LAND AT ENDERBY WHARF, CHRISTCHURCH WAY, LONDON BOROUGH OF GREENWICH SE10 0AG (NGR: TQ 3925 7873): ENVIRONMENTAL ARCHAEOLOGICAL ANALYSIS REPORT

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INTRODUCTION

This report summarises the findings arising out of the environmental archaeological analysis undertaken by Quaternary Scientific (University of Reading) in connection with the proposed development at Enderby Wharf, Christchurch Way, London Borough of Greenwich (National Grid Reference centred on: TQ 3925 7873; Figures 1 and 2). The site is approximately 4.0 hectares in size, and located towards the south-western corner of Greenwich Peninsula, bounded to the west by the River Thames and to the east by Blackwall Lane. Greenwich Peninsula is formed and bounded by a meander of the Thames to the west, east and north of the site, and lies opposite the confluence of the River Lea. The ground across the area originally formed part of the natural floodplain of the Thames and is underlain by river alluvium (British Geological Survey 1:50,000 sheets 256 North London 1993, 257 Romford 1996, 270 South London 1998, 271 Dartford 1998).

A number of geoarchaeological investigations have taken place on the Greenwich Peninsula in recent years (e.g. Corcoran, 2002; Batchelor, 2013, 2014; Young & Batchelor, 2013a,b; Batchelor et al., 2014; Young, 2015; Figure 1). These investigations have revealed an undulating Shepperton Gravel surface ranging from >-4m to <-2m OD, overlain by a sequence of Holocene alluvial deposits including peat. Proposed development at the Enderby Wharf site provided an opportunity to investigate the geoarchaeological deposits and enhance the existing model in the south-western corner of Greenwich Peninsula. Furthermore, the site is located within 150m of Bellot Street where Bronze Age trackways have been recorded (McLean, 1993; Phil & Garrod, 1994; Branch *et al.*, 2005; Hawkins, 2005), providing additional significance to the location of the site.

During the course recent geotechnical (Babtie, 2003) and geoarchaeological (Young, 2013) boreholes put down across the Enderby Wharf site demonstrated that the surface of the Shepperton Gravel is relatively deep in this area of the Peninsula lying between -3.5 and -4.0m OD, with a potential west-east aligned palaeochannel located beyond its south-eastern margins. A thick sequence of alluvial deposits overlies including a peat horizon recorded between *ca*. 0.0 and -2.5m OD, and generally between 1 and 2m thick. Subsequent laboratory-based assessment of one of the collected borehole sequences indicate that the peat accumulated between at least 5290-4980 and 4420-4230 cal BP (middle to late Neolithic). In addition, assessment of the pollen and macrofossils demonstrated the potential of the samples for providing a detailed reconstruction of the environmental history of the site and its environs, which might include evidence of the following important events: (1) the Mesolithic/Neolithic elm decline; (2) the late Neolithic/Bronze Age colonisation/decline of yew and elm from the peat surface; (3) the Bronze Age decline of dryland woodland, and (4) palaeoenvironmental evidence of human activity around the time of trackway construction at the nearby Bellot Street sites (Young *et al*., 2013).

As a consequence of the assessment findings, analysis of the sequence from borehole <QBH1> was recommended. This analysis was suggested to consist of: (1) two further radiocarbon dates to confirm the full duration of peat accumulation, and (2) analysis of the pollen assemblages from suitable samples. Investigation of the diatom remains was also recommended, but subsequent assessment revealed the remains to be too limited to provide further information on the hydrological history of the site.


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Blackwall
River Thames
Royal Victoria Dock
Custom House
Exhibition Centre
Silvertown
Bugsby's Reach
Millwall
Isle of Dogs
Cubitt Town
New Charlton
West India and Millwall Docks
Millwall Outer Dock
Beckton District Park

Figure 1: Location of (1) Enderby Wharf, Christchurch Way, London Borough of Greenwich and other geoarchaeological and archaeological sites nearby: (2) Plot MO117 (JHW13; Young & Batchelor, 2013a); (3) Plot MO115 (Young & Batchelor, 2013b) (4) Tunnel Avenue (GPF12; Batchelor, 2013); (5) Greenwich Millennium Village (Miller & Halsey, 2011); (6) Atlas Wharf (AWF98; Lakin, 1998); (7) Mast House Terrace (MHT95; Bowsher & Wilkinson, 1995); (8) Victoria Deep Water Terminal (TUA02; Corcoran, 2002); (9) Greenwich Peninsula (Corcoran, 2002); (10) Canning Town (Stafford, 2012); (11) Lower Lea Valley Mapping Project (Corcoran *et al*., 2011); (12) Bellot Street (GLB05; Branch *et al*., 2005); (13) 72-88 Bellot Street (BSG93; McLean, 1993; Philp, 1993); (14) Canning Town Regeneration Area 7 & 1C (CTR12; Green & Young, 2012); (15) the Cable Car route (CAB11; Batchelor *et al*., 2015) (A) North Station; (B) North Intermediate Tower; (C) North Tower; (D) South Tower; (E) South Station); (16) Silvertown (BWC96; Wilkinson *et al*., 2000); (17) Fort Street (HW-FO94; Wessex Archaeology, 2000; Crockett et al., 2002); (18) Greenwich Industrial Estate (GIE02; Morley, 2003); (19) Royal Docks Community School (PRG97; Holder, 1998); (20) Preston Road (PPP06; Branch *et al*., 2007); (21) East India Docks (Pepys, 1665); (22) Plot MO401 (Batchelor, 2014). (23) 105-107 Tarling Road (Batchelor & Young, 2014); (24) St Luke's Square (LUC07; Wicks, 2008); (25) Caxton Works (Young, 2014); (26) 118 Victoria Dock Road (Barnett *et al*., 2010); (27) Tidal Basin Road (Young & Batchelor, 2013c); (28) Silvertown Tunnel (Young, 2015); (29) Barnwood Court (HW-BC97; Farid, 1997); (30) Thames Barrier Park East (TBP06; Green *et al*., 2006); (31) Royal Wharf, Silvertown (Batchelor *et al*., 2014). ***Contains Ordnance Survey data © Crown copyright and database right [2015]***

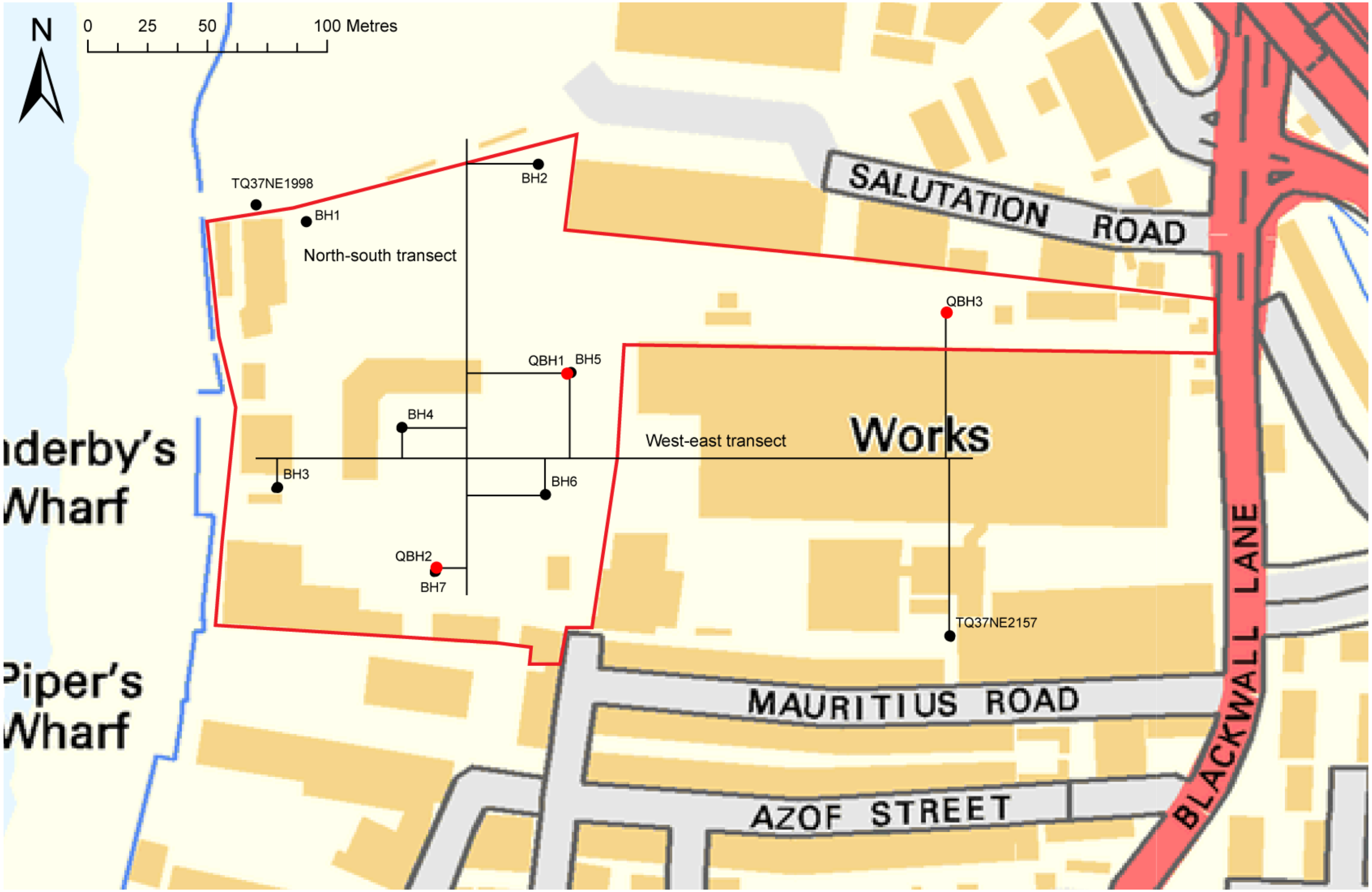

Figure 2: New geoarchaeological and existing geotechnical borehole locations at Enderby Wharf, Christchurch Way, London Borough of Greenwich. ***Contains Ordnance Survey data © Crown copyright and database right [2012]***

METHODS

Previous investigations (field investigations and deposit modelling)

Seven geotechnical boreholes were put down at the site by URS by cable percussion (BH1 to BH7). Selected boreholes (BH2, BH3, BH5 and BH7) were monitored and described in the field by Quaternary Scientific, and compared with the geotechnical descriptions provided by the drilling team (see Appendix 1). The resulting sedimentary logs were combined with those of the geotechnical boreholes and used to produce a deposit model for the site, in combination with boreholes put down nearby to the site, provided by the British Geological Society (NERC). Co-ordinates and OD height data was not available for the previous geotechnical boreholes put down at the site by WESA (2003), Babtie (2003) and URS (2003); these boreholes were thus not included in the deposit model.

An additional three boreholes (boreholes <QBH1> to <QBH3>) were put down at the site in January 2014 following the results of the deposit modelling exercise (Young, 2013; Figure 2). Borehole core samples were recovered using an Eijkelkamp window sampler and gouge set using an Atlas Copco TT 2-stroke percussion engine. This coring technique is a suitable method for the recovery of continuous, undisturbed core samples and provides sub-samples suitable for not only sedimentary and microfossil assessment and analysis, but also macrofossil analysis. The recovered core samples were wrapped in clear plastic to prevent moisture loss, labelled with the depth (metres from ground surface) and orientation (top and base) and returned to Quaternary Scientific for storage in a purpose built facility at 2^{o}C. This temperature prevents fungal growth on the core surface, which may lead to anomalous radiocarbon dates, and moisture loss. The spatial attributes of each borehole were recorded (Table 1 and Figure 2).

The sedimentary logs from these boreholes were combined with those of the previous deposit model, resulting in a total of 11 sediment logs for the deposit modelling process. Sedimentary units from the boreholes were classified into the following groupings: (1) Shepperton Gravel; (2) Lower Alluvium, (3) Peat, (4) Upper Alluvium and (5) Made Ground. The Lower Alluvium and Peat were not recorded in all boreholes; and where only alluvium was recorded, this was designated as the Upper Alluvium. The classified data for groups 1-5 were input into a database with the RockWorks 2006 geological utilities software. Models of surface height (using a nearest neighbour routine) were generated for the Shepperton Gravel, Lower Alluvium, Peat and Upper Alluvium (Figures 5, 6, 7 and 9). The thickness of the Peat, combined Alluvium and Made Ground was also modelled (also using a nearest neighbour routine) (Figures 8, 10 and 11). In addition, north-south and west-east 3-

Dimensional interpolated transects are provided for the site; these include selected borehole records for comparative purposes (Figures 3 and 4).

Table 1: Borehole attributes, Enderby Wharf, Christchurch Way, London Borough of Greenwich

Borehole number	Easting	Northing	Elevation (m OD)
<QBH1>	539270.39	178739.98	1.84
<QBH2>	539215.97	178659.37	2.32
<QBH3>	539428.27	178765.33	1.59

Lithostratigraphic descriptions

The lithostratigraphy of boreholes <QBH1> to <QBH3> was described in the laboratory using standard procedures for recording unconsolidated sediment and organic sediments, noting the physical properties (colour), composition (gravel, sand, clay, silt and organic matter) and inclusions (e.g. artefacts) (Tröels-Smith, 1955). The procedure involved: (1) cleaning the samples with a spatula or scalpel blade and distilled water to remove surface contaminants; (2) recording the physical properties, most notably colour using a Munsell Soil Colour Chart; (3) recording the composition; gravel (Grana glareosa; Gg), fine sand (Grana arenosa; Ga), silt (Argilla granosa; Ag) and clay (Argilla steatoides); (4) recording the degree of peat humification and (5) recording the unit boundaries e.g. sharp or diffuse. The results are displayed in Figures 3, 4 and 12 and in Tables 2 to 4.

