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KENT WHARF DEPTFORD LONDON BOROUGH OF LEWISHAM

Environmental Archaeological Analysis Report

NGR: TQ 3760 7745

Site Code: KWF15

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1. NON-TECHNICAL SUMMARY

The geoarchaeological and palaeoenvironmental analysis report was aimed at fully addressing the five original project aims, with particular emphasis on comparing the results with those from nearby Old Seager Distillery.

The Shepperton Gravel surface rests between -1.64 and -2.23m OD across the majority of the site. This is overlain by 0.96-2.2m of Lower Alluvium, representing Holocene floodplain sedimentation in a moderate to low energy fluvial or estuarine environment. Towards the south of the site, the Lower Alluvium is absent, and appears either: (a) to have been eroded by a former channel or tributary of the Deptford Creek, which was subsequently abandoned and infilled by a 2m thick horizon of Peat; or (b) removed during the formation of a tree-throw hollow, which was subsequently infilled by Peat.. Both the Peat and Lower Alluvium were succeeded by the deposition of Upper Alluvium, representative of an overbank floodplain or estuarine environment, finally capped by *ca*. 3m of Made Ground, which in places truncates the Upper Alluvium. Radiocarbon dating and age-depth modelling of the Peat in Kent-QBH1 indicates it accumulated between at least 7550-7000 and 3160-2960 cal BP; a period of nearly 4000 years spanning the late Mesolithic to late Bronze Age cultural periods.

The sequences contain no definitive evidence of human activity. However, peaks in microcharcoal towards the base of the peat suggest nearby burning during the late Mesolithic that may be of natural or anthropogenic origin. Further up the sequence, certain pollen taxa may indicate disturbance and/or cultivation; herbivore dung and intestinal parasite eggs are also sporadically recorded. No evidence such as the lithic artefacts recorded at Old Seager Distillery were recorded.

Pollen and NPP analysis has provided a partially complete vegetation history for the site, which adds to that from Old Seager Distillery and therefore for the Deptford Channel as a whole. The record highlights three key vegetation events: (1) the apparent late Mesolithic expansion of pine; evidence for which appears to be increasing across the Lower Thames Valley as a whole; (2) the early Neolithic decline of elm, and (3) the Bronze Age decline of woodland on the floodplain and dryland.

The aims and objectives of the project are considered to have been successfully achieved, as above, providing an important record from this area of the Lower Thames Valley. The results from the investigation do not warrant publication in isolation, but the findings are of importance, enhancing those from the published Old Seager Distillery site. It is recommended that the findings are integrated into a future publication that integrates the findings from multiple sites and has a key central theme (e.g. vegetation history of the Lower Thames Valley).

2. INTRODUCTION

2.1 Site context

This report summarises the findings arising out of the geoarchaeological and palaeoenvironmental analysis undertaken by Quaternary Scientific (University of Reading) in connection with the proposed development of land at Kent Wharf, Deptford, London Borough of Lewisham (NGR centred on: TQ 3760 7745; site code: KWF15; Figures 1 & 2). Quaternary Scientific were commissioned by CgMs Consulting Ltd to undertake the investigations. The area of investigation at Kent Wharf (*centred* on NGR TQ 3760 7745; Figure 1) lies in the valley of the Ravensbourne, a minor right bank tributary of the River Thames that rises in Bromley (Barton, 1992). The site is within the tidal reach of the River, known here as Deptford Creek, around 500m upstream from its confluence with the Thames. British Geological Survey (BGS) mapping (1:50,000 Sheet 270 South London 1998) shows the valley of the Ravensbourne cutting down into the Upper Chalk and the floor of the valley occupied by Alluvium, with a narrow strip of terrace gravel (the Kempton Park Gravel) present on both sides of the valley.

Recent fieldwork and assessment of the Kent Wharf site (Batchelor *et al*., 2015a; Batchelor & Young, 2016) reveals a Shepperton Gravel surface resting between -1.64 and -2.23m OD across the majority of the site. This is overlain by 0.96-2.2m of Lower Alluvium, representing Holocene floodplain sedimentation in a moderate to low energy fluvial or estuarine environment. Towards the south of the site, the Lower Alluvium is not present, and appears either: (a) to have been eroded by a former channel or tributary of the Deptford Creek, which was subsequently abandoned and infilled by a 2m thick horizon of Peat; or (b) removed during the formation of a tree-throw hollow, which was subsequently infilled by Peat.. Both the Peat and Lower Alluvium were succeeded by the deposition of Upper Alluvium, representative of an overbank floodplain or estuarine environment. sequence is capped by *ca*. 3m of Made Ground, which in places truncates the Upper Alluvium. Radiocarbon dating of the Peat in Kent-QBH1 indicates it accumulated between at least 6660-6490 and 3160-2960 cal BP; a period of more than 3000 years spanning the late Mesolithic to late Bronze Age cultural periods.

2.2 Geoarchaeological, Palaeoenvironmental and Archaeological potential

The different deposits recorded are significant as they represent different environmental conditions that would have existed in a given location. For example: (1) variations in the topography of the River Terrace Gravels could indicate the position of former channels and islands on the floodplain (as indicated above); (2) the presence of soils and peat represent former terrestrial or semi-terrestrial land-surfaces, and (3) the less organic alluvial deposits of sands/silts/clays represent periods of varying hydrological conditions on the floodplain. By studying the sub-surface stratigraphy across the site in greater detail, it will be possible to build a greater understanding of the former landscapes and environmental changes that took place over space and time at this location.

The detailed palaeoenvironmental reconstruction in the Ravensbourne tributary has previously been restricted by very poor preservation of palaeoecological remains (e.g. Batchelor *et al*., 2009, 2014). The preservation of palaeoenvironmental remains at Kent Wharf is variable, but nevertheless represents a better opportunity to reconstruct the former environment than that recorded previously., thus from the site offer an opportunity to contribute to our understanding of landscape evolution in this part of the Ravensbourne tributary and Lower Thames Valley.

