in the sediment logs. The predominance of marine and glacial deposits suggests that these cores have low geo-archaeological potential and would therefore not require any geo-archaeological recording to assess palaeo-environmental potential.

3.7. The nearshore / onshore cores were identified as having higher geo-archaeological potential. These demonstrated the presence of similar stratigraphic units as those identified in the offshore cores, along with the presence of:

- Peat horizons (including the submerged forests identified at Claycastle); and
- Estuarine clay.

3.8. The following cores were identified as having potential from the three landfall / nearshore sites:

- BW2-BH3
- RB-CPT_VC-1
- CL-BH1
- CL-BH3
- CL-CPT_VC-1A

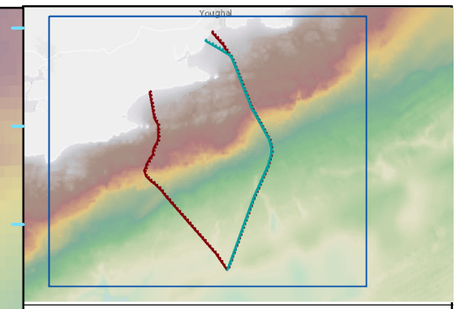
559000 561000 563000 565000 567000 569000 571000 573000 575000 577000 579000 581000 583000 585000 587000 589000 591000 593000 595000 597000

5756000 5754000 5752000 5750000 5748000 5746000 5744000 5742000 5740000 5738000 5736000 5734000 5732000 5730000 5728000 5726000 5724000

Killeagh
Mogeely
Castlemartyr
Ballymacoda
Shanagarry
Ballycotton
Churchtown South
Celtic Sea
N25
73 m
89 m

CL-TP1 CL-TP2 CL-BH-1 CL-BH-2 CL-BH-3 CL-CPT_VC-1 CL-CPT_VC-1A RB-TP2 RB-TP1 RB-BH-3 RB-BH-2 RB-BH-4 CL-VC-02 CL-CPT _ VC-2 RB-CPT _ VC-1 CL-CPT _ VC-3 RB-VC-02A RB-CPT _ VC-2 CL-VC-04 CL-VC-05 CL-VC-06 CL-VC-07 CL-VC-08 CL-VC-09 CL-VC-10 CL-VC-11 CL-VC-11A CL-VC-12 CL-VC-12A CL-VC-13 CL-VC-13A CL-VC-14 CL-VC-14A CL-VC-15 CL-VC-16 CL-VC-16A CL-VC-17 CL-VC-17A CL-VC-18 CL-VC-18A CL-VC-19 CL-VC-19A CL-VC-20 CL-VC-20A CL-VC-21 CL-VC-21A CL-VC-22 CL-VC-23 CL-VC-23A CL-VC-23B CL-VC-24 CL-VC-24A

BW2-TP2 BW2-TP1 BW2-BH-2 BW2-BH-1 BW2-BH-3 BW2-CPT _ VC-1 BW2-CPT _ VC-2 BW2-VC-03 BW2-VC-04 BW2-VC-04A BW2-VC-05 BW2-VC-05A BW2-VC-06 BW2-VC-07 BW2-VC-07A BW2-VC-08 BW2-VC-08A BW2-VC-09 BW2-VC-10 BW2-VC-10A BW2-VC-11 BW2-VC-12 BW2-VC-12A BW2-VC-13 BW2-VC-14 BW2-VC-14A BW2-VC-15 BW2-VC-15A BW2-VC-16 BW2-VC-16A BW2-VC-17 BW2-VC-18 BW2-VC-18A



Legend

- 2018 Sample Locations
- Previous Coring
- Redbarn Route
- Claycastle Route
- Ballinwilling route

Bathymetry (m LAT)