Organic matter determinations

47 sub-samples from borehole <QBH1> were taken for determination of the organic matter content (Table 5; Figure 12). These records were important as they can identify increases in organic matter possibly associated with more terrestrial conditions. The organic matter content was determined by standard procedures involving: (1) drying the sub-sample at 110^0C for 12 hours to remove excess moisture; (2) placing the sub-sample in a muffle furnace at 550°C for 2 hours to remove organic matter (thermal oxidation), and (3) re-weighing the sub-sample obtain the 'loss-on-ignition' value (see Bengtsson and Enell, 1986).

Radiocarbon dating

Sub-samples of unidentified twig wood (<2-3 years old) were extracted from the various Peat horizons in borehole <QBH1> for radiocarbon dating. Two samples were submitted for AMS radiocarbon dating to the Scottish Universities Environmental Research Centre (SUERC), East Kilbride, Glasgow; the other two samples were sent to Beta Analytic, Florida. The results have been calibrated using OxCal v4.2 (Bronk Ramsey, 1995; 2001 and 2007) and the IntCal13 atmospheric curve (Reimer *et al.*, 2013). The results are displayed in Figure 12 and in Table 6.

Pollen analysis

Ten sub-samples from borehole <QBH1> were extracted for pollen analysis. The pollen was extracted as follows: (1) sampling a standard volume of sediment (1ml); (2) adding two tablets of the exotic clubmoss *Lycopodium clavatum* to provide a measure of pollen concentration in each sample; (3) deflocculation of the sample in 1% Sodium pyrophosphate; (4) sieving of the sample to remove coarse mineral and organic fractions (>125µ); (5) acetolysis; (6) removal of finer minerogenic fraction using Sodium polytungstate (specific gravity of 2.0g/cm^3); (7) mounting of the sample in glycerol jelly. Each stage of the procedure was preceded and followed by thorough sample cleaning in filtered distilled water. Quality control is maintained by periodic checking of residues, and assembling sample batches from various depths to test for systematic laboratory effects. Pollen grains and spores were identified using the University of Reading pollen type collection and the following sources of keys and photographs: Moore *et al* (1991); Reille (1992). The analysis procedure consists of counting the pollen and spores present until a count of 300 total land pollen is (TLP) is reached. This consists of tree, shrub and herb taxa; aquatics and spores are counted as a percentage of total land pollen. Pollen grains and spores were identified using the University of Reading pollen type collection and the following sources of keys and photographs: Moore *et al* (1991); Reille (1992). The results are displayed in Figure 13.

Macrofossil assessment

A total of seven small bulk samples from borehole <QBH1> were extracted for the recovery of macrofossil remains including waterlogged plant macrofossils, waterlogged wood, insects and Mollusca. The extraction process involved the following procedures: (1) removing a sample up to 10cm in thickness; (2) measuring the sample volume by water displacement, and (3) processing the sample by wet sieving using 300µm and 1mm mesh sizes. Each sample was scanned under a stereozoom microscope at x7-45 magnifications, and sorted into the different macrofossil classes. The concentration and preservation of remains was estimated for each class of macrofossil. Preliminary identifications of the waterlogged seeds have been made using modern comparative material and reference atlases (Cappers *et al.* 2006). Nomenclature used follows Stace (2005) (Table 8).

RESULTS AND INTERPRETATION OF THE LITHOSTRATIGRAPHIC DESCRIPTIONS, DEPOSIT MODELLING, ORGANIC MATTER CONTENT AND RADIOCARBON DATING

The lithostratigraphic description of boreholes <QBH1> to <QBH3> and quantification of the organic matter content (<QBH1>) are displayed in Figure 12 and Tables 2 to 5. The results of the deposit modelling are displayed in Figures 3 to 10. Figures 3 to 8 provide surface elevation and thickness models for each of the main stratigraphic units, whilst Figures 9 and 10 provide 2-Dimensional west-east and north-south transects across the site respectively. The results of the deposit modelling demonstrate that a sufficient number and spread of boreholes have been put down to permit modelling across the majority of the site.

The basal unit recorded in the deposit model for the site is a horizon of sand and gravel (the Shepperton Gravel). These sediments were deposited during the Late Devensian (Marine Isotope Stage 2, *ca*. 16,000-11,500 cal BP), within a high energy braided river system. The surface of this unit is relatively even across the site, recorded at between *ca*. -3.5 and -4.0m OD in the majority of boreholes (Figure 3). The Gravel surface rises in the northern part of the site however towards borehole BH2, where it was recorded at -2.8m OD, and to the east to -3.21m OD in the area of <QBH3>. Southeast of the site the Gravel surface falls in the area of BGS borehole TQ37NE2157 to -4.9m OD. Where the Shepperton Gravel is recorded at its lowest in boreholes BH7 and TQ37NE2157, and geoarchaeological boreholes <QBH1> and <QBH2>, it is overlain by a horizon of sand, between -4.01 and -4.08m OD in <QBH1> (less than 1% organic content; Table 5), -3.85 and -4.47m OD in <QBH2>, -3.86 and -4.06 in BH7 and -4.4 and -4.9m OD in TQ37NE2157. Where this unit is recorded, it is indicative of a gradual reduction in flow rate from that which deposited the coarser Shepperton Gravel, and was most likely deposited within depressions in the Gravel surface during the Early Holocene. Elsewhere, the Shepperton Gravel is overlain by sandy or clayey silt with frequent detrital organic inclusions of wood or herbaceous material, which in borehole <QBH1> contains generally less than 5% organic content (Table 5; Figure 12). This unit is considered to represent the Lower Alluvium, and is indicative of the former presence of low energy fluvial or estuarine conditions during the Early to Middle Holocene. The surface of this unit across the site lies at between -0.5 and -2.5m OD (Figure 4), generally sloping down towards the east of the site, falling from -0.5m OD in borehole BH3 in the west to -2.8 (BH2) and -2.45m OD (BH5) in the east. Beyond the southeastern margin of the site the surface of the Lower Alluvium lies at -3.7m OD in borehole TQ37NE2157.

In borehole <QBH1> a Peat horizon is recorded within the Lower Alluvium between -2.61 and -2.77m OD (up to 80% organic content), generally lower than that the Peat horizons recorded elsewhere and perhaps indicative of a localised transition towards semi-terrestrial conditions that occurred earlier at this location. This horizon is overlain by silty clay Alluvium (indicative of flooding of the Peat surface). Elsewhere, and in all boreholes except BH6 (where Peat is absent), the Lower Alluvium is overlain by a generally woody or herbaceous Peat horizon which lies at between 0.0 and -2.5m OD, and is generally between 0.5 and 2m thick (Figures 5 and 6). In boreholes <QBH1>, <QBH2> and <QBH3> the Peat horizon is woody, and is recorded between -0.84 and -2.11m OD (<QBH1>; up to 80% organic content), -0.60 and -2.36m OD (<QBH2>) and -0.41 and -2.41m OD (<QBH3>). Beyond the southeastern margin of the site, the Peat was recorded as 3.3m thick in borehole TQ37N2157, between -0.4 and -3.7m OD. The Peat formation is indicative of a transition to semi-terrestrial conditions across the site, supporting the growth of wetland vegetation including herbaceous and woody taxa. Radiocarbon dating of borehole <QBH1> (-2.06 to -2.11m OD) indicates that this transition occurred during the Middle Neolithic (between 5450-5070 and 5290-4980 cal BP; Table 6).

Notably, in almost all boreholes the Peat is separated by a horizon of organic clayey silt (up to 35% organic in borehole <QBH1>), of variable thicknesses between *ca*. 0.5 and 1.0m but generally recorded between *ca*. -1.0 and -2.0m OD. Although not recorded at exactly the same elevation in all boreholes, this horizon may represent a broadly contemporaneous episode of flood events which brought an influx of mineral-rich material across the Peat surface. In borehole <QBH1> Peat formation had re-commenced by the Late Neolithic/Early Bronze Age (4420-4240 cal BP; -1.48 to -1.53m OD).

The Peat is overlain across the site at between -0.5 and 0.0m OD by a horizon of silty clay, with occasional detrital organic matter and Mollusca fragments (generally <10% organic content), referred to here as the Upper Alluvium. This unit is representative of flooding of the Peat surface, and occurred around 3390-3370 cal BP. The surface of the Upper Alluvium is relatively even across the site, generally lying at between 1.0 and 0.5m OD (Figure 7). The Upper Alluvium is overlain by variable thicknesses of Made Ground (1-3m; Figure 9); the Made Ground is thickest towards the west, where it is recorded in borehole BH3 at 2.45m thick, and in BGS borehole TQ37NE1998 (just beyond the northwest margin of the site) at 4.0m thick. The modern surface of the site generally lies at between 2.5 and 2.0m OD.

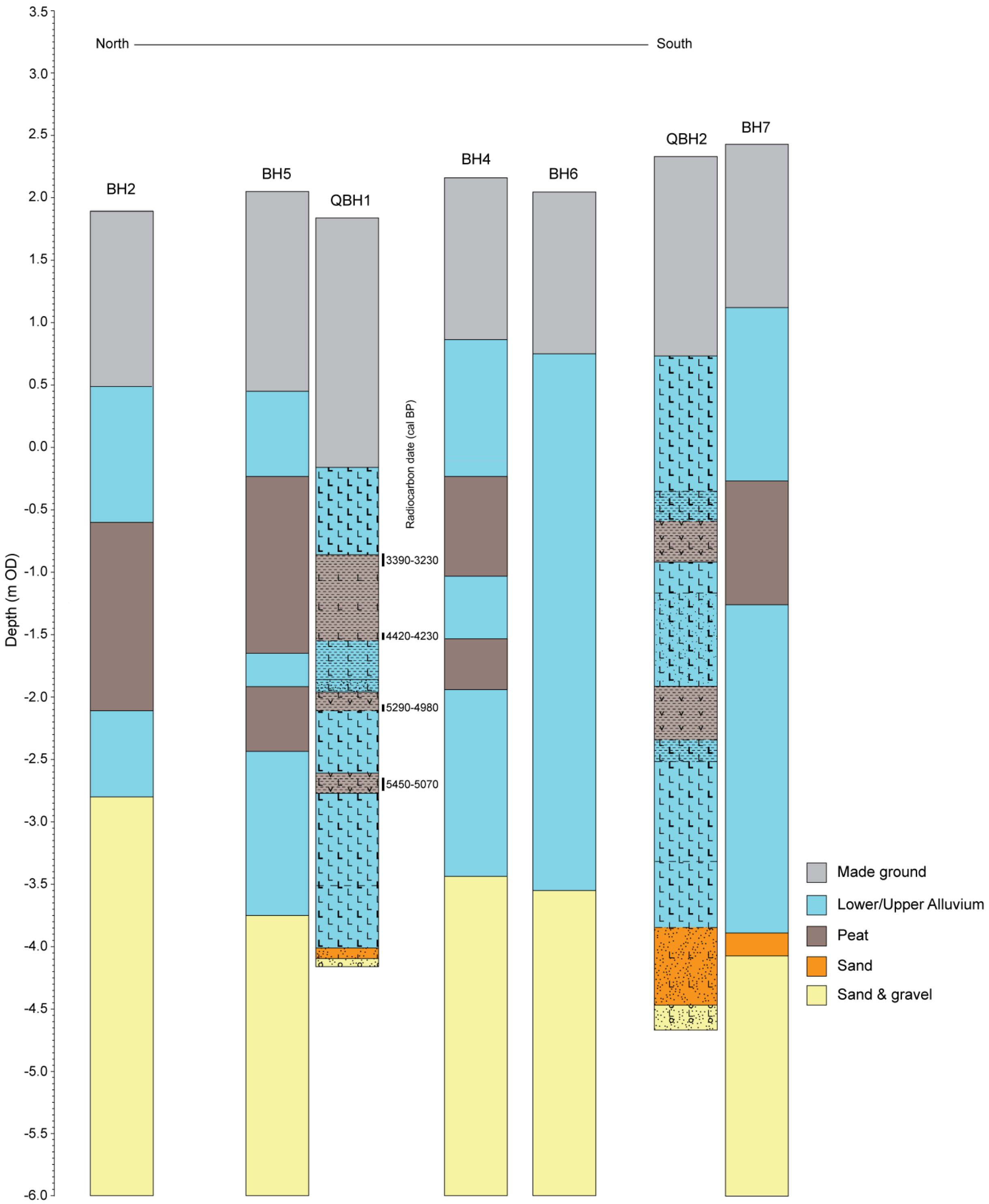

Figure 3: North-south transect of geoarchaeological and geotechnical boreholes across the site at Enderby Wharf, Christchurch Way, London Borough of Greenwich