Organic-rich sediments (in particular peat) also have high potential to provide a detailed reconstruction of prehistoric environments on both the wetland and dryland. In particular, there is the potential to increase knowledge and understanding of the interactions between hydrological change, human activity, vegetation succession and climate in this area of the Middle Thames Valley. Significant vegetation changes include the early Holocene/early Mesolithic transition from pine-dominated to mixed-deciduous dominated woodland; the late Mesolithic/Neolithic decline of elm woodland, the Neolithic colonisation and decline of yew woodland; the late Neolithic/early decline of wetland and dryland woodland. Such investigations are carried out through the assessment/analysis of palaeoecological remains (e.g. pollen, plant macrofossils & insects) and radiocarbon dating. So called palaeoenvironmental reconstructions have been carried out on the sedimentary sequences from elsewhere in this general area, including at Greenwich Creekside East (RAS15; Batchelor, 2015), Old Seager Distillery (DEG00; Batchelor *et al*., 2009a) and the DLR Lewisham Extension site (DXK96; Sidell *et al*., 1999) (Figure 1).

Finally, areas of high gravel topography, soils and peat represent potential areas that might have been utilised or even occupied by prehistoric people, evidence of which may be preserved in the archaeological (e.g. features and structures) and palaeoenvironmental record (e.g. changes in vegetation composition). Such evidence includes multiple *in situ* prehistoric lithic artefacts within a tree-throw hollow at Old Seager Distillery (Batchelor *et al*., 2014).

2.3 Aims and objectives

The Geoarchaeological Written Scheme of Investigation originally outlined the following research aims for the site (Batchelor, 2015b):

1. To clarify the nature of the sub-surface stratigraphy across the site;
2. To clarify the nature, depth, extent and date of any alluvium and peat deposits
3. To investigate whether the sequences contain any artefact or ecofact evidence for prehistoric or historic human activity
4. To investigate whether the sequences contain any evidence for natural and/or anthropogenic changes to the landscape (wetland and dryland)
5. To integrate the new geoarchaeological record with other recent work in the local area for publication in an academic journal

The preceding geoarchaeological and palaeoenvironmental reports have partly addressed these aims; the following report aims to fully address them. In particular it is highlighted that: (1) indications of human activity were recorded during the assessment that might be correlated to previous archaeological and geoarchaeological evidence recorded at the nearby Old Seager Distillery site, and (2) as above, the preservation of remains at Kent Wharf is variable, but represents a better opportunity to reconstruct the former environment than that recorded previously.

Figure 1: Location of (1) Kent Wharf, Deptford, London Borough of Lewisham, and nearby sites discussed in the text: (2) Greenwich Creekside East (Batchelor, 2015c); (3) Faircharm Creative Quarter (FCM14; Young, 2014); (4) Old Seager Distillery (DEG00; Batchelor *et al*., 2014); (5) the DLR Lewisham Extension site (DXK96; Sidell et al., 1999) & (6) Hope Wharf (HOP17; Young, 2017). Contains ordnance survey data © Crown copyright and database right [2017].

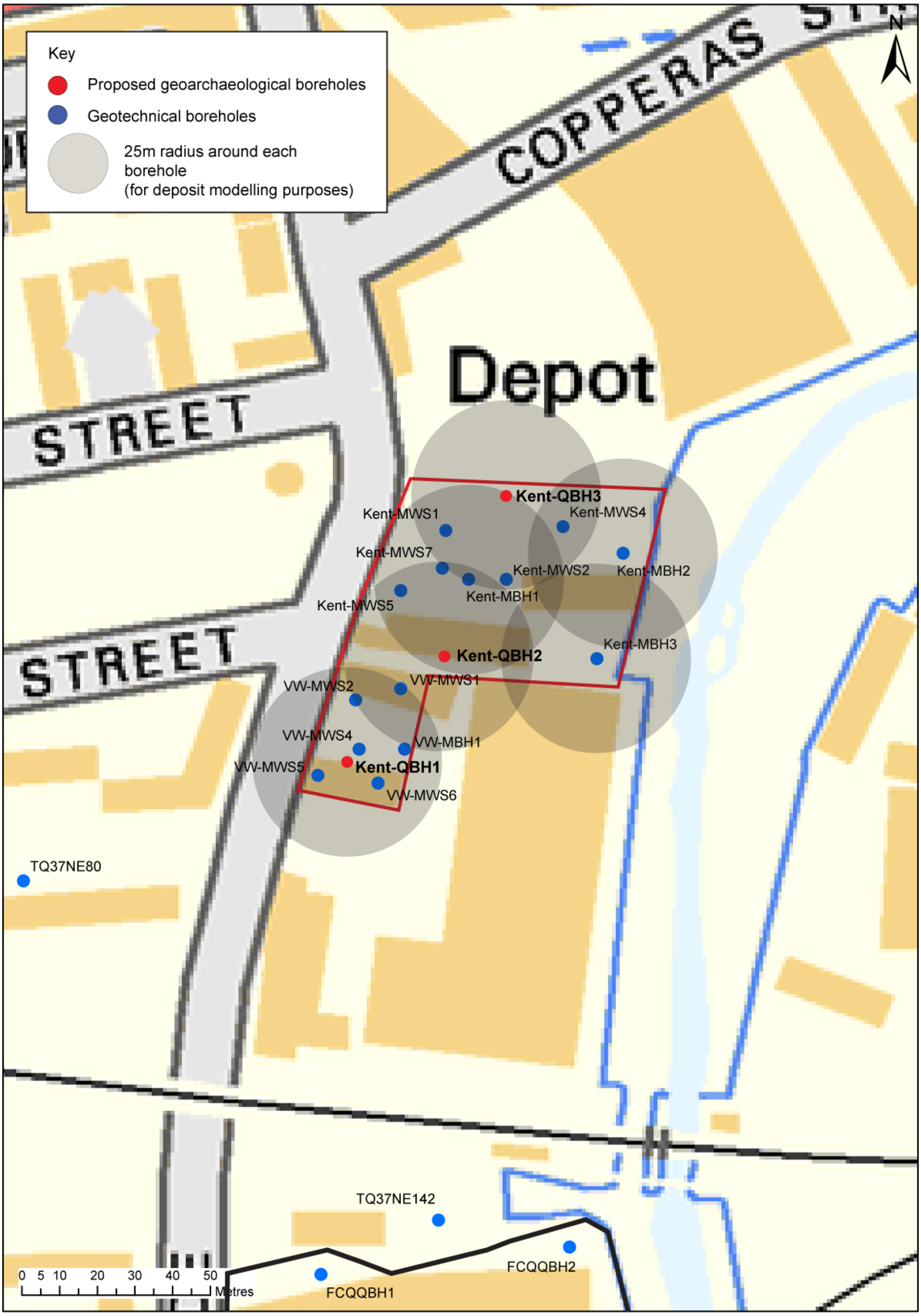

Figure 2: Locations of the geoarchaeological boreholes, and historic geotechnical records