High : 3

Low : -85

0 5,000m

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PROJECT TITLE

Celtic Interconnector project

FIGURE TITLE

Geotechnical Coring Locations

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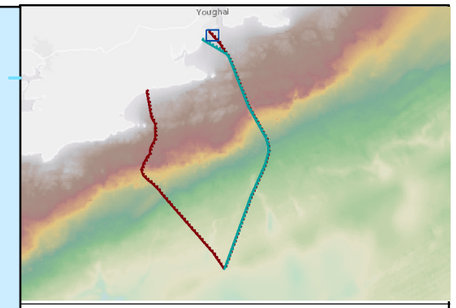
CHECKED BY	**MW**	*DATE*	**23/01/2019**	**1**
APPROVED BY	**xx**	*SCALE@A3*	**1:125,000**	

578500
579000
579500
5754500
5754000
5753500
CL-BH-1
CL-TP1
CL-BH-2
CL-TP2
CL-BH-3
CL-CPT_VC-1A
CL-CPT_VC-1
Claycastle Beach
Irish Sea



Legend

- 2018 Sample Locations
- Redbarn Route
- Claycastle Route
- Ballinwilling route

Bathymetry (m LAT)

High : 1.41

Low : -3.12083

0 200m

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PROJECT TITLE

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FIGURE TITLE

Geotechnical Site Investigations Claycastle

DRAWN BY	**MJG (UoS)**	*PROJECT NO*	**17758**	*FIGURE NO.*	
CHECKED BY	**MW**	*DATE*	**25/01/2019**		**2**
APPROVED BY	**xx**	*SCALE@A3*	**1:5,000**		

Ballinwilling

3.9. BW2-BH3

At 1.5 - 2.0m (-2.0 to -2.5m LAT) the geology is described (by Next Geosolutions) as a 'red (2.5Y 4/8) CLAY with frequent plant remains (wood) and pockets of gravel. Plant remains are intact. Gravel is fine to medium, rounded'. This deposit may be comparable to the deposit recorded by IAC Archaeology (2018: 3.2.1; Plate 1) in BW2-BH1 where a 'very loose brown slightly clayey silty fine to medium sand with occasional medium to coarse sub-rounded gravel and occasional stains of organic matter' was encountered at 5.5-10.9m (1.23 to -4.17m LAT). Although this deposit was noted in the field it was, unfortunately, not recovered in the borehole and therefore no physical samples were retained to permit geo-archaeological assessment (Fig. 3).

Figure 3 Samples from BW2-BH3 (from Next Geosolutions)

Redbarn

RB-CPT_VC-1

3.10. The geological description noted the presence of a thin peat recorded at 3.3 - 3.5m (-6.4 to -6.6m LAT) overlying probable Till. The core photographs, however, do not show the presence of a peat horizon. Next GeoSolutions account for this discrepancy by stating that the only organic matter encountered was related to smears of clayey organic matter on the walls of the SPT sampler (Figure 4). The core was therefore deemed to have no geo-archaeological potential.

Figure 4 Samples from RB-CPT-VC-1 (from Next Geosolutions)

Claycastle

CL-BH1

3.11. At 4.5 - 6.0m the geological description (supplied by Next Geosolutions) was of a 'dense dark brown (7.5YR 3/4) to black (10 YR 2/1) slightly gravelly, slightly sandy PEAT with frequent decayed plant material'. This peat deposit is part of the submerged forest located on the foreshore (Cotswold Archaeology 2018b) and was monitored by IAC Archaeology (2018; 3.4.1).

3.12. All the material from 4.5 - 5.0m in Shelby tube P4 was used for geotechnical testing purposes; the only retained sample from 5.0 - 5.45m consisted of a deposit described as sands with organic matter within SPT4. There was no sample recovery at 5.5 - 6.0m, but the next sample recovered, at 6.0m, contained no evidence of peat, thus providing a maximum potential depth for the base of the peat (of 6m) and a thickness of up to 1.5m (Fig. 5).