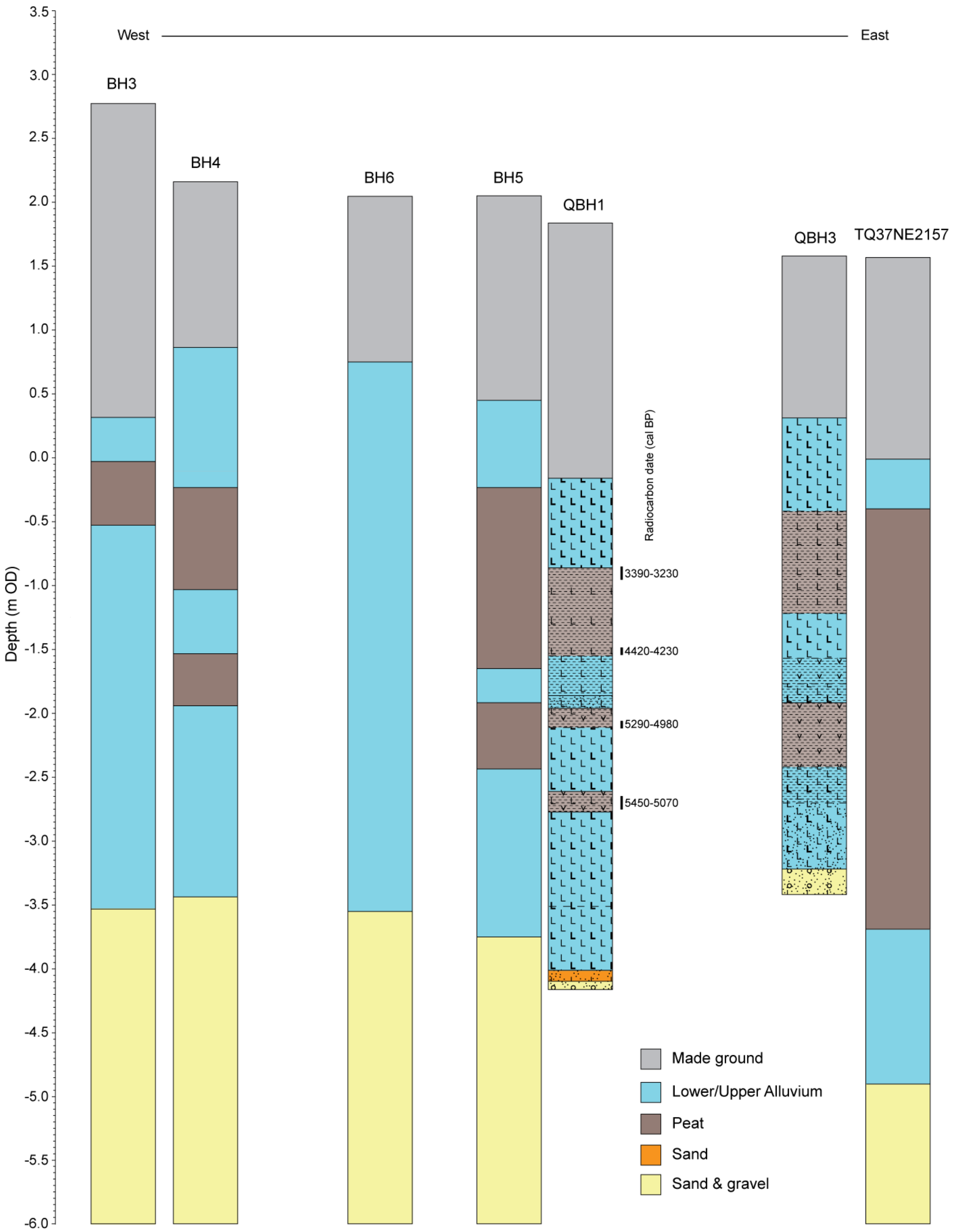

Figure 4: West-East transect of geoarchaeological and geotechnical boreholes across the site at Enderby Wharf, Christchurch Way, London Borough of Greenwich

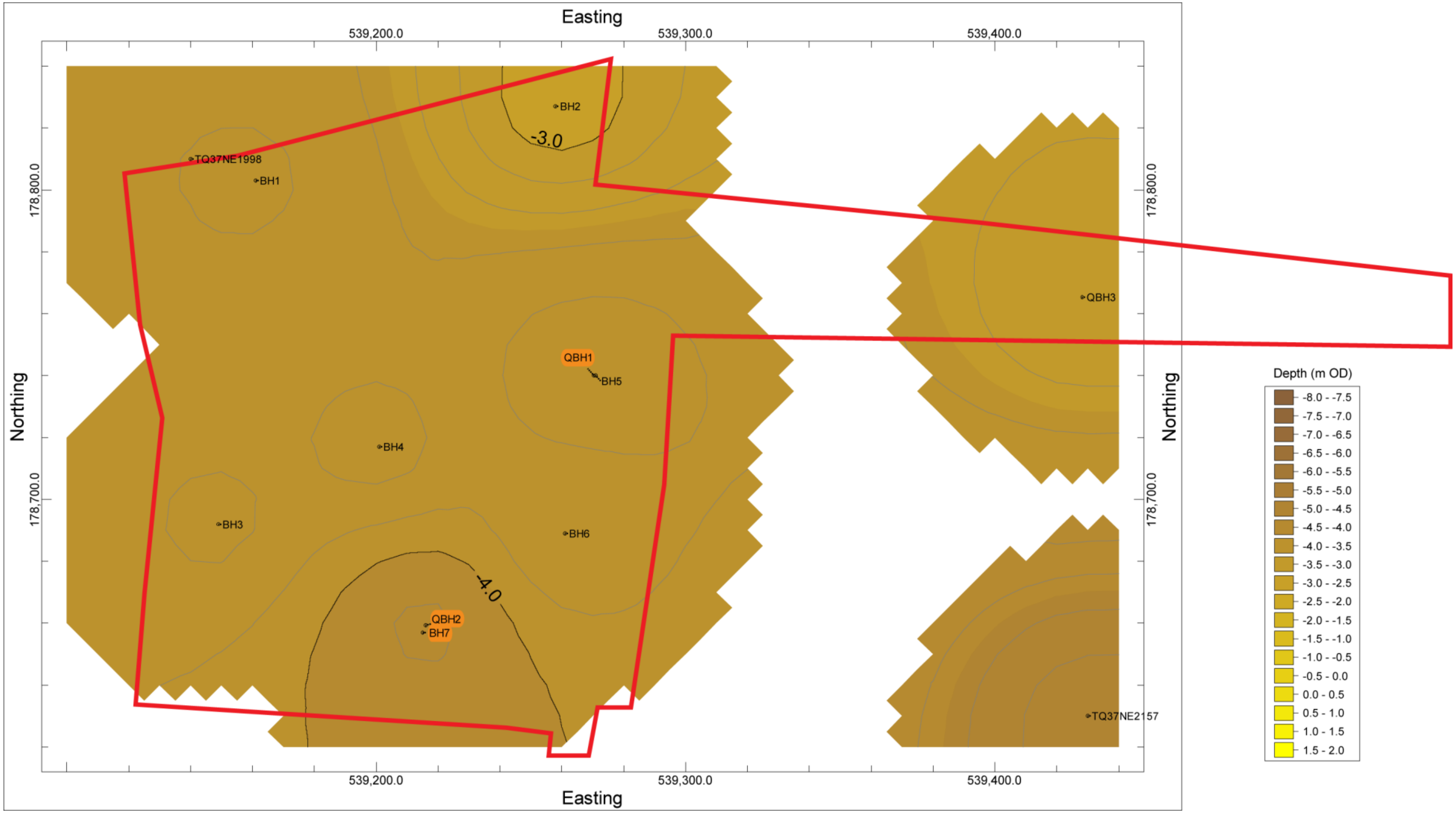

Figure 5: Modelled surface of the Shepperton Gravel (contour heights in metres OD). Where the Shepperton Gravel is overlain by sand these boreholes are highlighted in orange.

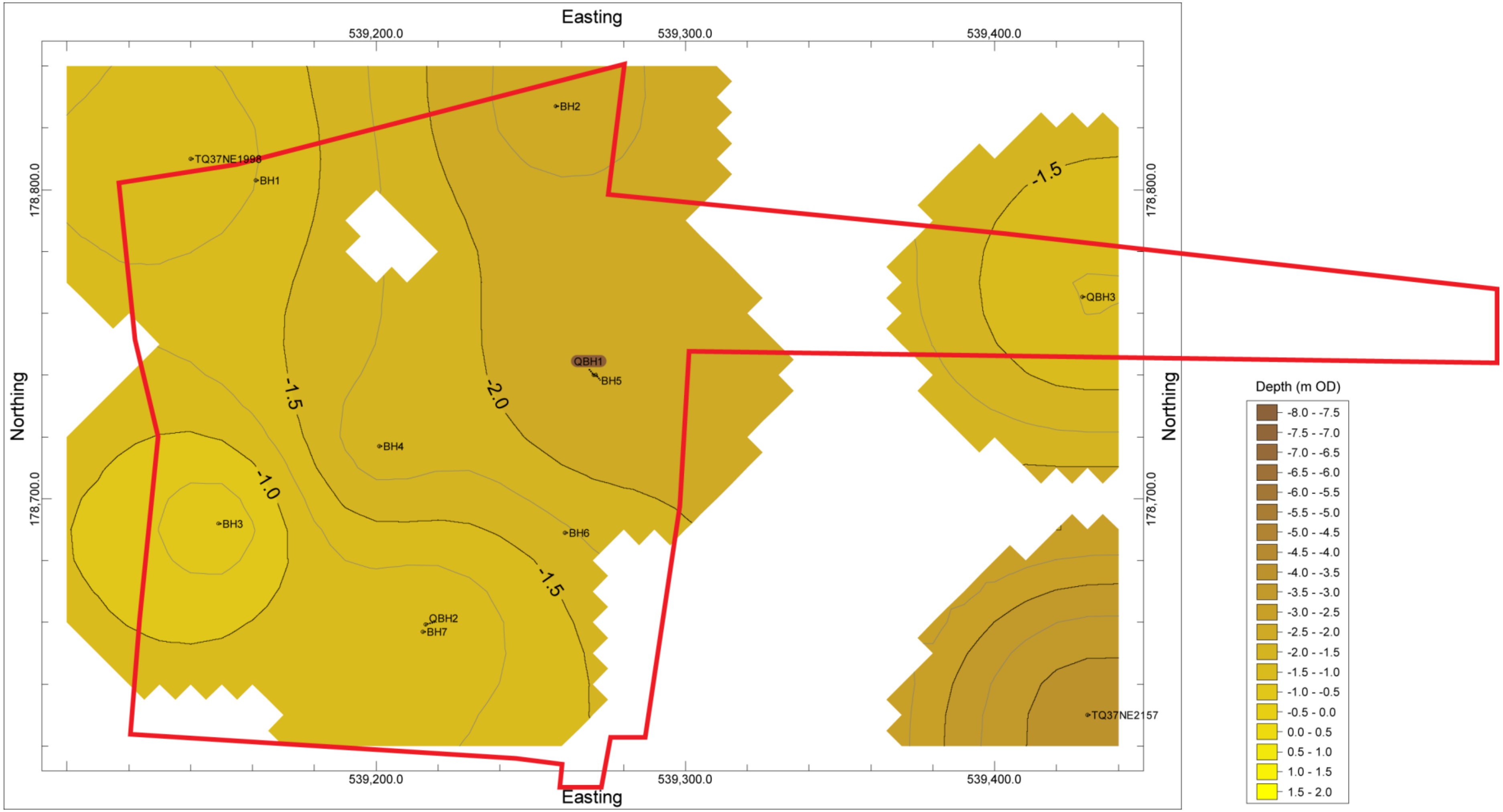

Figure 6: Modelled surface of the Lower Alluvium (contour heights in metres OD). The Lower Alluvium contains a silty Peat at the location of <QBH1> (highlighted in brown).

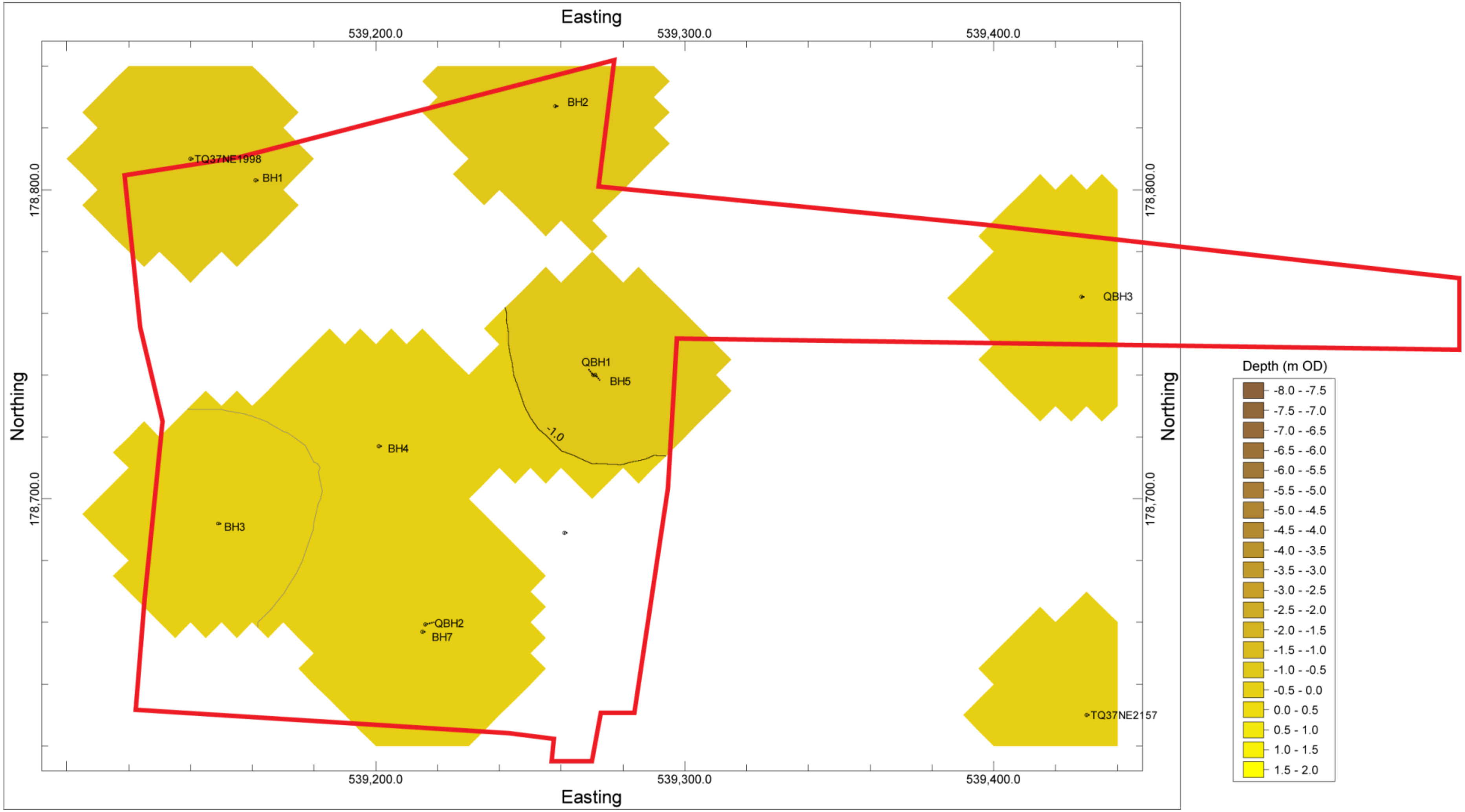

Figure 7: Modelled surface of the Peat horizon (contour heights in metres OD).