3. METHODS

3.1 Geoarchaeological field investigations and deposit modelling

Three geoarchaeological boreholes (boreholes Kent-QBH1 to QBH3) were put down at the site in October 2015 (Figure 2) by Quaternary Scientific. 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 new and historic borehole locations were obtained with reference to site maps and recent topographic surveys (Table 1).

The lithostratigraphy of the retained core samples 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 sample using a scalpel; (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 (west-east transect) and 4 (north-south transect) and in Tables 2 to 4.

The deposit model was based on a review of 17 borehole records, incorporating the three new geoarchaeological boreholes, and historical records from within or around the site (Figure 2; Table 1). Sedimentary units from the boreholes were classified into three groupings: (1) Gravel, (2) Lower Alluvium; (3) Peat; (4) Upper Alluvium and (5) Made Ground. The classified data for groups 1-5 were then input into a database with the RockWorks 16 geological utilities software. Models of surface height (using a nearest neighbour routine) were generated for the Gravel, Lower Alluvium and Upper Alluvium Alluvium (Figures 5, 6 & 9). Thickness of the Lower Alluvium, Peat, Upper Alluvium and Made Ground (Figures 7, 8, 10 & 11) was also modelled (also using a nearest neighbour routine). Two-dimensional transects of selected boreholes are shown in Figures 3 & 4.

How effectively Rockworks portrays the relief features of stratigraphic contacts or the thickness of sediment bodies depends on the number of data points (boreholes/test pits) per unit area, and the extent to which these points are evenly distributed across the area of interest. The portrayal is also affected by the significance assigned to these data points, in terms of the extent of the area around the point to which the data are deemed to apply. This can be predetermined for each data set, and in the present case the value chosen for each data point (borehole) is equivalent to an area of 25m radius for all models. The boreholes are relatively well distributed over the area of investigation. In general, reliability improves towards the core area of boreholes where mutually supportive data are likely to be available from several adjacent data points. Reliability is also affected by the quality of the stratigraphic records, which in turn are affected by the nature of the sediments and/or their post-depositional disturbance during previous stages of land-use on the site. Quality is also affected where boreholes have been put down at different times and recorded using different descriptive terms and subject to differing technical constraints in terms of recorded detail including the exact levels of the stratigraphic boundaries. Of the records used in the deposit model, the cores from the geoarchaeological boreholes put down by Quaternary Scientific represent the most detailed record of the sediment sequences. Finally, because of the 'smoothing' effect of the modelling procedure, the modelled levels of stratigraphic contacts may differ slightly from the levels recorded in borehole logs.

3.2 Organic matter determinations

A total of 29 subsamples 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^{0}C 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. The samples were then re-weighed after 2 hours at 950°C for determination of the calcium carbonate content (see Bengtsson and Enell, 1986).

3.3 Radiocarbon dating & age-depth monitoring

Four subsamples of unidentified twig wood (<2-3 years old) were extracted from the top and base of the Peat horizon in borehole QBH1 for radiocarbon dating. The samples were submitted for AMS radiocarbon dating to the BETA Analytic Radiocarbon Dating Facility, Miami, 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.

An age-depth model was created for the sequence using OxCal version 4.2 Bronk Ramsey (1995, 2001), and follow the approach of Blockley et al. (2007) (Figure 12; Table 7). Radiocarbon dates were initially inserted into a 'Sequence' which makes no prior assumption about sedimentation rate, only that age increases with depth. This allows the exclusion of any dates that disagreed with this assumption. The age-depth model was then constructed using a 'P-Sequence', which allowed the insertion of stratigraphic information. The P-Sequence allows a degree of control over the assumed rate of sedimentation during model construction by varying the value of 'k'. 'k' is defined by the size of deposition events (Bronk Ramsey, 2007). A low k value indicates a variable sedimentation rate, and higher k values reflect more stable deposition, suitable for the accumulation of fine grained sediments and peat (Marshall, pers comm.). Appropriate k values for peat range between 100 and 300 events/metre (Blockley, pers comm.). A k factor of 130 was selected for the QBH1 sequence as it accounted for variations in the rate of peat accumulation caused, for example by flooding events. The output of the constructed age-depth model provides an Overall Agreement Index (OAI). If the OAI is greater than 60%, the model is considered statistically reliable and may be used (Bronk Ramsey, 2007).

3.4 Pollen and non-pollen palynomorph analysis

Twenty-two sub-samples from the peat in 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. Each slide was initially scanned to establish the concentration, preservation and main taxa present. Those samples with a sufficiently high concentration and preservation of remains underwent full analysis.

The analysis procedure consisted of counting all pollen to 300 Total Land Pollen where possible (TLP; trees, shrubs and herbs) where possible. Aquatic pollen, spores, testate amoeba, non-pollen palynomorphs and intestinal parasites were also counted. 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). Pollen percentage and pollen concentration diagrams were produced in 'Tilia'. Pollen percentage values were calculated as follows: Tree, shrub and herb taxa were calculated as a percentage of total land pollen (TLP); other remains (spores, testate amoeba, non-pollen palynomorphs and intestinal parasites) were calculated as a percentage of TLP. The concentration of microcharcoal with dimensions >20um along at least one axis, was also recorded together with total pollen concentration. The results are also displayed in Figure 13.