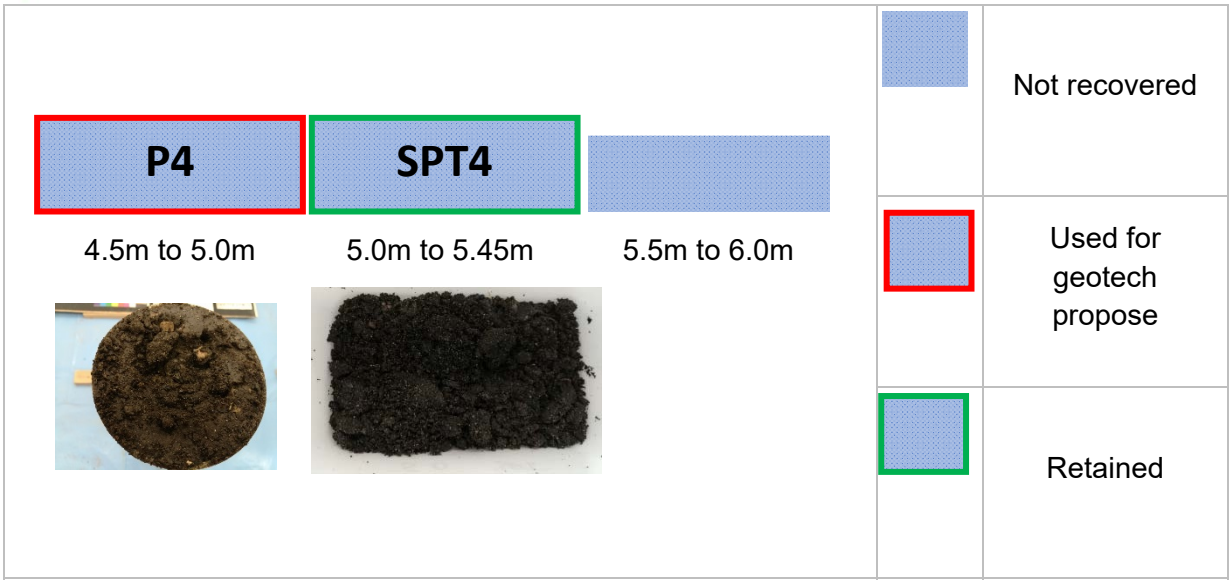


Figure 5 Samples from CL-BH1 (from Next Geosolutions)

CL-BH2

3.13. This core was taken adjacent to the known exposure of the submerged forest and was also encountered in CL-TP2 (see IAC 2018). The recorded sequence was:

- 0.00 - 0.90m: Loose brown (10YR 5/3) gravelly slightly silty fine to medium SAND. Gravel is fine to coarse and sub-angular to sub-rounded of various lithologies;
- 0.90 - 1.50m: Grey silty sand with pockets of silt with rare spongy pseudo-fibrous peat and pseudo-fibrous spongy plant and wood remains. Intense organic odour;
- 1.50 - 3.40m: Very loose grey (2.5Y 5/1) to olive brown (2.5Y 4/4), slightly silty fine to coarse organic SAND with amorphous and fibrous peat;
- 3.40 - 6.50m: Very soft grey (2.5Y 5/1) to greenish grey (GLEY1 5/1) slightly sandy silty CLAY. Between 4.50 - 5.00m a band of slightly gravelly slightly sandy clayey silt, and at 6.00m a light grey (10YR 7/2) slightly gravelly very sandy very silty CLAY. Gravel is fine to coarse, sub-rounded to sub-angular of mudstone.

3.14. The adjacent core (**CL-TP2)** confirmed that the peat deposit was between 0.25m and 1.80m, overlying sand with shell fragments. This could indicate that the peat represents an extension of the peat over previous riverine / marine sand deposits and could therefore potentially provide a useful Late Holocene sea level index point