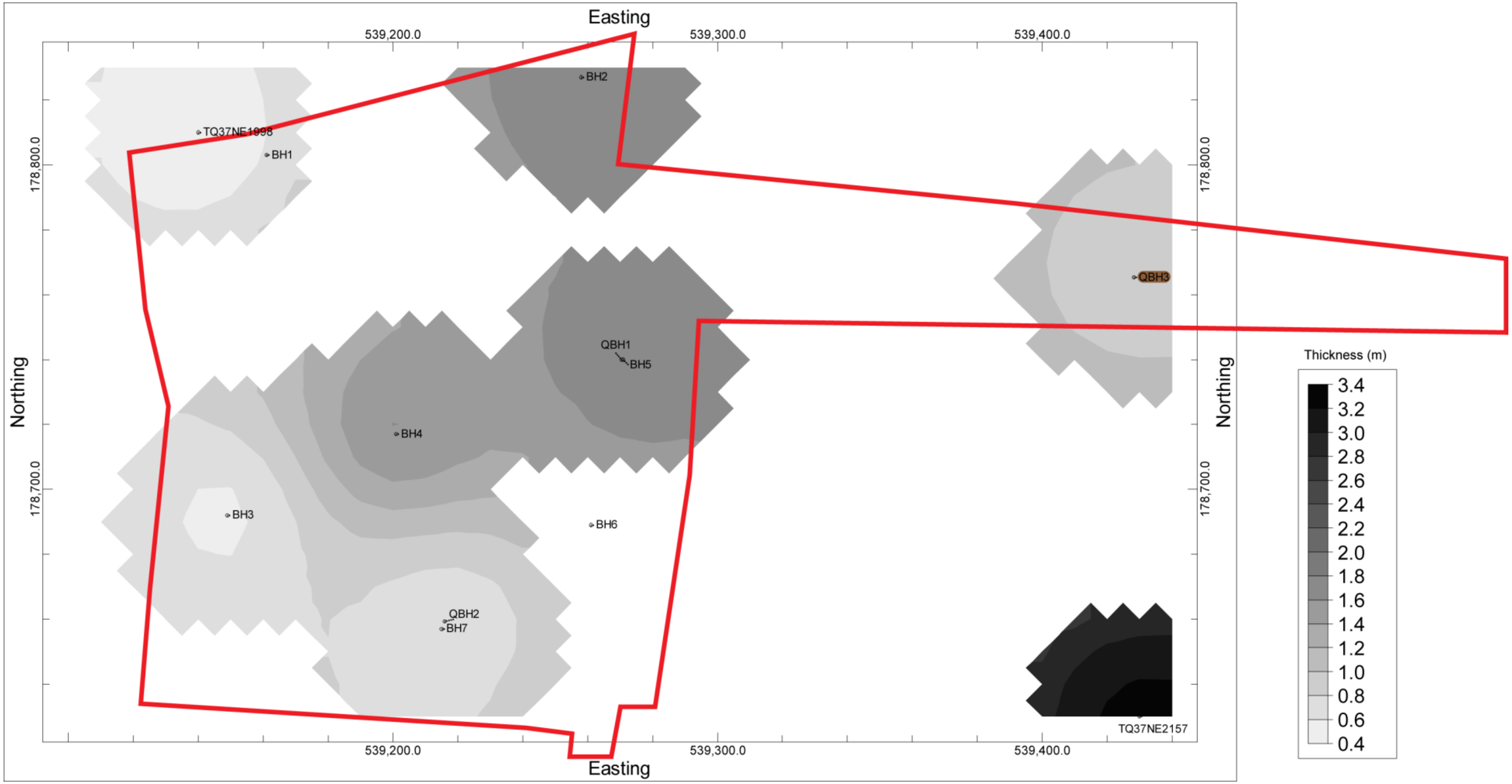

Figure 8: Modelled thickness of the Peat/organic sediment complex (metres).

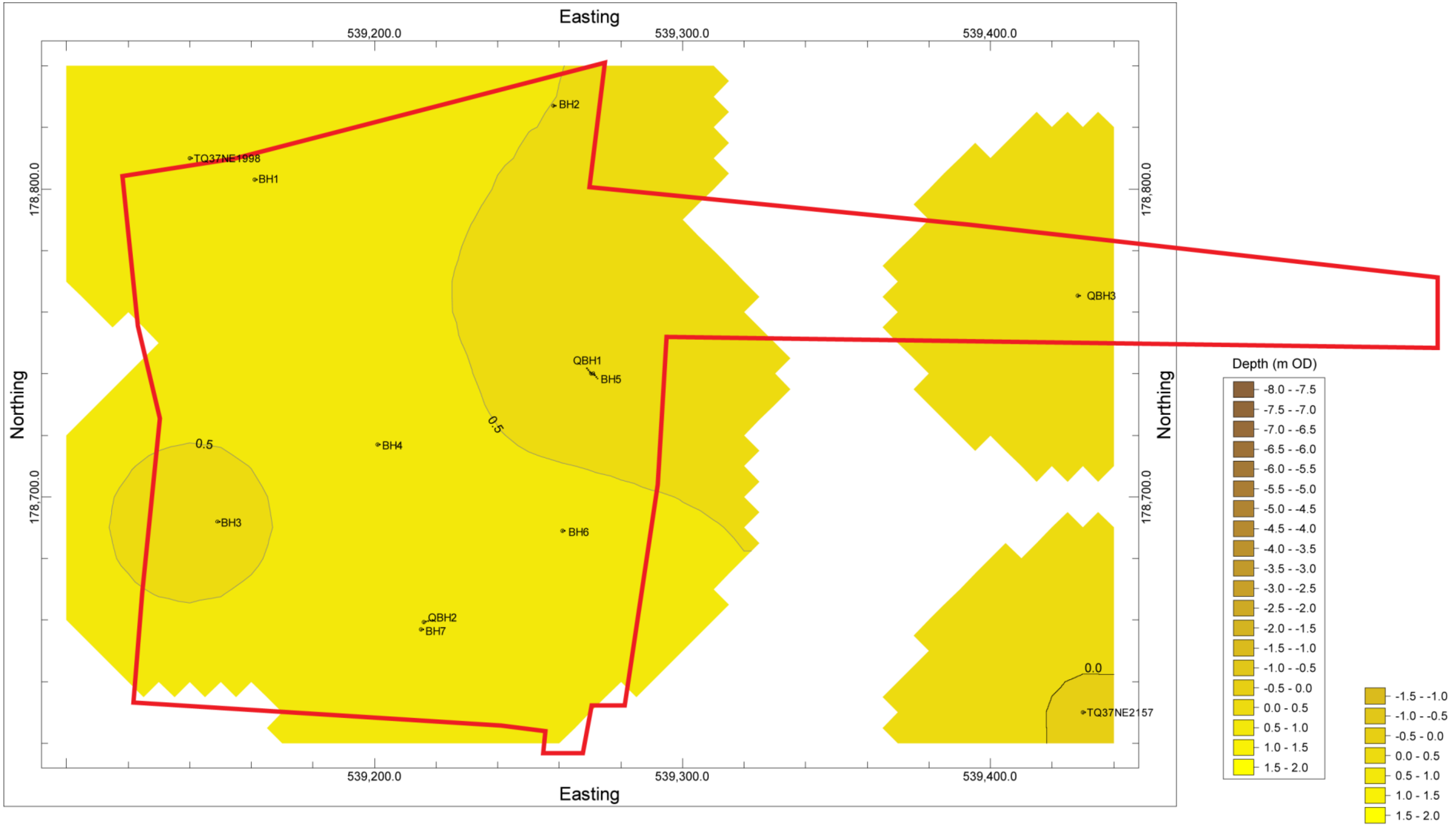

Figure 9: Modelled surface of the Upper Alluvium (contour heights in metres OD)

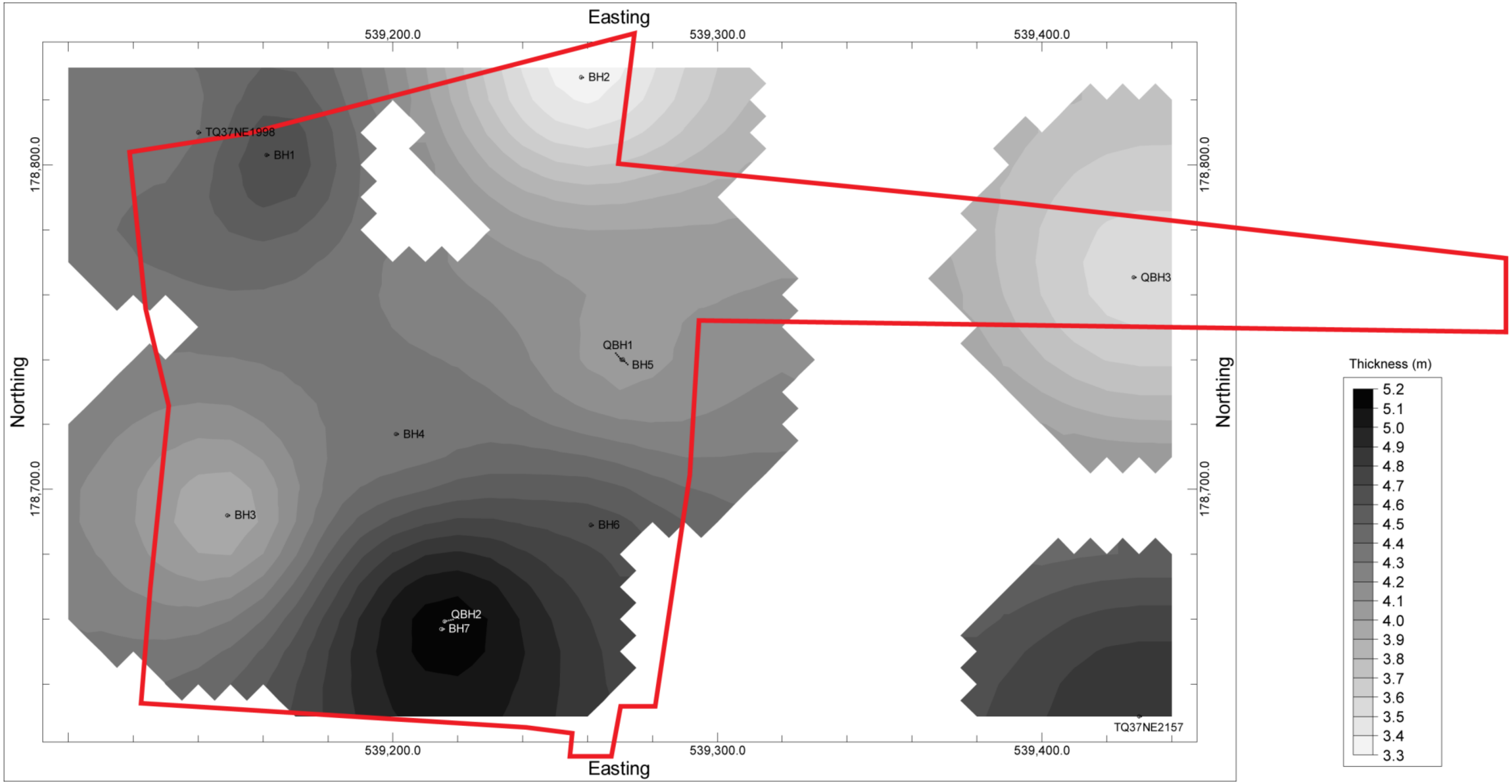

Figure 10: Modelled thickness of the combined Alluvium (incorporating the Lower Alluvium, Peat and Upper Alluvium) (metres)