3.5 Diatom assessment

Four sub-samples were extracted for diatom assessment/analysis from QBH1. All samples were treated with hydrogen peroxide (30% solution) to remove organic material. Samples were then sieved using a 10μm mesh to remove fine minerogenic sediments. The residue was transferred to a plastic vial, from which a slide was prepared for subsequent assessment. A minimum of four slide traverses were undertaken across each slide sample.

3.6 Macrofossil assessment

A total of six small bulk samples from borehole QBH1 were extracted for the recovery of macrofossil remains including waterlogged plant macrofossils, wood, insects and Mollusca. The extraction process involved the following procedures: (1) removing a sample of either 5 or 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 (Table 8). 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 9).

Table 1: Borehole attributes for those records used in the deposit model, Kent Wharf, Deptford, London Borough of Lewisham

Borehole number	Easting	Northing	Height (m OD)	Borehole depth (m)	Top of Upper Alluvium (m bgl)	Top of Peat (m bgl)	Top of Lower Alluvium (m bgl)	Top of Gravel (m bgl)	Notes
Geoarchaeological borehole									
Kent-QBH1	537565	177421	4.2	7	2.60	4.30	-	6.21	UA organic-rich between 3.72 & 4.30m bgl
Kent-QBH2	537591	177449	4.3	6	2.60	-	5.00	5.96	Uncertainty distinguishing LA and UA; Gravel horizon towards the base of the LA
Kent-QBH3	537607	177256	4.8	7	2.60	-	4.61	6.90	
Geotechnical boreholes									
Kent-MBH1	537598	177470	4.8	10	3.1	-	5.40	7	Uncertainty distinguishing LA and UA; Gravel horizon towards the base of the LA
Kent-MBH2	537639	177477	4.72	10	-	-	5	6.95	
Kent-MBH3	537632	177449	4.56	10	-	-	4	6.2	
VW-MBH1	537581	177425	4.5	10	2.7	4.8	-	5.7	
Geotechnical window samples									
Kent-MWS1	537592	177483	4.9	5.45	2.8				
Kent-MWS2	537608	177470	4.8	5	2.5				
Kent-MWS4	537623	177484	4.75	5.45	2.9				
Kent-MWS5	537580	177467	5.44	5.45	2.8				
Kent-MWS7	537591	177473	4.8	4.45	1.9				
VW-MWS1	537580	177441	4.5	4	3				
VW-MWS2	537568	177438	4.5	4	3				
VW-MWS4	537569	177425	4.5	4	2.5				
VW-MWS5	537558	177418	4.5	4	2.5				
VW-MWS6	537574	177416	4.5	4	3				

4. RESULTS AND INTERPRETATION OF THE GEOARCHAEOLOGICAL BOREHOLE INVESTIGATIONS, DEPOSIT MODELLING & RADIOCARBON DATING

The geoarchaeological investigations (Tables 2 to 5) have permitted a programme of deposit modelling of the surface elevation and thickness of each major stratigraphic unit (Figures 3 to 11). The results of the organic matter content determinations and radiocarbon dating of Kent-QBH1 are displayed in Figure 12 and Tables 5 and 6.

The basal unit at the site is a horizon of sand and gravel, probably equivalent to the Shepperton Gravel that underlies the Holocene alluvium of the Thames (Gibbard, 1985), deposited during the Late Devensian (15,000 to 10,000 years before present) within a high energy braided river environment (Figures 3 to 5). This surface is reached by 7 of the 17 borehole records which are well distributed across the site. The surface of the Gravel was generally relatively even across the site, ranging between -2.23 (Kent-MBH2) and -1.64m OD (Kent-MBH3). Only in VW-MBH1 was the surface outside of this range, resting at -1.2m OD. These results thus indicate a fairly even valley floor across the site, with the possibility of a rising Gravel surface towards the south.

Three stratigraphic units were recognised above the Shepperton Gravel: the Lower Alluvium (Figures 6 & 7), Peat (Figure 8) and Upper Alluvium (Figures 9 & 10), which in turn were capped by a variable thickness of Made Ground (Figure 11). It is noted however that distinguishing between the Lower Alluvium and Upper Alluvium is difficult within the sedimentary sequences from Kent Wharf, due to the similarity of the material. This is particularly true of the geotechnical borehole records.

The Gravel surface is overlain by deposits of generally silty clay, with various inclusions (e.g. detrital plant remains and Mollusca). This horizon is indicative of deposition within a moderate-energy fluvial environment, and is considered to represent the Lower Alluvium recorded elsewhere in the Lower Thames Valley, most likely deposited during the Early Holocene, following a reduction in flow rate at the end of the Late Glacial period. This stratigraphic unit is recorded in all boreholes located towards the north of the site (Kent-QBH2 & QBH3, Kent-MBH1 to MBH3), and varies between 0.96 and 2.2m thick. During the accumulation of the Lower Alluvium, a high energy flood event(s) is indicated across at least part of the site, by the deposition of silty clay with sub-rounded gravel clasts up to 30mm in size in Kent-QBH2 and Kent-QBH3.

Towards the south of the site however, Lower Alluvium is absent and a 2m thick horizon of well-preserved moderately-humified wood Peat is recorded (VW-BH1 & Kent-QBH1). It is unlikely that this horizon accumulated at the same time as the Lower Alluvium. Instead, it is thought more likely that the Lower Alluvium was eroded in this area of the site, most likely by a former course or tributary of the Deptford Creek. This channel was subsequently abandoned, and became infilled by Peat deposits, supporting the growth of wetland woodland. On the basis of the available evidence, it is not possible to ascertain the dimensions or orientation of the former channel, but it must have exceeded 16m in size (the distance between VW-MBH1 & Kent-QBH1). An alternative possibility to the infilling of a former channel, is that the Peat deposits recorded are representative of the infilling of a tree-throw hollow. Whatever the sequence of events, radiocarbon dating of the Peat sequence from Kent-QBH1 indicates that it accumulated between at least 6660-6490 and 3160-2960 cal BP (Figure 12; Table 5); a period of more than 3000 years spanning the late Mesolithic to late Bronze Age cultural periods. During this period, frequent inundation of the Peat surface is indicated by the moderate and variable organic matter values (35-80%; Figure 12, Table 6).