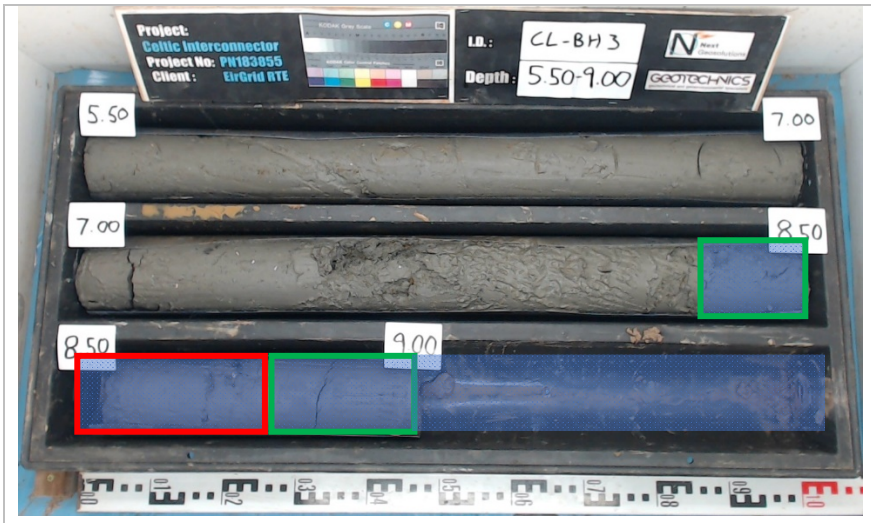
(SLIP). There was no sample retention of the peat deposits suitable for geo-archaeological recording.

CL-BH3

3.15. A further extension of the submerged forest was recorded, with a possible basal palaeosol preserved at the base of the sequence. The geological description (supplied by Next Geosolutions) for the section of interest, 8.3 - 9.1m (-7.9 to -8.7m LAT), was:

- 8.30 - 8.50m: Black (10YR 2/1) spongy clayey fibrous PEAT;
- 8.50 - 8.80m: Firm grey (2.5 5/1) soft (12 kPa) very gravelly very sandy CLAY with blocks of pseudo-fibrous spongy plant remains;
- 8.80 - 9.10m: Reddish brown (2.5YR 4/3) slightly silty slightly clayey very gravelly fine to medium SAND. Gravel is fine to coarse, sub-rounded to rounded meta-sandstone (low grade) quartz and flint.

3.16. The samples from this core that were available for the depths of interest were limited to 8.20 - 8.50m and 8.80 - 9.00m (Fig. 6); the remainder were either destructively tested or not retained. The core photos do not show a distinct peat horizon; Next GeoSolutions confirmed that the only rare evidence of spongy clayey fibrous peat was encountered at about 8.3m.



	Not recovered
	Used for geotech propose
	Retained

Figure 6 Samples from CL-BH3 (from Next Geosolutions)

CL-CPT_VC-1A

3.17. The geological logs recorded clays with shells and occasional organic matter at 1.6 - 5.5m (-4.0 to -7.9m LAT). Next GeoSolutions confirmed that there was no evidence of peat present and only occasional evidence of amorphous organic matter was highlighted. This core appears to contain a series of clays representing estuarine deposits (Fig. 7). Core **CL-CPT_VC-1**, immediately adjacent to this vibrocore, contained a similar sedimentary sequence.