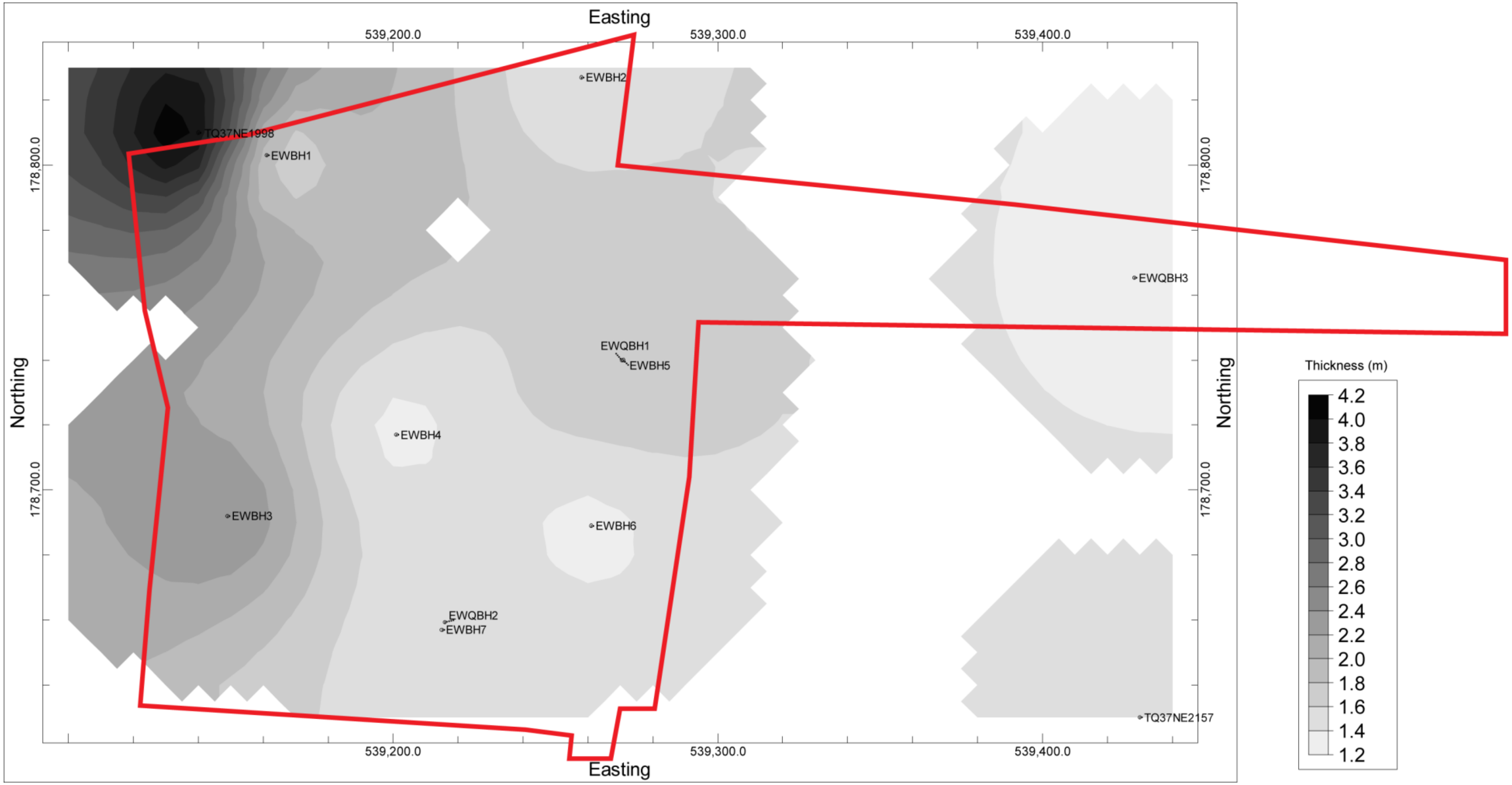

Figure 11: Modelled thickness of the Made Ground (metres)

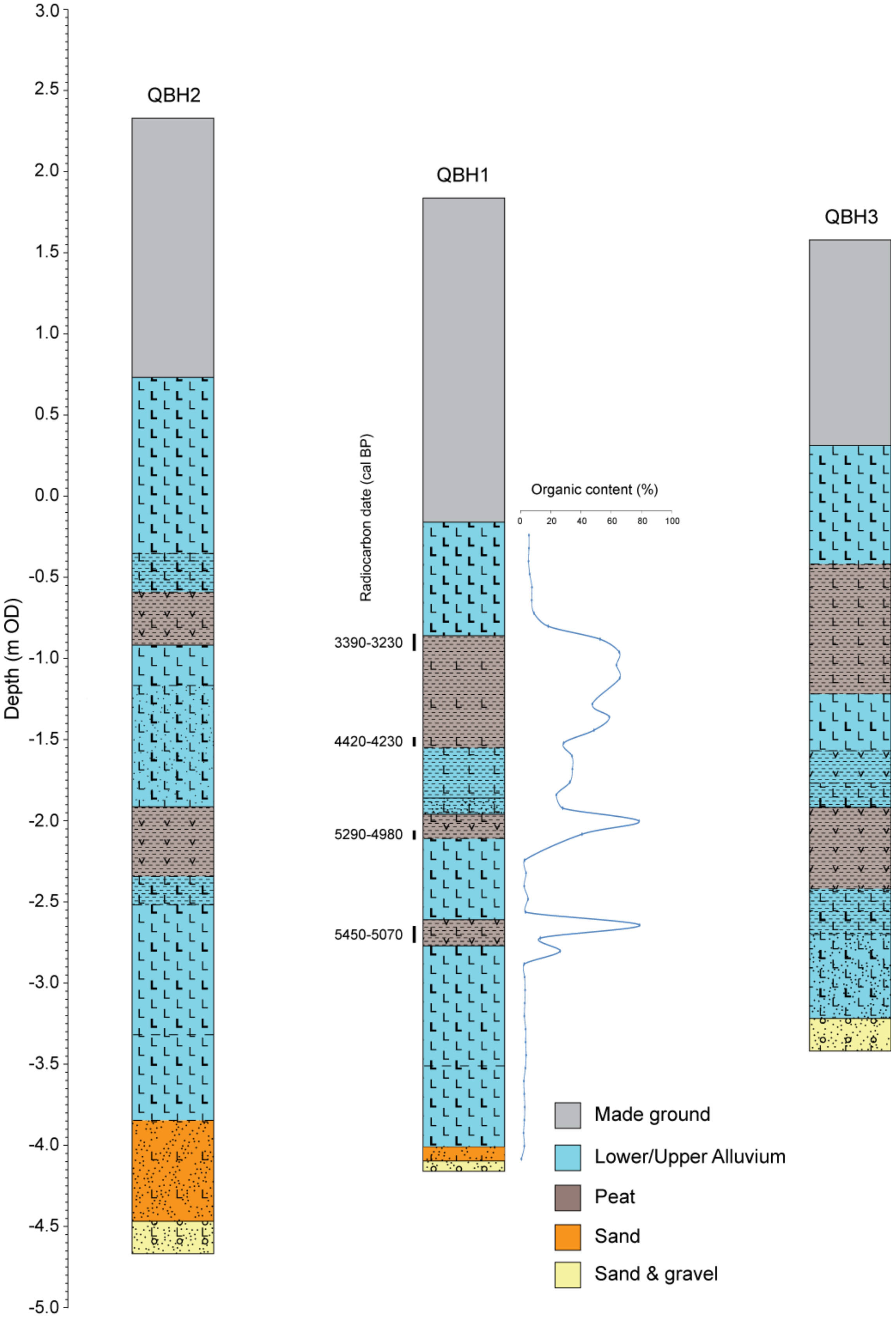

Figure 12: Results of the borehole <QBH1>, <QBH2> and <QBH3> lithostratigraphic analysis, incorporating lithostratigraphic descriptions and organic matter content, plotted with associated radiocarbon dates, Enderby Wharf, Christchurch Way, London Borough of Greenwich

Table 2: Lithostratigraphic description of borehole <QBH1>, Enderby Wharf, Christchurch Way, London Borough of Greenwich

Depth (m OD)	Depth (m bgs)	Composition
1.84 to -0.16	0.00 to 2.00	Made Ground
-0.16 to -0.84	2.00 to 2.68	Gley 1 5/10Y; As3 Ag1; greenish grey silty clay. Sharp contact in to:
-0.84 to -1.53	2.68 to 3.37	2.5YR 2.5/1; Sh3 Ag1 Tl+ Th+; Humo. 2; reddish black moderately humified silty peat with traces of herbaceous and woody material. Diffuse contact in to:
-1.53 to -1.88	3.37 to 3.72	7.5YR 4/1; Sh2 Ag2 Tl+ Th+; Humo. 3; dark grey well humified silt and peat with a trace of herbaceous and woody material. Sharp contact in to:
-1.88 to -1.95	3.72 to 3.79	Ag2 Ga1 Sh1 Dh+; horizontal beds of sandy silt or organic silt with traces of detrital herbaceous material. Beds are 8-4mm in thickness. Sharp contact in to:
-1.95 to -2.11	3.79 to 3.95	2.5YR 2.5/1; Sh2 Tl^{1}1 Ag1; Humo. 2; reddish black moderately humified silty herbaceous peat. Diffuse contact in to:
-2.11 to -2.61	3.95 to 4.45	Gley 1 5/10Y; Ag3 As1 Dl+ Sh+; greenish grey clayey silt with traces of detrital wood and organic matter. Sharp contact in to:
-2.61 to -2.77	4.45 to 4.61	10YR 2/1; Sh2 Ag1 Dl/Tl^{1}1; Humo. 2; black moderately humified silty peat with detrital or in situ woody material. Sharp contact in to:
-2.77 to -3.51	4.61 to 5.35	Gley 1 4/10Y; Ag2 As2; dark greenish grey silt and clay.
-3.51 to -4.01	5.35 to 5.85	Gley 1 4/10Y; Ag2 As2; dark greenish grey silt and clay. Sharp contact in to:
-4.01 to -4.08	5.85 to 5.92	Gley 1 4/10Y; Ga3 Ag1; dark greenish grey silty sand. Sharp contact in to:
-4.08 to -4.16	5.92 to 6.00	Gg3 Ga1; sandy gravel.

Table 3: Lithostratigraphic description of borehole <QBH2>, Enderby Wharf, Christchurch Way, London Borough of Greenwich

Depth (m OD)	Depth (m bgs)	Composition
2.32 to 0.72	0.00 to 1.60	Made Ground
0.72 to -0.37	1.60 to 2.69	Gley 1 5/10Y; Ag2 As2; greenish grey silt and clay with some calcareous nodules. Diffuse contact in to:
-0.37 to -0.60	2.69 to 2.92	10YR 3/2; Ag2 As1 Sh1; very dark greyish brown organic clayey silt. Diffuse contact in to:
-0.60 to -0.93	2.92 to 3.25	2.5YR 2.5/1; Sh2 Ag1 Tl^{2}1; Humo. 2; reddish black moderately humified silty woody peat. Sharp contact in to:
-0.93 to -1.18	3.25 to 3.50	Gley 1 4/N; Ag3 As1 Ga+; dark grey clayey silt with a trace of sand. Diffuse contact in to:
-1.18 to -1.93	3.50 to 4.25	Gley 1 4/N; Ag2 Ga1 As1 Dh+; dark grey sandy clay silt with some horizontal bedding. Sharp contact in to:
-1.93 to -2.36	4.25 to 4.68	2.5YR 2.5/1; Sh3 Tl^{2}1 Ag+; Humo. 2; reddish black moderately humified woody peat with a trace of silt. Diffuse contact in to:
-2.36 to -2.52	4.68 to 4.84	10YR 2/1; Ag2 As1 Sh1; black organic clayey silt. Diffuse contact in to:
-2.52 to -3.33	4.84 to 5.65	Gley 1 3/10Y; Ag3 As1 Dl+; very dark greenish grey clayey silt with a trace of detrital wood. Diffuse contact

		in to:
-3.33 to -3.85	5.65 to 6.17	Gley 1 6/10Y; Ag3 As1 Dl+; greenish grey clayey silt with a trace of detrital wood and some calcareous nodules. Diffuse contact in to:
-3.85 to -4.47	6.17 to 6.79	Gley 1 4/10Y; Ga3 Ag1; dark greenish grey silty sand. Sharp contact in to:
-4.47 to -4.68	6.79 to 7.00	Gley 1 4/10Y; Gg2 Ga1 Ag1; dark greenish grey silty sandy gravel.

Table 4: Lithostratigraphic description of borehole <QBH3>, Enderby Wharf, Christchurch Way, London Borough of Greenwich

Depth (m OD)	Depth (m bgs)	Composition
1.59 to 0.32	0.00 to 1.27	Made Ground
0.32 to -0.41	1.27 to 2.00	10YR 4/2; As2 Ag2; dark greyish brown silt and clay with some calcareous nodules. Some iron staining.
-0.41 to -1.21	2.00 to 2.80	10YR 2/1; Sh2 Ag2 Dl/Tl+; Humo. 3; black well humified silt and peat with a trace of detrital or in situ wood. Diffuse contact in to:
-1.21 to -1.54	2.80 to 3.13	Gley 1 4/10Y; Ag3 As1 Dh+; dark greenish grey clayey silt with a trace of detrital herbaceous material. Diffuse contact in to:
-1.54 to -1.76	3.13 to 3.35	10YR 4/1; Ag3 Sh1 Dh+; dark grey organic silt with a trace of detrital herbaceous material. Diffuse contact in to:
-1.76 to -1.89	3.35 to 3.48	Gley 1 4/10Y; Ag3 As1 Dh+; dark greenish grey clayey silt with a trace of detrital herbaceous material. Sharp contact in to:
-1.89 to -2.41	3.48 to 4.00	2.5YR 2.5/1; Sh3 Tl^{2}1 Th+ Ag+; Humo. 2/3; moderately to well humified woody peat with traces of herbaceous material and silt.
-2.41 to -2.68	4.00 to 4.27	10YR 2/1; Ag2 As1 Sh1 Dh+; black organic clayey silt with a trace of detrital herbaceous material. Diffuse contact in to:
-2.68 to -3.21	4.27 to 4.80	Gley 1 3/10Y; Ag2 As1 Ga1 Dh+; very dark greenish grey clayey sandy silt with a trace of detrital herbaceous material. Sharp contact in to:
-3.21 to -3.41	4.80 to 5.00	Gley 1 3/10Y; Gg2 Ga1 Ag1; very dark greenish grey sandy silty gravel.