Both the Lower Alluvium and Peat deposits were overlain by silty clay. These sediments most likely represent deposition on the floodplain at a distance from any active channels and are analogous to the Upper Alluvium recorded elsewhere in the Lower Thames Valley and its tributaries. This horizon is likely to have accumulated from the late Neolithic period onwards, as a result of increased sediment supply resulting from woodland clearance and agricultural activity within the river catchment. The Upper Alluvium is recorded across the site and is fairly consistent in thickness (2-2.5m). However in certain locations the deposits have been truncated by Made Ground (Kent-MBH2 and Kent-MBH3).

The sequence across the site is capped by variable thicknesses of Made Ground, averaging between 2.5 and 3m.

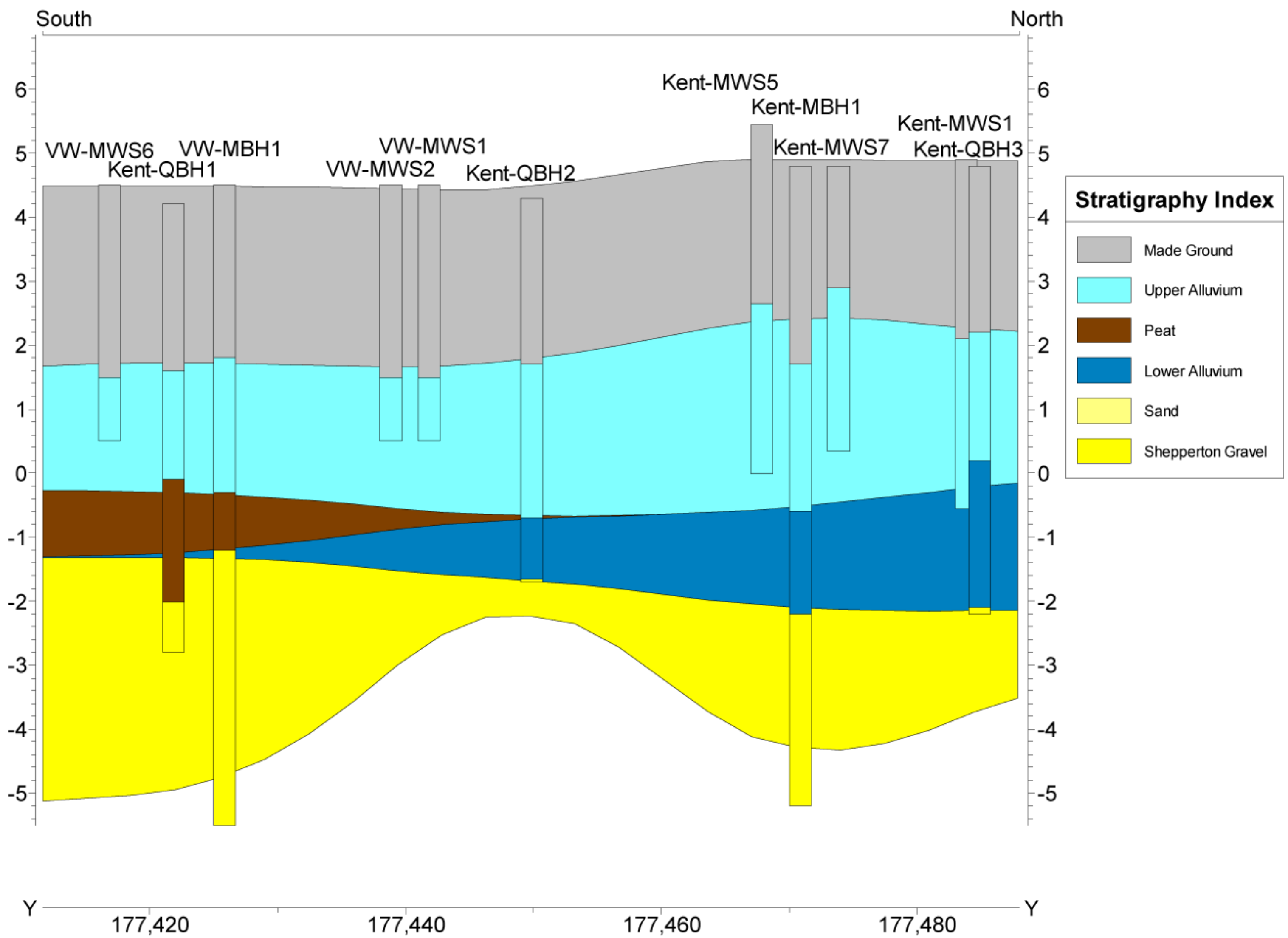

Figure 3: North-South transect of selected boreholes across Kent Wharf, Deptford, London Borough of Lewisham