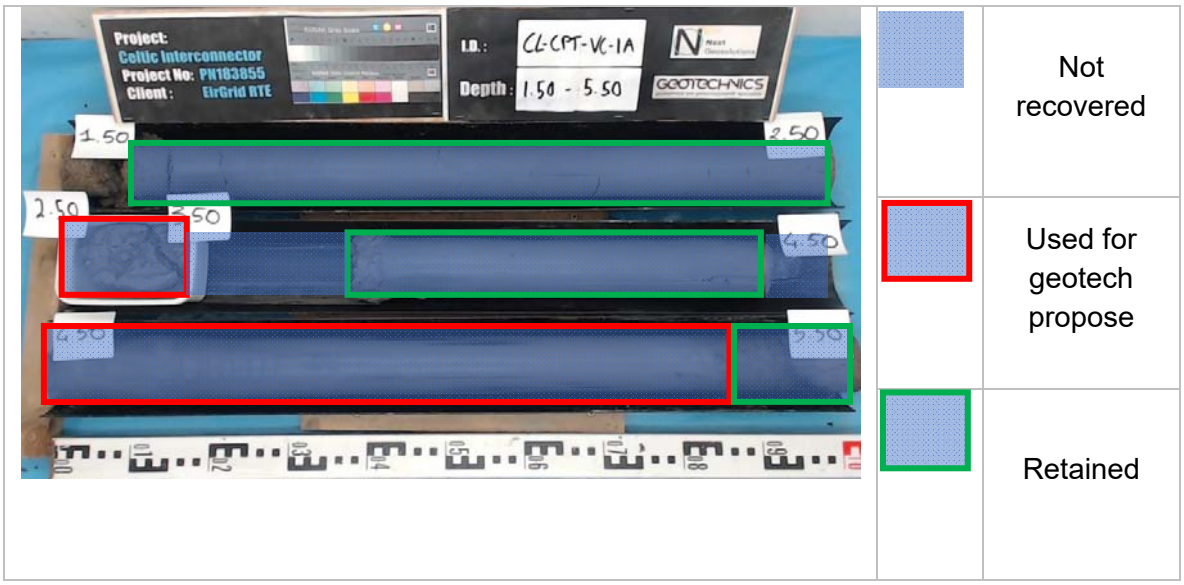


Figure 7 Samples from CL-CPT_VC-1A (from Next Geosolutions)

3.18. The desk-based assessment, and updated descriptions from Next GeoSolutions, resulted in the identification of four core sections from Claycastle beach where sediment was retained that might hold palaeo-environmental potential:

- CL-BH1: 5.00-5.45m;
- CL-BH3: 8.20-9.00m;
- CL-CPT-VC1A 1.6-2.5m; and 3.50-4.50m

3.19. These cores sections were sent to Cotswold Archaeology for geo-archaeological recording (below).

4. GEO-ARCHAEOLOGICAL RECORDING

4.1. The geo-archaeological assessment followed Historic England (2015) guidelines, with descriptions according to Hodgson (1997) including sediment type, depositional structure, texture and colour. Interpretations regarding mode of deposition, formation processes, likely environments represented, and potential for palaeo-environmental analysis were also noted. The results have been tabulated and are presented below (Tables 2, 3 & 4). As all the samples had been sub-sampled, there was little available information regarding sedimentary structures (bedding, laminations, etc) or stratigraphic boundaries. A photographic record of the samples, including key stratigraphic features, has been made to supplement the sedimentary descriptions.

5. RESULTS

5.1. Geoarchaeological descriptions of the samples from each of the four core samples are provided below.

CL-BH1: 5.00 - 5.45m

5.2. A single bulk sample was obtained and confirmed the presence of a woody peat. The elevation of the peat suggests it is probably an onshore extension of the submerged forest deposits encountered on the foreshore and observed in CL-BH2 and CL-TP2 (see IAC Archaeology 2018). The sample may be suitable for an assessment of the waterlogged plant remains but would be of little use for other techniques such as pollen as the sample only represents a single bulk sample.

Table 2 Geo-archaeological description of CL-BH1

Depth in core	Depth (m LAT)	Description	Interpretation
5.00 - 5.45m	-1.67 to -2.12m	10YR 1/1 peat, some fibrous ?root remains and also small wooden ?twigs.	Peat

CL-BH3: 8.20 - 9.00m

5.3. The core sections available represent an estuarine deposit overlying a probable Late Pleistocene Glacial Till. The estuarine deposit was only sampled between 8.20 - 8.50m but contained distinct laminations which may relate to rhythmite deposition within a saltmarsh or mudflat environment. Broken shell could point towards the nearby presence of a channel with higher flow rates leading to the deposition of broken shell during periods of flooding. The base of the sequence, which could

indicate a transgressive surface, was not sampled. The core, however, might have palaeo-environmental potential for understanding the environment of deposition associated with the deposits at 8.20 - 8.50m, especially if the organic material within the core is suitable for radiocarbon dating.