Table 5: Results of the borehole <QBH1> organic matter determinations, Enderby Wharf, Christchurch Way, London Borough of Greenwich

Depth (m OD)		Organic matter content (%)
From	To	
-0.24	-0.25	5.59
-0.32	-0.33	5.60
-0.40	-0.41	5.33
-0.48	-0.49	6.13
-0.56	-0.57	7.61
-0.64	-0.65	7.48
-0.72	-0.73	8.97
-0.80	-0.81	18.31
-0.88	-0.89	52.64
-0.96	-0.97	65.30

-1.04	-1.05	63.50
-1.12	-1.13	65.59
-1.28	-1.29	47.57
-1.36	-1.37	58.71
-1.44	-1.45	48.62
-1.52	-1.53	28.56
-1.60	-1.61	34.09
-1.68	-1.69	34.33
-1.76	-1.77	32.66
-1.84	-1.85	23.70
-1.92	-1.93	27.99
-2.00	-2.01	78.38
-2.08	-2.09	40.71
-2.24	-2.25	2.79
-2.32	-2.33	3.71
-2.40	-2.41	2.48
-2.48	-2.49	5.04
-2.56	-2.57	3.38
-2.64	-2.65	78.70
-2.72	-2.73	13.09
-2.80	-2.81	26.25
-2.88	-2.89	2.47
-2.96	-2.97	2.79
-3.04	-3.05	3.10
-3.12	-3.13	2.87
-3.20	-3.21	2.60
-3.28	-3.29	3.44
-3.36	-3.37	3.42
-3.44	-3.45	3.75
-3.52	-3.53	3.28
-3.60	-3.61	2.25
-3.68	-3.69	2.50
-3.76	-3.77	2.87
-3.84	-3.85	2.61
-3.92	-3.93	2.06
-4.00	-4.01	2.56
-4.08	-4.09	0.64

Table 6: Results of the borehole <QBH1> radiocarbon dating, Enderby Wharf, Christchurch Way, London Borough of Greenwich

Laboratory code / Method	Material and location	Depth (m OD)	Uncalibrated radiocarbon years before present (yr BP)	Calibrated age BC/AD (BP) (2-sigma, 95.4% probability)	δ13C (‰)
BETA-408999	Twig wood; top of upper peat	-0.86 to -0.96	3110 ± 30	1440-1280 cal BC (3390-3230 cal BP)	-28.1
SUERC-50522 (GU33051)	Twig wood; base of upper peat	-1.48 to -1.53	3879 ± 27	2470-2280 cal BC (4420-4230 cal BP)	-28.6
SUERC-50523 (GU33052)	Twig wood; base of middle peat	-2.06 to -2.11	4480 ± 29	3340-3030 cal BC (5290-4980 cal BP)	-28.5
BETA-408998	Twig wood; base of lower peat	-2.66 to -2.76	4590 ± 30	3500-3120 cal BC (5450-5070 cal BP)	-27.7

RESULTS AND INTERPRETATION OF THE POLLEN ANALYSIS

Results of the pollen analysis

Figure 13 has been divided into two local pollen assemblage zones (LPAZs END1 & 2) based upon the results of the pollen-stratigraphical analysis.

LPAZ END1 -2.72 to -1.96m OD *Alnus* – *Quercus* – Cyperaceae

This zone is characterised by high values of tree pollen (65%): *Alnus* dominates (40%) with *Quercus* (20%), *Tilia*, *Pinus*, *Ulmus* (all <5%) and sporadic occurrences of *Fraxinus* and *Betula*. Shrubs (10%) are dominated by *Corylus* type with sporadic occurrences of *Salix* and *Hedera*. Herbs are dominated by Cyperaceae (20%) with Poaceae (5%), Apiaceae, Lactuceae, *Artemisia*, *Plantago lanceolata, Chenopodium* type and *Sinapis* type (all <2%). Aquatic taxa are represented by *Sparganium* type only (<2%). Spores are dominated by *Filicales* (50-<5%) with *Pteridium aquilinum* and *Polypodium vulgare*.

LPAZ END2 -1.96 to -0.87m OD *Alnus* – *Quercus* – *Corylus* type

This zone is characterised by an increase in tree pollen percentage values (ca. 80%): *Alnus* dominates (60%) with *Quercus* (20%), *Tilia* (10%), *Pinus*, *Ulmus, Taxus, Fraxinus* (all <5%) and sporadic occurrences of *Betula*. Shrubs (10%) are dominated by *Corylus* type (10%) with *Salix, Hedera, Vibernum* and *Sambucas nigra*. Herbs (*ca*. 10%) comprise Cyperaceae, Poaceae, Apiaceae, Lactuceae, *Chenopodium* type, *Artemisia*, *Plantago lanceolata, Rumex acetosa/acetosella, Ranunculus* type and *Sinapis* type. Aquatic values are limited including sporadic occurrences of *Sparganium* type, *Potamogeton* type, *Typha latifolia* and *Menyanthes trifoliata* (<2%). Spores are dominated by *Filicales* (50-<5%) with *Pteridium aquilinum* and *Polypodium vulgare*.

Interpretation of the pollen analysis

The results of the pollen-stratigraphical analysis indicate that during LPAZ END-1 (5450-5070 to 5290-4980 cal BP), *Alnus* (alder) and Salix (willow) occupied the wetland environment, with an understorey comprising Poaceae (grasses, e.g. *Phragmites australis* - reeds), Cyperaceae (sedges), Sparganium type (bur-reed) *Filicales* (ferns) and *Polypodium vulgare* (polypody fern). The relatively high ratio of Cyperaceae pollen to that of Alnus indicates that this wetland community was relatively damp, most likely forming alder-carr swamp and sedge fen communities with areas of still/standing water, as opposed to a more mature and dry fen-carr woodland community. *Chenopodium* type pollen is also recorded throughout this period, perhaps indicating the influence of saline conditions at the site. Genera of the family Chenopodiaceae (goosefoot family) may be found growing in two main locations: (1) waste, dry ground and cultivated land (e.g. *Chenopodium album* – fat hen), and (2) salt marshes (e.g. *Suaeda maritima* – annual sea-blite). Although the former may be growing on nearby dryland, it is more likely that the presence of *Chenopodium* type pollen indicates fluvial inundation of the site and the influence of estuarine conditions.

Quercus (oak), *Betula* (birch), *Corylus* type (e.g. hazel), *Hedera* (ivy) and possibly *Ulmus* (elm) may have accompanied alder on the floodplain surface. However, these taxa more commonly occur on the dryland where they would have formed a mosaic of mixed deciduous woodland with *Tilia* (lime). The entomophilous (insect pollinated) nature of *Tilia* suggests that even low percentages of pollen can represent the considerable growth of lime on the dryland. The limited values of *Ulmus* pollen however, indicate that the sequence post-dates the well-documented middle Holocene (early Neolithic) elm decline that occurred across the Lower Thames Valley and British Isles between 6347 and 5281 cal BP (Parker *et al*., 2002; Batchelor *et al*., 2014).

The transition into LPAZ END-2 (around 5290-4980 cal BP) is characterised by a decline in sedges and willow values and increase of tree taxa (specifically alder). This change in taxa is indicative of a transition on the wetland from alder-willow swamp carr and sedge fen communities to more mature and drier fen carr woodland. Changes in the structure and composition of the dryland woodland are also indicated as both lime and elm pollen percentage values increase relative to oak. The increased occurrence of elm pollen after 5290-4980 cal BP is of some interest, as it correlates with other recent pollen and macrofossil records from various sites along the Lower Thames Valley (such as Barking Riverside (Green *et al*., 2014), Norman Road (Batchelor *et al*., 2009) and the Erith Foreshore (Seel, 2001)). Combined, these records suggest that elm may have formed a component of the floodplain woodland during the late Neolithic and Bronze Age after its decline from the dryland around the Mesolithic/Neolithic transition.

Also of note is the occurrence of *Taxus* pollen from *ca*. 4420-4230 cal BP indicating the nearby growth of yew woodland, potentially on the peat surface. The growth of yew on peat during the Middle Holocene is now a well-documented occurrence, proven by multiple pollen, wood and plant macrofossil records across the Lower Thames Valley (e.g. Seel, 2001; Batchelor, 2009; Branch *et al*., 2012; Green *et al*., 2014). These records indicate that yew colonised a dry peat surface between approximately 5000 and 4000 cal BP; the occurrence of yew pollen at Enderby Wharf appears to be towards the end of this period. Furthermore, there are very few records demonstrating the growth of yew in this area of the Lower Thames Valley; this stratigraphic sequence has therefore increased our knowledge and understanding of the spatial extent of yew growth across Lower Thames Valley floodplain.

The final sample from the sequence at 3390-3320 cal BP is characterised by a decline in alder suggesting a reduction in woodland cover on the wetland. Instead, an increase in herb and aquatic taxa including grasses, sedges, bur-reed, bulrush (*Typha latifolia*) and pondweed (*Potamogeton* type) indicate the transition towards a wetter environment at the site. Elevated values of *Chenopodium* type may be suggestive of an estuarine influence during this period.

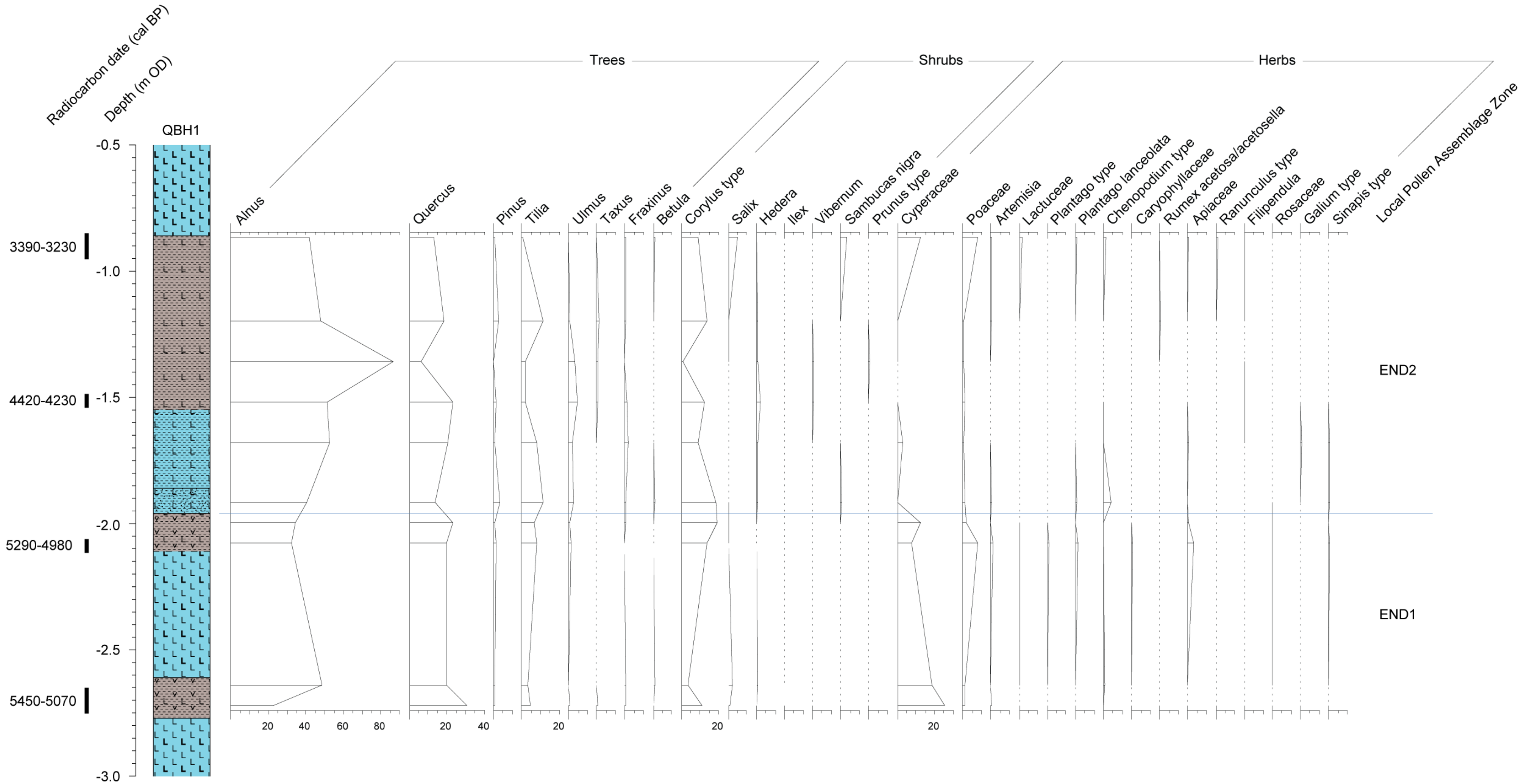

Figure 13: Pollen percentage diagram, <QBH1>, Enderby Wharf, Christchurch Way, London Borough of Greenwich