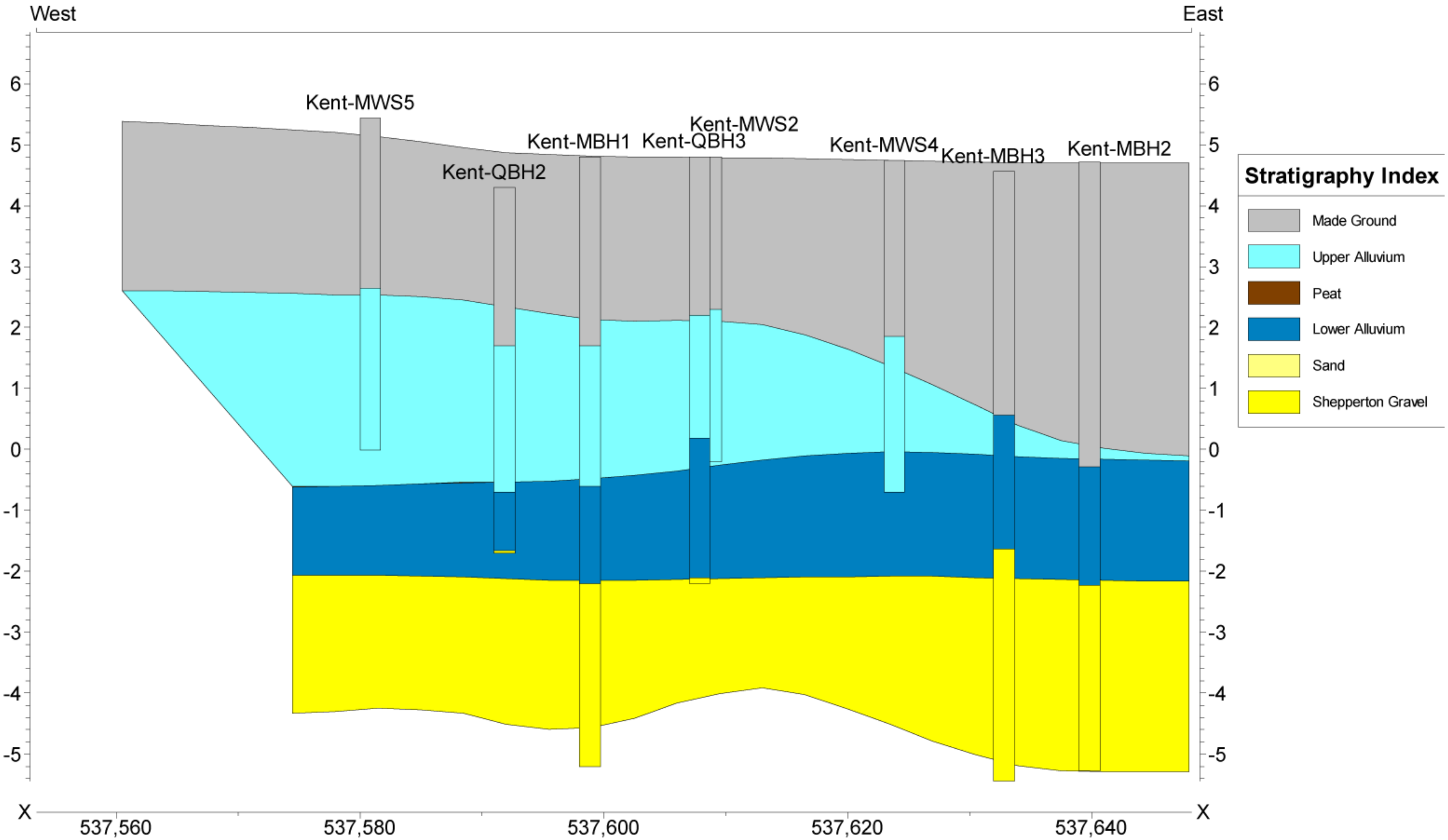

Figure 4: West-East transect of selected boreholes across Kent Wharf, Deptford, London Borough of Lewisham

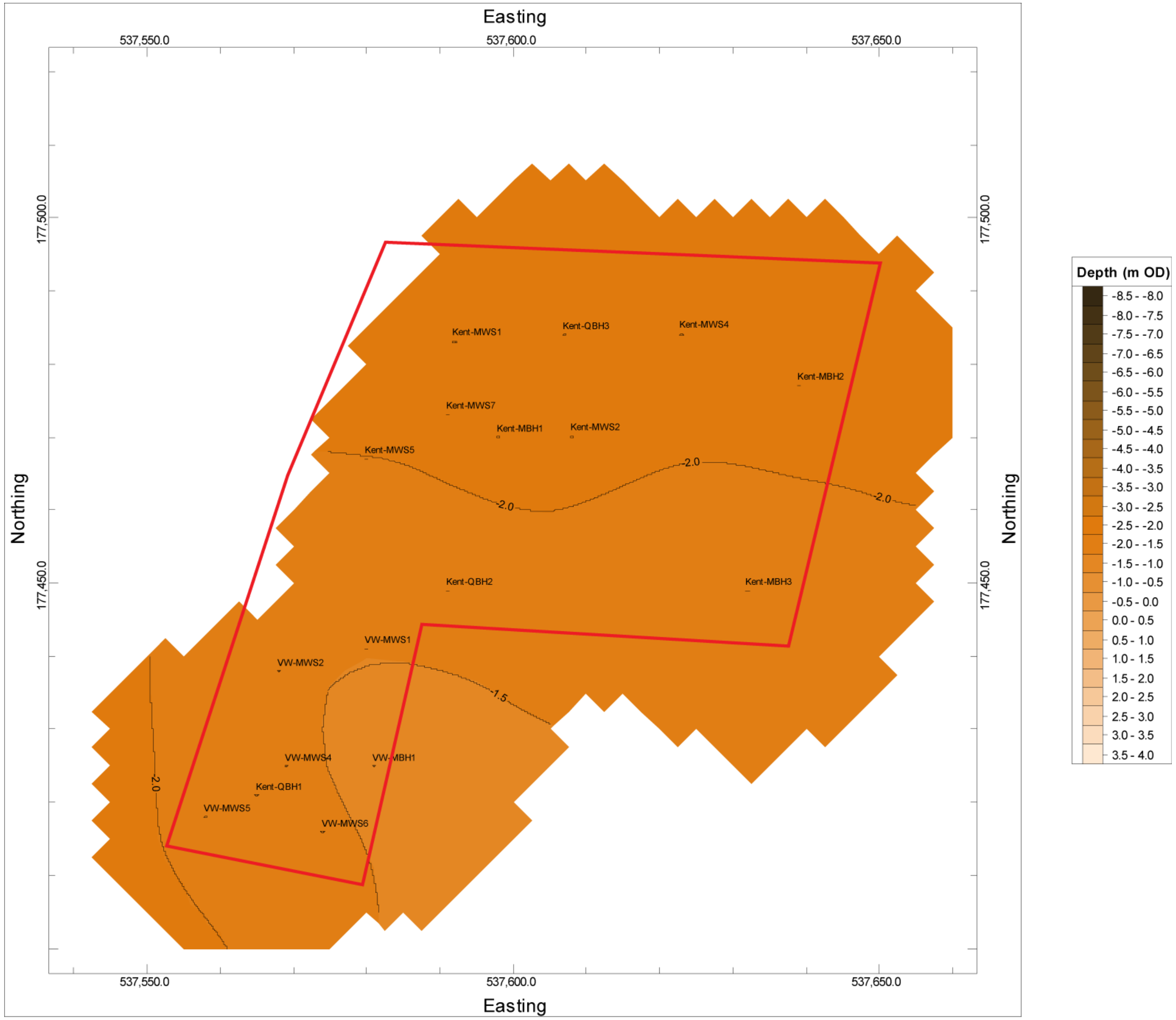

Figure 5: Top of the Shepperton Gravel (m OD) (site outline in red)