Table 3 Geo-archaeological description of CL-BH3

Depth in core	Depth (m LAT)	Description	Interpretation
8.20 - 8.50m	-5.57 to -8.87m	10YR 7/3 No mottles silty clay, finely laminated, stoneless, broken shell at 8.28 and 8.43m, 1-2%, organics, slightly laminated but not full core width, at 8.28, 8.33, 8.37, 8.43, 8.46, 8.51 and 8.57m. Base not reached	Estuarine deposit
8.50 - 8.80m	-8.87 to -9.17	GAP	
8.80 - 9.00m	-9.17 to -9.37	10YR 5/4 1-2% fine mottle, very dense (?over consolidated) 10YR 6/6 clay, finely laminated, sub-rounded to rounded / tabular stones, 10-40mm, very slightly stony, no shell, no organics, base not reached	Possible Glacial Till

CL-CPT-VC1A 1.60 - 2.50m and 3.50 - 4.50m

5.4. The top and base of the 1.60 - 2.50m section was not marked, so it is assumed that the coarser sand-rich horizon is the top of this core section. This is supported by the fact that the underlying Shelby sample is composed of clay with no sand inclusions.

5.5. The core contained a long estuarine sequence, although the base of this sequence was not reached. The coarsening of the grain size in the core suggests a transition towards a higher energy environment and the proximity of channels and / or the littoral zone. The basal clays are likely to represent intertidal environments.

5.6. The presence of intact bivalve molluscs in this deposit suggests a low energy environment and could also be diagnostic, relating to establishing the indicative elevation of this deposit, as well as providing good potential for radiocarbon dating.

5.7. Overlying organics are likely to reflect saltmarsh or reedbed deposits. Some organics could be dated if deemed appropriate taphonomically (i.e. not roots). This core

provides the potential to date the change in estuarine conditions which might provide a palaeo-landscape context for the onshore submerged forest.

5.8. If dating is successful, this core could also provide a sea level record if coupled with foraminifera, diatom and pollen assessments.

Table 4 Geo-archaeological description of CL-CPT-VC1A

Depth in core	Depth (m LAT)	Description	Interpretation
1.60 - 1.625m	-4.01 to -4.035m	10YR2/1 No mottles, sandy silt loam, stoneless, small shell (<5mm), 1-2%, no visible organics, Abrupt boundary to:	Estuarine deposit
1.625 - 1.685m	-4.035 to -4.095m	10YR4/1 No mottles, sandy clay, rounded tabular stones, slightly stoney, up to 15mm, bivalve shell (up to 8mm), 2%, no visible organics. Sharp boundary to:	Estuarine deposit
1.825 - 2.50m	-4.095 to -4.91m	10YR4/1 No mottles, silt loam, stoneless (very rare), broken bivalve shell, 1.75, 2.26 and 2.38m. fine organics present at 2.14, 2.20m, with vertical rooting between 2.33-2.42m. Base not reached	Estuarine deposit
2.50 - 3.50m	-4.91 to -5.91m	GAP	
3.50 - 4.50m	-5.91 to -6.91m	10YR 5/1 no mottles, clay, stoneless, intact bivalves up to 25mm, both horizontal and vertical orientation, but not articulated, 3.60-3.66 and 3.77m, 1% small organic at 3.52 and 3.75m. Base not reached	Estuarine deposit

6. PALAEO-ENVIRONMENTAL POTENTIAL

6.1. The three cores subjected to geo-archaeological recording display good potential for understanding the Holocene palaeo-landscape of the Claycastle area. Onshore and offshore cores confirm the presence of estuarine deposits, which correlate with the channel area identified previously in the assessment of the marine geophysical survey data. The submerged forest deposits appear to extend from their intertidal exposures up to the location of **CL-BH1** and may be up to 1.6m in thickness.

6.2. Both the peat and estuarine deposits have the potential to provide material suitable for radiocarbon dating. Coupled with assessments of waterlogged plant remains, molluscs, pollen, diatoms and foraminifera, these cores could provide an important insight into the timing of marine transgression and regression in this area of southeast Ireland.

6.3. The geotechnical samples from **CL-CPT-VC1A** and **CL-BH3** provide sufficient material for an assessment of the changing sedimentary sequence. The sample from **CL-BH1** (coupled with **CL-BH2**) demonstrate the extent of the submerged forest but provide insufficient material for palaeo-environmental assessment.