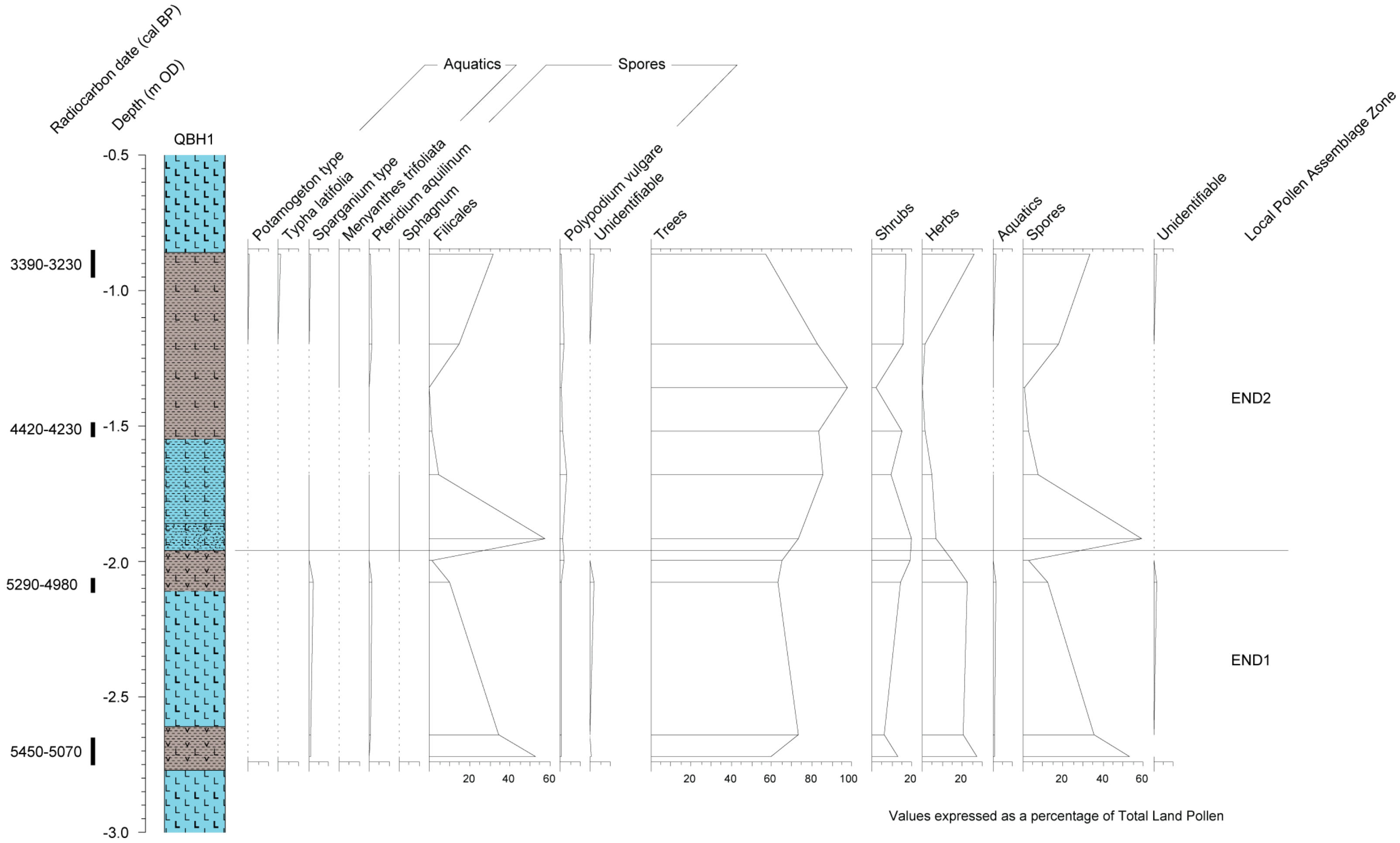

Figure 13: Pollen percentage diagram, <QBH1>, Enderby Wharf, Christchurch Way, London Borough of Greenwich

RESULTS AND INTERPRETATION OF THE MACROFOSSIL ASSESSMENT

A total of seven small bulk samples were extracted from borehole <QBH1> for the recovery of macrofossil remains including waterlogged plant macrofossils, waterlogged wood, insects and Mollusca (Table 7). The samples were focussed on the silty peat within the Lower Alluvium (-2.77 to -2.61m OD) and the sequence of peat and organic-rich sediments between -2.11 and -0.84m OD. The results of the macrofossil assessment indicate that charcoal was present in low quantities in one sample (-1.66 to -1.76m OD); however, charred remains were absent in the remainder of the samples. Insects, the majority of which were preserved as fragments, were present in moderate quantities in two samples (-0.86 to -0.96 and -1.06 to -1.16m OD) and in low quantities in three samples (-1.26 to -1.36, -2.66 to -2.76 and -1.66 to -1.76m OD).

Waterlogged wood was present in low to moderate quantities in all seven samples, whilst waterlogged seeds were present in low quantities in four samples (-0.86 to -0.96, -1.66 to -1.76, -1.26 to -1.36 and -1.06 to -1.16m OD). No Mollusca or bone were recorded in the seven samples assessed.

The combined seed assemblage comprised *Alnus glutinosa* (alder), *Ranunculus* cf. *repens* (cf. creeping buttercup), *Rumex*/*Polygonum* sp. (dock/sorrel/knotweed) and *Corylus avellana* (hazel). Whilst limited, the taxa recorded are typical of wetland fen environments; below -1.66m OD the assemblage is dominated by species indicative of wetland woodland (alder). The limited concentration of remains prevents any further interpretation of this assemblage.

Table 7: Results of the macrofossil assessment of borehole <QBH1>, Enderby Wharf, Christchurch Way, London Borough of Greenwich

				Charred					Waterlogged		Mollusca		Bone			
Depth (m OD)	**Volume sampled (l)**	**Volume processed (l)**	**Fraction**	**Charcoal (>4mm)**	**Charcoal (2-4mm)**	**Charcoal (<2mm)**	**Seeds**	**Chaff**	**Wood**	**Seeds**	**Whole**	**Fragments**	**Large**	**Small**	**Fragments**	**Insects**
-0.86 to -0.96	0.05	0.05	>300µm	-	-	-	-	-	2	*Ranunculus* cf. *repens* (creeping buttercup) (1)	-	-	-	-	-	2
-1.06 to -1.16	0.075	0.075	>300µm	-	-	-	-	-	2	Unidentified (1)	-	-	-	-	-	2
-1.26 to -1.36	0.05	0.05	>300µm	-	-	-	-	-	2	*Corylus avellana* nut shell (hazel) (1) *Rumex*/*Polygonum* sp. (dock/sorrel/knotweed) (1) *Ranunculus* cf. *repens* (creeping buttercup) (1)	-	-	-	-	-	1
-1.46 to -1.56	0.025	0.025	>300µm	-	-	-	-	-	1	-	-	-	-	-	-	-
-1.66 to -1.76	0.05	0.05	>300µm	1	1	-	-	-	1	*Alnus glutinosa* catkin (alder) (4) *Alnus glutinosa* fruit (alder) (1)	-	-	-	-	-	1
-1.96 to -2.06	0.05	0.05	>300µm	-	-	-	-	-	3	-	-	-	-	-	-	-
-2.66 to -2.76	0.025	0.025	>300µm	-	-	-	-	-	2	-	-	-	-	-	-	1

Key: 0 = Estimated Minimum Number of Specimens (MNS) = 0; 1 = 1 to 25; 2 = 26 to 50; 3 = 51 to 75; 4 = 76 to 100; 5 = 101+

DISCUSSION AND CONCLUSIONS

Sedimentary and hydrological history

The deposits recorded at Enderby Wharf are analogous to those recorded across much of the Lower Thames Valley, with a sequence of Shepperton Gravel overlain by Holocene alluvium (including peat), capped by Made Ground. The results of the deposit modelling have revealed that the altitude and relief of the Gravel surface is relatively even, lying at between *ca*. -3.5 and -4.0m OD across the site, before falling south-eastwards towards a possible Late Pleistocene/Early Holocene palaeochannel where the Gravel surface is recorded at -4.9m OD in BGS borehole TQ37NE2157. Enderby Wharf site lies *ca*. 300m southwest of Corcoran's (2002) Landscape Zone B, where the Sand and Gravel surface is described as lying at between -4 and -2m OD, and 'probably not overlain by sand'. The deposit model for the site shows that the surface of the Shepperton Gravel lies within this range. However, in boreholes QBH1, QBH2, BH7, and BGS borehole TQ37NE2157 (generally where the Gravel surface is recorded below -4.0m OD in the central and southern parts of the site), it is overlain by a horizon of sand. These boreholes thus show similarities to Corcoran's (2002) landscape zone D, where Gravel surfaces below -4m OD are often overlain by a horizon of sand that accumulated within palaeochannels most likely of late Pleistocene/early Holocene date. It is possible therefore that a palaeochannel is present in the area southeast of the Enderby Wharf site, and that the edge of this palaeochannel is recorded within the southeastern part of the site itself (in the area of boreholes QBH1, QBH2 and BH7). To the south of this possible palaeochannel, at the Bellot Street site (Branch *et al*., 2005) *ca*. 150m to the south of Enderby Wharf, the Shepperton Gravel surface is recorded substantially higher between -0.70 and -1.49m OD.

Elsewhere on Greenwich Peninsula, relatively high Shepperton Gravel surfaces (between *ca*. -1.0 and -1.7m OD) have been recorded at the Tunnel Avenue (Landscape Zone B; Batchelor, 2013) and Victoria Deep Water Terminal sites (Landscape Zone A; Corcoran, 2002). Towards the north-east of the Tunnel Avenue site however, the Shepperton Gravel surface drops to below -4m OD. It does the same towards the south-west and south-east of the MO115 (Landscape Zone B; Young & Batchelor, 2013a) and MO117 (Landscape Zones A and B; Young & Batchelor, 2013b) sites, and in the far south-eastern corner of Greenwich Millennium Village (Miller & Halsey, 2011). In addition, smaller 'patches' of lower gravel surface >-4m OD are recorded towards the centre and south-western areas of the Millennium Festival Site (Landscape Zone D). These areas of lower Gravel surface have been interpreted as either localised hollows, or part of interconnected palaeochannels. It is possible that the depression in the Gravel surface recorded to the southeast of the Enderby Wharf site represents a south-westwards extension of the possible channel recorded to the south of the MO117/Millenium Festival Sites (Young & Batchelor, 2013a,b). However, additional borehole records would be required for this area (outside of the Enderby Wharf site) in order to test this hypothesis.

The results of the lithostratigraphic description of the three new boreholes have revealed that a lower, silty peat horizon is recorded within the lower alluvium in the area of borehole <QBH1> between -2.61 and -2.77m OD. The results of the radiocarbon dating indicate that peat accumulation commenced here around 5450-5070 cal BP (middle Neolithic). This horizon appears to be distinct to a thicker complex of generally woody or herbaceous peat and organic sediment, that lies between 0.0 and -2.5m OD across much of the site, and is generally between 0.5 and 2m thick. Radiocarbon dating of the base of this horizon has demonstrated that accumulation began here a few hundred years later (5290-4980 cal BP).

In almost all boreholes between *ca*. -1.0 and -2.0m OD, the peat is divided by a horizon of clayey or organic clayey silt, of variable thicknesses between *ca*. 0.5 and 1.0m. Although not recorded at exactly the same elevation in all boreholes, this horizon might represent a broadly contemporaneous episode of flood events which brought an influx of mineral-rich material across the peat surface. The increased occurrence of *Chenopodium* type pollen in the <QBH1> record at the beginning of this period may indicate flooding was influenced by enhanced saline conditions. Radiocarbon dating indicates that this event occurred prior to 4420-4240 cal BP (late Neolithic/early Bronze Age), by which time peat formation had re-commenced.

The periods of peat formation, including the lower, silty peat (on the basis of the pollen evidence) and the complex of peat and organic sediments at the Enderby Wharf site therefore appear to be contemporaneous with a widespread period of accumulation recorded elsewhere across the Lower Thames Valley, between *ca*. 6500-3000 cal BP, largely driven by variations in relative sea level rise (e.g. Devoy, 1979; Sidell, 2003). They are also consistent with those recorded elsewhere on the Greenwich Peninsula. At the Victoria Deep Water Terminal site, peat accumulation was radiocarbon dated to 5280-4660 cal BP (Neolithic; Corcoran, 2002), whilst at the Cable Car South Station in SSBH1C , the base of the peat was recorded around 5580-5310/5890-5610 cal BP and continued until 3380-3210 cal BP (Neolithic through to Bronze Age; Batchelor *et al*., 2014).

Vegetation history

The combined results of the pollen-stratigraphical and macrofossil analysis indicate that during the early stages of peat formation between 5450-5070 and 5290-4980 cal BP (middle Neolithic), the wetland environment was occupied by alder-carr swamp and sedge fen communities with areas of still/standing water, and potentially a limited tidal influence. From shortly after 5290-4980 to around 3390-3230 cal BP (middle Neolithic to Bronze Age), this vegetation community underwent a transition towards more mature and drier fen carr woodland dominated by alder, but may also have included hazel, ivy, elm, ash and yew. The expansion of elm and yew are discussed in greater detail below. At the very top of the sequence around 3390-3320 cal BP, a reduction in fen woodland cover and increase in herbaceous and aquatic taxa indicate the transition towards a wetter environment at the site. The timing of the event in combination with elevated values of *Chenopodium* pollen suggests this transition was caused by an increased saline influence.

The results of the pollen-stratigraphic analysis indicate that the dryland environment was occupied by mixed deciduous woodland dominated by oak with lime, birch, hazel, elm and ash from 5450-5070 to 5290-4980 cal BP (middle Neolithic). The limited values of *Ulmus* pollen during this period, indicate that the sequence post-dates the well-documented middle Holocene (early Neolithic) elm decline that occurred across the Lower Thames Valley and British Isles between 6347 and 5281 cal BP (Parker *et al*., 2002; Batchelor *et al*., 2014). Changes in the structure and composition of the dryland woodland are indicated from shortly after 5290-4980 to 3390-3230 cal BP as both lime and elm increase relative to oak.

<u>The expansion of yew and elm</u>

Elm, a tree normally associated with dryland woodland, may well have also occupied the peat surface between 5290-4980 and 3390-3230 cal BP as indicated by increased pollen percentage values. This finding has similarities with a number of other records that indicate an increase in *Ulmus* pollen, including Broadness Marsh (Devoy, 1979), Mar Dyke (Wilkinson *et al.*, 1988), Bryan Road (Tucker, 1993), Silvertown (Wilkinson *et al.*, 2000). These pollen records have previously been interpreted as a possible regional secondary expansion (recovery) of elm after the middle Holocene (early Neolithic) elm decline. However, the presence of macrofossils in the peat at sites such as Barking Riverside (Green *et al*., 2014), Norman Road (Batchelor *et al*., 2009) and the Erith Foreshore (Seel, 2001) suggests that these increases in *Ulmus* pollen may represent its establishment on the floodplain as opposed to a widely occurring phenomenon (Seel, 2001).