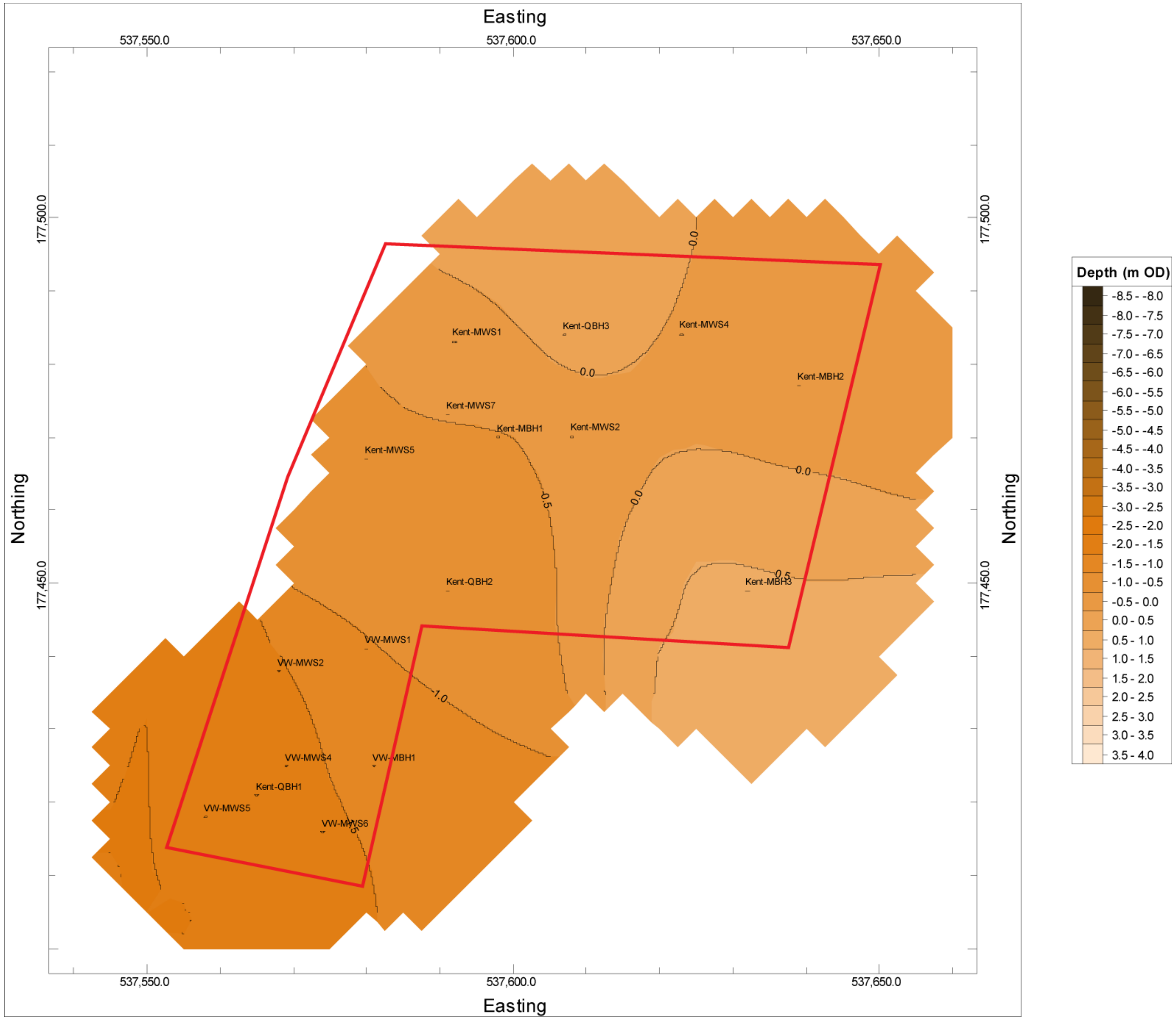

Figure 6: Top of the Lower Alluvium (m OD) (site outline in red)