7. RECOMENDATIONS

7.1. Palaeo-environmental assessment should be undertaken on material from cores **CL-CPT-VC1A** and **CL-BH3**. An assessment of the waterlogged plant remains, and molluscs would identify material suitable for radiocarbon dating. Pollen, diatoms and foraminifera should also be assessed from each core. The proposed sampling strategy for each core is provided in Tables 5 and 6, with total number of samples per technique provided in Table 7

Table 5 Proposed sampling for CL-BH3

Depth in core	Depth (m LAT)	Description	Proposed Sampling
8.20 - 8.50m	-5.57 to -8.87m	10YR 7/3 No mottles silty clay, finely laminated, stoneless, broken shell at 8.28 and 8.43m, 1-2%, organics, slightly laminated but not full core width, at 8.28, 8.33, 8.37, 8.43 and 8.46m. Base not reached	2P, 2D, 2F, 2WL, 1C^{14}
8.50 - 8.80m	-8.87 to -9.17m	GAP	
8.80 - 9.00m	-9.17 to -9.37m	10YR 5/4 1-2% fine mottle, very dense (?over consolidated) 10YR 6/6 clay, finely laminated, sub-rounded to rounded / tabular stones, 10-40mm, very slightly stony, no shell, no organics, base not reached	No sampling

P = Pollen; D = Diatoms; F = Foraminifera; WL = Waterlogged plant remains and molluscs; C^{14} = radiocarbon

Table 6 Proposed sampling for CL-CPT-VC1A

Depth in core	Depth (m LAT)	Description	Proposed Sampling
1.60 - 1.625m	-4.01 to -4.035m	10YR 2/1 No mottles, sandy silt loam, stoneless, small shell (<5mm), 1-2%, no visible organics, Abrupt boundary to:	1P, 1D, 1F, 1WL
1.625 - 1.685m	-4.035 to -4.095m	10YR 4/1 No mottles, sandy clay, rounded tabular stones, slightly stoney, up to 15mm, bivalve shell (up to 8mm), 2%, no visible organics. Sharp boundary to:	1P, 2D, 1F, 1WL
1.825 - 2.50m	-4.095 to -4.91m	10YR 4/1 No mottles, silt loam, stoneless (very rare), broken bivalve shell, 1.75, 2.26 and 2.38m. fine organics present at 2.14, 2.20m, with vertical rooting between 2.33 - 2.42m. Base not reached	2P, 3D, 3F, 2WL, $1C^{14}$
2.50 - 3.50m	-4.91 to -5.91m	GAP	
3.50 - 4.50m	-5.91 to -6.91m	10YR 5/1 no mottles, clay, stoneless, intact bivalves up to 25mm, both horizontal and vertical orientation, but not articulated, 3.60 - 3.66m and 3.77m, 1% small organic at 3.52 and 3.75m. Base not reached	3P, 3D, 3F, 3WL, $1C^{14}$

P = Pollen; D = Diatoms; F = Foraminifera; WL = Waterlogged plant remains and molluscs; C^{14} = radiocarbon

Table 7 Proposed total number of samples for assessment

Technique	Number of samples
Waterlogged plant remains and molluscs	9
Pollen	9
Diatoms	11
Foraminifera	10
Radiocarbon dating	Up to 3

7.2. The palaeo-environmental assessment of the core samples will aim to:

- Establish the range of freshwater, brackish and marine deposits recorded;
- Determine the preservation of different ecofacts;
- Establish the age of the organic deposits / shells;
- Establish the potential for determining SLIPs from the sediments; and
- Establish any evidence for human activity in the sedimentary record

7.3. The submerged forest deposits at Claycastle should be subject to further investigation. A short campaign of hand-auguring across the beach, by suitably qualified specialists, might prove beneficial to better understand the nature of the peat deposits by a) establishing the depth of the peat deposits across the site, and b) possibly identifying the extent of the deposits. Further archaeological investigation could also be undertaken if there were any further project-specific site investigations in this area. This could take the form of a watching brief, together with palaeo-environmental sampling, during cable installation.

Palaeo-environmental assessment methodology

7.4. A brief outline of the methods to be employed during the palaeo-environmental assessment is provided below. The proposed specialists are listed in Table 8.