Seel (2001) also hypothesises that there is a case for suggesting that the relatively dry floodplain surface of the peat may have provided a refuge location for elm after the primary decline. It is suggested that the floodplain may have provided protection from the factors that originally thought to have bought about its decline (e.g. human activity and disease – see Parker *et al*., 2002; Batchelor *et al*., 2014), and that its establishment on the peat surface created an increase in pollen which is interpreted as a secondary regeneration.

Also of note is the occurrence of *Taxus* pollen from *ca*. 4420-4230 cal BP indicating the nearby growth of yew woodland, potentially on the peat surface. The growth of yew on peat during the Middle Holocene is now a well-documented occurrence, proven by multiple pollen, wood and plant macrofossil records across the Lower Thames Valley (e.g. Seel, 2001; Batchelor, 2009; Branch *et al*., 2012; Green *et al*., 2014). These records indicate that yew colonised a dry peat surface between approximately 5000 and 4000 cal BP; the occurrence of yew pollen at Enderby Wharf appears to be towards the end of this period. There are very few records demonstrating the growth of yew in this area of the Lower Thames Valley; this stratigraphic sequence has therefore increased our knowledge and understanding of the spatial extent and timing of yew growth across Lower Thames Valley floodplain.

<u>Evidence for human activity on the landscape</u>

No definitive indicators of human activity (such as cereal pollen or enhanced values of microcharcoal) were recorded through the sequence, and specifically around the time of trackway construction at the 72-88 Bellot Street (Philp & Garrod, 1994; 3380 to 3500 cal BP) and Bellot Street (Branch *et al*., 2005; (3890-3680 to 3720-3570 cal BP) sites.

Furthermore, the near-contemporaneous Bronze Age decline of the wetland and dryland woodland is not definitively recorded at Enderby Wharf as it is in other records from the Lower Thames Valley. Most likely this occurred just after 3390-3230 with the transition from peat formation to the upper alluvium. This transition is considered largely to have been caused by estuarine inundation consequent of an increase in relative sea level rise (RSL); not only would this have caused flooding of the wetland woodland, but would also have caused the expansion of wetland onto areas of former dryland, and/or the saturation of dryland soils, thus leading the decline of dryland woodland. However, Bronze Age clearance taking place on the neighbouring dryland edge, is also likely increased both sediment and water runoff, contributing to flooding on the floodplain. There seems little doubt therefore that whilst RSL driven processes could have influenced the rate of woodland decline on both the wetland and dryland; the precise temporal and spatial relationships between RSL change, soil deterioration, human activity and woodland decline remain very difficult to measure.

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APPENDIX 1: MONITORED GEOTECHNICAL BOREHOLE LOGS

Geotechnical description of borehole BH1 (not monitored)

Depth (m OD)	Depth (m bgs)	Geotechnical description	Geoarchaeological interpretation
2.25 to 1.05	0.00 to 1.20	Made Ground	Made Ground
1.05 to -0.25	1.20 to 2.50	Clay	Upper Alluvium
-0.25 to -1.15	2.50 to 3.40	Peaty clay	
-1.15 to -3.85	3.40 to 6.10	Sandy clay	
-3.85 to -5.45	6.10 to 7.70	Gravel	Shepperton Gravel
< -5.45	7.70+	Sandy gravel	

Lithostratigraphic description of borehole BH2

Depth (m OD)	Depth (m bgs)	Geotechnical description	Geoarchaeological description	Geoarchaeological interpretation
1.90 to 0.50	0.00 to 1.40	Made Ground	-	Made Ground
0.50 to -0.60	1.40 to 2.50	Clay	As3 Ag1; grey silty clay	Upper Alluvium
-0.60 to -1.60	2.50 to 3.50	Peaty clay		
-1.60 to -2.10	3.50 to 4.00		Sh3 $Tl^2$1 Th+ Ag+; humo. 2/3; brown moderately to well humified woody peat with a trace of herbaceous material and silt.	Peat
-2.10 to -2.40	4.00 to 4.30		Ag2 As2; grey silt and clay	Lower Alluvium
-2.40 to -2.80	4.30 to 4.70	Sandy clay	Ag2 As2 Dh+; grey silt and clay with a trace of detrital herbaceous material.	
-2.80 to -3.00	4.70 to 4.90	Sandy gravel	Gg3 Ga1; sandy gravel. Flint clasts 20-60mm in diameter; well-rounded to sub-angular.	Shepperton Gravel
-3.00 to -4.90	4.90 to 6.80	Gravel		
< -4.90	6.80+	Sandy gravel		

Lithostratigraphic description of borehole BH3

Depth (m OD)	Depth (m bgs)	Geotechnical description	Geoarchaeological description	Geoarchaeological interpretation
2.77 to 0.32	0.00 to 2.45	Made Ground	Made Ground	Made Ground
0.32 to -0.03	2.45 to 2.80	Peaty clay	Sh2 Ag1 Dl1; brown very organic silt with detrital herbaceous material.	Upper Alluvium
-0.03 to -0.53	2.80 to 3.30	Clay	Sh3 $Tl^1$1 Ag+; humo. 2/3; brown moderately to	Peat

			well humified woody peat with a trace of silt.	
-0.53 to -2.43	3.30 to 5.20		As2 Ag2 Ga+ Dh+; grey silt and clay with a trace of sand and detrital herbaceous material	Lower Alluvium
-2.43 to -3.53	5.20 to 6.30	Slightly clayey, slightly silty sand	Ga3 Ag1; greenish blue silty sand with occasional Mollusca fragments.	
-3.53 to -4.03	6.30 to 6.80	Gravel with sand	Gg3 Ga1 Ag+; sandy gravel with a trace of silt	Shepperton Gravel
< -4.03	6.80+	Sandy gravel		

Geotechnical description of borehole BH4 (not monitored)

Depth (m OD)	Depth (m bgs)	Geotechnical description	Geoarchaeological interpretation
2.16 to 0.86	0.00 to 1.30	Made Ground	Made Ground
0.86 to -0.24	1.30 to 2.40	Clay	Upper Alluvium
-0.24 to -1.04	2.40 to 3.20	Clayey peat with some woody remains and bands of clay	Peat
-1.04 to -1.54	3.20 to 3.70	Clayey silt	
-1.54 to -1.94	3.70 to 4.10	Slightly clayey peat with some plant remains	
-1.94 to -2.74	4.10 to 4.90	Silty clay	Lower Alluvium
-2.74 to -3.44	4.90 to 5.60	Sandy gravelly clay	
-3.44 to -4.64	5.60 to 6.80	Gravel	Shepperton Gravel
< -4.64	6.80+	Slightly sandy gravel	

Lithostratigraphic description of borehole BH5

Depth (m OD)	Depth (m bgs)	Geotechnical description	Geoarchaeological description	Geoarchaeological interpretation
2.05 to 0.45	0.00 to 1.60	Made Ground	Made Ground	Made Ground
0.45 to 0.25	1.60 to 1.80		As3 Ag1; blue grey silty clay with Mollusca fragments.	Upper Alluvium
0.25 to -0.15	1.80 to 2.20	Clay		
-0.15 to -0.25	2.20 to 2.30	Slightly clayey peat		
-0.25 to -0.85	2.30 to 2.90		Sh3 $Tl^2$1; humo. 2; reddish brown moderately humified woody peat	Peat

-0.85 to -1.65	2.90 to 3.70		Sh2 $Th^2$1 $Tl^2$1; humo. 2; moderately humified reddish brown herbaceous and wood peat	
-1.65 to -1.75	3.70 to 3.80		Ag2 Dl1 As1; blue grey clayey silt with detrital wood	
-1.75 to -1.95	3.80 to 4.00	Clay	Ag2 Dl1 As1; blue grey clayey silt with detrital wood	
-1.95 to -2.45	4.00 to 4.50		Sh2 $Th^2$1 $Tl^2$1; humo. 2; moderately humified reddish brown herbaceous and wood peat	
-2.45 to -3.05	4.50 to 5.10	Clay going in to slightly clayey sand	Ag2 Dl1 As1; blue grey clayey silt with detrital wood	Lower Alluvium
-3.05 to -3.75	5.10 to 5.80		Ag2 As1 Ga1 Dl+; grey clayey sandy silt with a trace of detrital wood material	
< -3.75	5.80+	Sandy gravel	Gg3 Ga1; sandy gravel. Flint clasts 40-60mm in diameter, rounded to sub-angular	Shepperton Gravel

Geotechnical description of borehole BH6

Depth (m OD)	**Depth (m bgs)**	**Geotechnical description**	**Geoarchaeological interpretation**
2.05 to 0.75	0.00 to 1.30	Made Ground	Made Ground
0.75 to -0.45	1.30 to 2.50	Clay with occasional gravel clasts	Upper Alluvium
-0.45 to -0.50	2.50 to 2.55	Clay with bands of organic clay	
-0.50 to -0.95	2.55 to 3.00	Peaty clay with rare fragments of plant remains	
-0.95 to -3.55	3.00 to 5.60	Clay with bands of peaty clay	
< -3.55	5.60+	Gravel	Gravel

Lithostratigraphic description of borehole BH7

Depth (m OD)	**Depth (m bgs)**	**Geotechnical description**	**Geoarchaeological description**	**Geoarchaeological interpretation**
2.44 to 1.14	0.00 to 1.30	Made Ground	Made Ground	Made Ground

1.14 to -0.26	1.30 to 2.70	Clay	As3 Ag1 Sh+ Dl+; grey silty clay with occasional pockets of organic matter and detrital wood.	Upper Alluvium
-0.26 to -1.26	2.70 to 3.70	Peat with plant remains including wood	-	Peat
-1.26 to -2.16	3.70 to 4.60	Clayey silt	As3 Ag1 Sh+ Dl+; grey silty clay with occasional pockets of organic matter and detrital wood.	Lower Alluvium
-2.16 to -3.56	4.60 to 6.00	Clay		
-3.56 to -3.86	6.00 to 6.30	Clay		
-3.86 to -4.06	6.30 to 6.50	Sand	-	
< -4.06	6.50+	Sandy gravel	Gg3 Ga1; sandy gravel. Flint clasts 20-60mm; rounded.	Shepperton Gravel

APPENDIX 2: OASIS

Project details	
Project name	Enderby Wharf, Christchurch Way, London Borough of Greenwich
Short description of the project	Geoarchaeological investigations were carried out at the site involving the collection of borehole samples, deposit modelling, laboratory-based assessment and analysis. The results of the investigation revealed a sequence of Shepperton Gravel overlain by Holocene alluvium including peat. The peat was radiocarbon dated from the middle Neolithic to Bronze Age. Analysis of the pollen provided a reconstruction of the vegetation history of the site; this suggested a wetland surface initially colonised by alder carr swamp and sedge fen, maturing towards fen carr woodland. Mixed deciduous woodland dominated by oak and lime occupied the dryland. No definitive evidence of human activity that might be correlated with the construction of the Bronze Age trackways at the nearby sites on Bellot Street were recorded.
Project dates	Start: 02-01-2014 End: 14-05-2015
Previous/future work	No / No
Any associated project reference codes	EWF14 - Sitecode
Type of project	Environmental assessment
Monument type	PEAT Neolithic
Monument type	PEAT Bronze Age
Significant Finds	POLLEN Neolithic
Significant Finds	POLLEN Bronze Age
Survey techniques	Landscape
Project location	
Country	England
Site location	GREATER LONDON GREENWICH GREENWICH Enderby Wharf
Postcode	SE10 0EG
Study area	30000.00 Square metres
Site coordinates	TQ 3925 7873 51.4898435826 0.00595584700797 51 29 23 N 000 00 21 E Point
Project creators	
Name of Organisation	Quaternary Scientific (QUEST)
Project brief originator	Consultant
Project design originator	D.S. Young
Project director/manager	C.R. Batchelor
Project supervisor	D.S. Young
Type of sponsor/funding body	Developer

Project archives

Physical Archive recipient	LAARC
Physical Contents	"Environmental"
Digital Archive Exists?	No
Paper Archive recipient	LAARC
Paper Contents	"none"
Paper Media available	"Report"

Project bibliography 1

Publication type	Grey literature (unpublished document/manuscript)
Title	A report on the geoarchaeological borehole investigations and deposit modelling on land at Enderby Wharf, Christchurch Way, London Borough of Greenwich SE10 0AG (NGR: TQ 3925 7873)
Author(s)/Editor(s)	Young. D.S.
Other bibliographic details	Quaternary Scientific Unpublished Report, November 2013.
Date	2013
Issuer or publisher	Quaternary Scientific
Place of issue or publication	University of Reading

Project bibliography 2

Publication type	Grey literature (unpublished document/manuscript)
Title	Land At Enderby Wharf, Christchurch Way, London Borough Of Greenwich SE10 0AG (NGR: TQ 3925 7873): Environmental Archaeological Assessment Report.
Author(s)/Editor(s)	Young, D.S.
Author(s)/Editor(s)	Batchelor, C.R.
Other bibliographic details	Quaternary Scientific (QUEST) Unpublished Report February 2014; Project Number 140/13
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Project bibliography 3

Publication type	Grey literature (unpublished document/manuscript)
Title	LAND AT ENDERBY WHARF, CHRISTCHURCH WAY, LONDON BOROUGH OF

	GREENWICH SE10 0AG (NGR: TQ 3925 7873): ENVIRONMENTAL ARCHAEOLOGICAL ANALYSIS REPORT
Author(s)/Editor(s)	Batchelor, C.R.
Author(s)/Editor(s)	Young, D.S.
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