Table 8 Proposed specialists for geoarchaeological stage 3 assessment

Technique	Specialist / supplier
Diatom	
Foraminifera	
Pollen	
Waterlogged plant remains (WPR) including assessment of presence of insect remains	
Mollusc	
Radiocarbon dating	SUERC

Diatom

7.5. Diatom samples will be prepared using the standard technique of Plater et al. (2000). Identifications will be made with reference to Hendy (1964) and van der Werff & Huls (1958–1974).

Foraminifera

7.6. Foraminifera assessments will follow Historic England (2011) guidance for environmental archaeology. Samples will be air-dried, and a standard volume sample of sediment will be passed through a 63µm mesh sieve in water. Foraminiferid tests and other items of palaeo-ecological interest will be extracted under low-power microscopy. Tests will be identified to species level by comparison to a reference collection and brief notes made about condition of preservation. Any ostracods encountered in these samples will be collected, quantified and stored for subsequent identification by a specialist, if required, during Stage 4 Analysis. The assessment will include a full statement of potential and recommendations for any further analysis or archiving / disposal.

Pollen

7.7. Standard preparation procedures will be used (Moore *et al*. 1991). 2cm^3 of sediment will be processed from each sample, with a Lycopodium spike added (two tablets from batch 3862) to allow the calculation of pollen concentrations (Stockmarr 1971). All samples will undergo the following treatment: 20 mls of 10% potassium hydroxide (KOH) (80°C for 30 minutes); 20mls of 60% hydrofluoric acid (HF) (80°C for 120 minutes); 15 mls of acetolysis mix (80°C for 3 minutes); stained in 0.2% aqueous solution of safranin and mounted in silicone oil following dehydration with tert-butyl alcohol. Due to the highly minerogenic nature of some of the samples additional sieving and decanting will be undertaken between the KOH and HF stages, along with an extended period of 10% hydrochloric acid (HCL) dissolution of the calcareous sediments.

7.8. Pollen counting will be undertaken at a magnification of x400 using a Nikon SE transmitted light microscope. Determinable pollen and spore types will be identified to the lowest possible taxonomic level with the aid of a reference collection kept at COARS, University of Southampton. The pollen and spore types used are those defined by Bennett (1994; Bennett et al. 1994), with the exception of Poaceae which will follow the classification given by Küster (1988), with plant nomenclature ordered according to Stace (2010). The pollen assemblage will be calculated as % total land

pollen (TLP). The TLP sum will exclude aquatics and pteridophyes, which will be calculated as % + Group. A TLP sum of 100 grains will be sought for the pollen assessment.

Waterlogged plant remains

7.9. Assessment of the waterlogged plant remains entails scanning of the unsorted flots and residues under a x10-x40 stereo-binocular microscope and the recording of presence and relative abundance of waterlogged plant remains. Preliminary identifications of dominant taxa are recorded and tabulated following the nomenclature of Stace (2010).

Mollusc

7.10. The flots and residues are assessed by scanning under a x10 – x40 stereo-binocular microscope to provide some information about shell preservation and species representation. The numbers of shells and the presence of taxonomic groups are quantified and tabulated. Nomenclature is according to Anderson (2005) and habitat preferences according to Kerney (1999).

Radiocarbon Dating

7.11. Wherever possible, identifiable short-lived terrestrial plant macrofossils suitable for dating (following Bayliss **et al**., 2008: xi) will be used. Alternatively, marine molluscs may be dated if intact and showing little evidence of reworking. Dates will be calibrated against the IntCal13 Northern Hemisphere radiocarbon curve (Reimer *et al*. 2013) using OxCal 4.3 (Bronk Ramsey, 1995, 2001) and quoted as calibrated years before present (BP) using the maximum intercept method (Bayliss *et al*. 2008). Date ranges are quoted using the 2σ calibrated range, with end points rounded outwards to 10 years (Mook 1986).

7.12. To conclude, nothing has yet been found at these sites that would prevent the cable coming ashore at any of these locations. Although the peat deposits on Claycastle beach have archaeological / palaeo-environmental potential, nothing has yet been discovered that could not be mitigated through further archaeological site investigation.

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