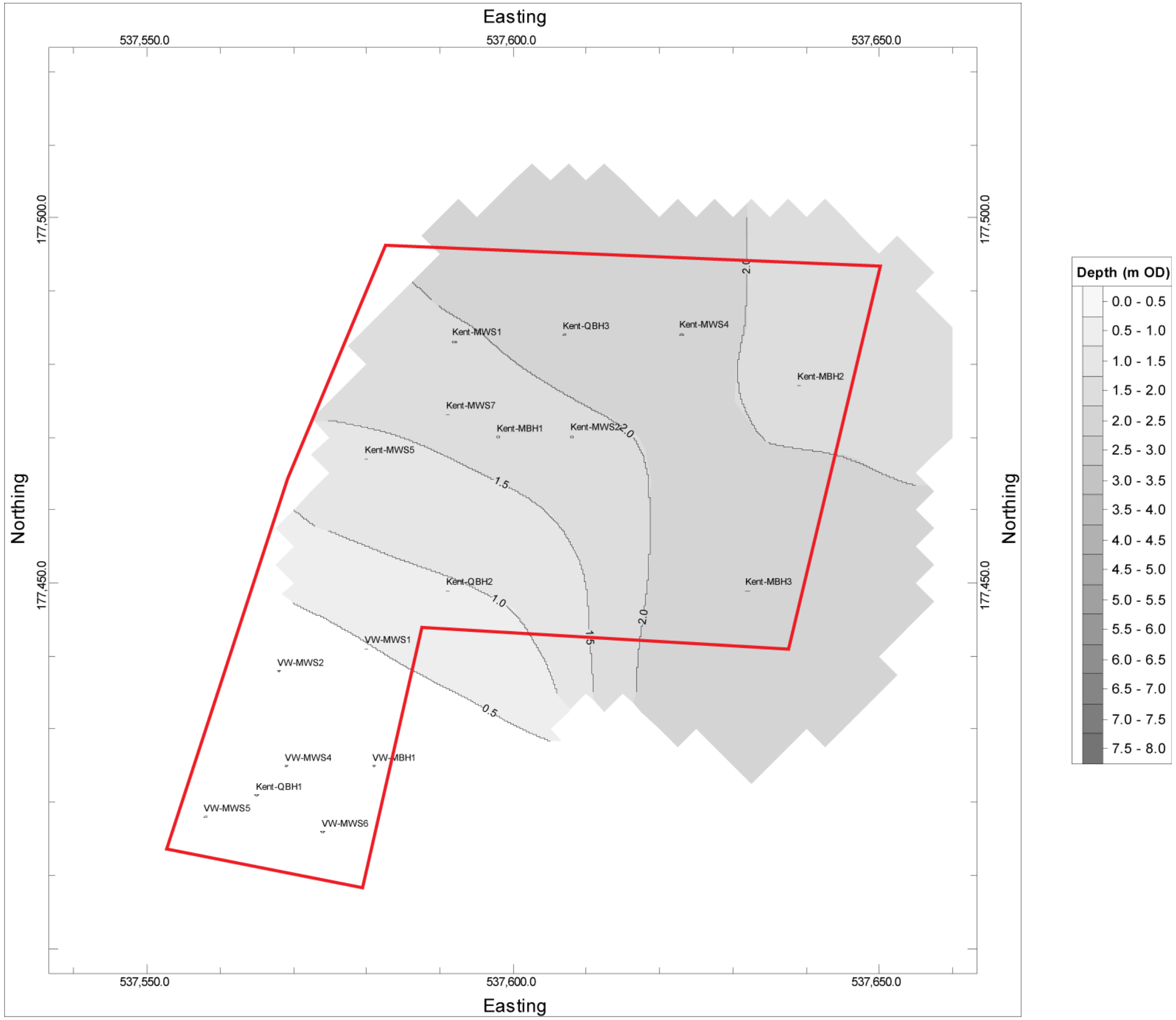

Figure 7: Thickness of the Lower Alluvium (m) (site outline in red)

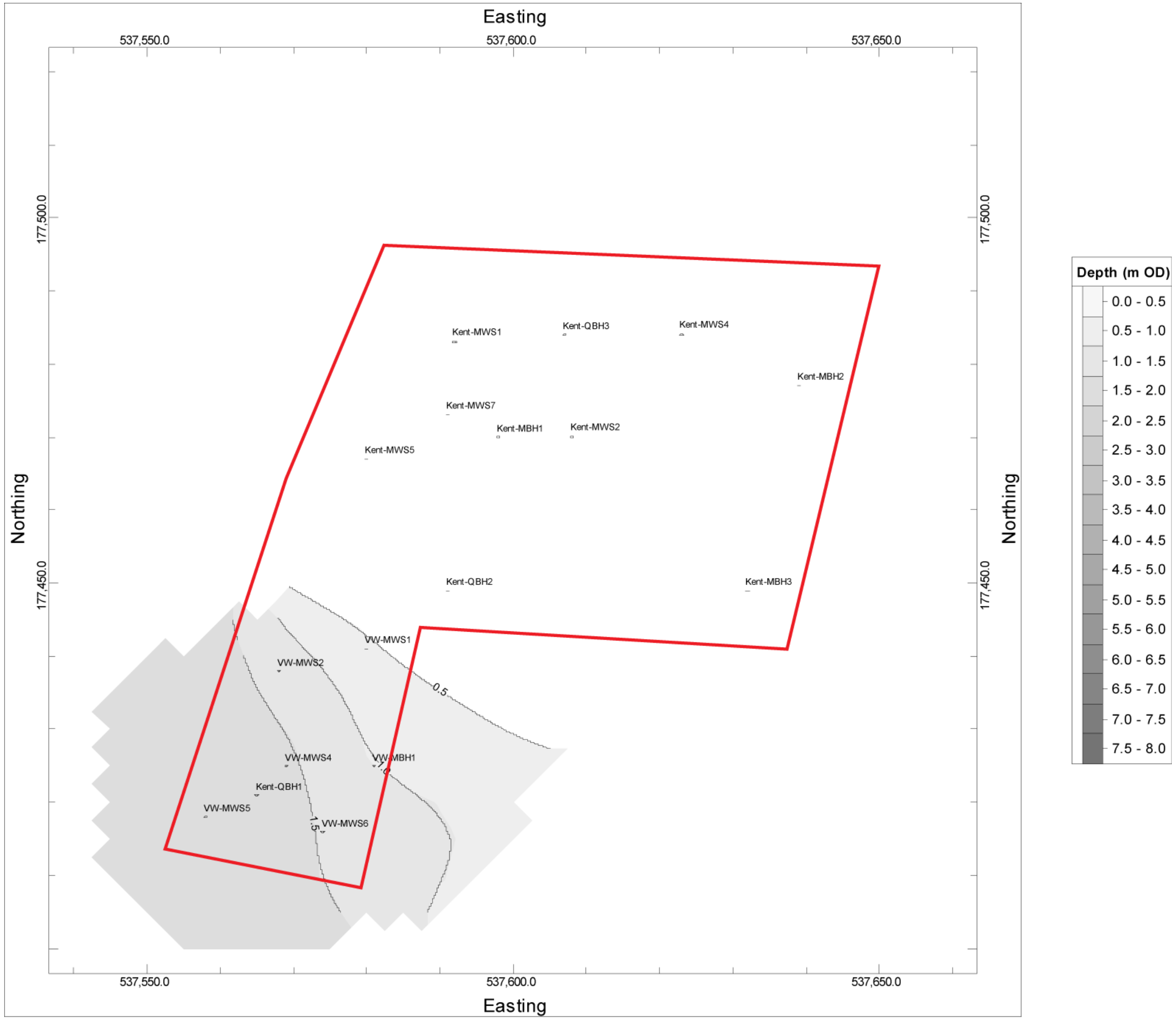

Figure 8: Thickness of Peat (m) (site outline in red)

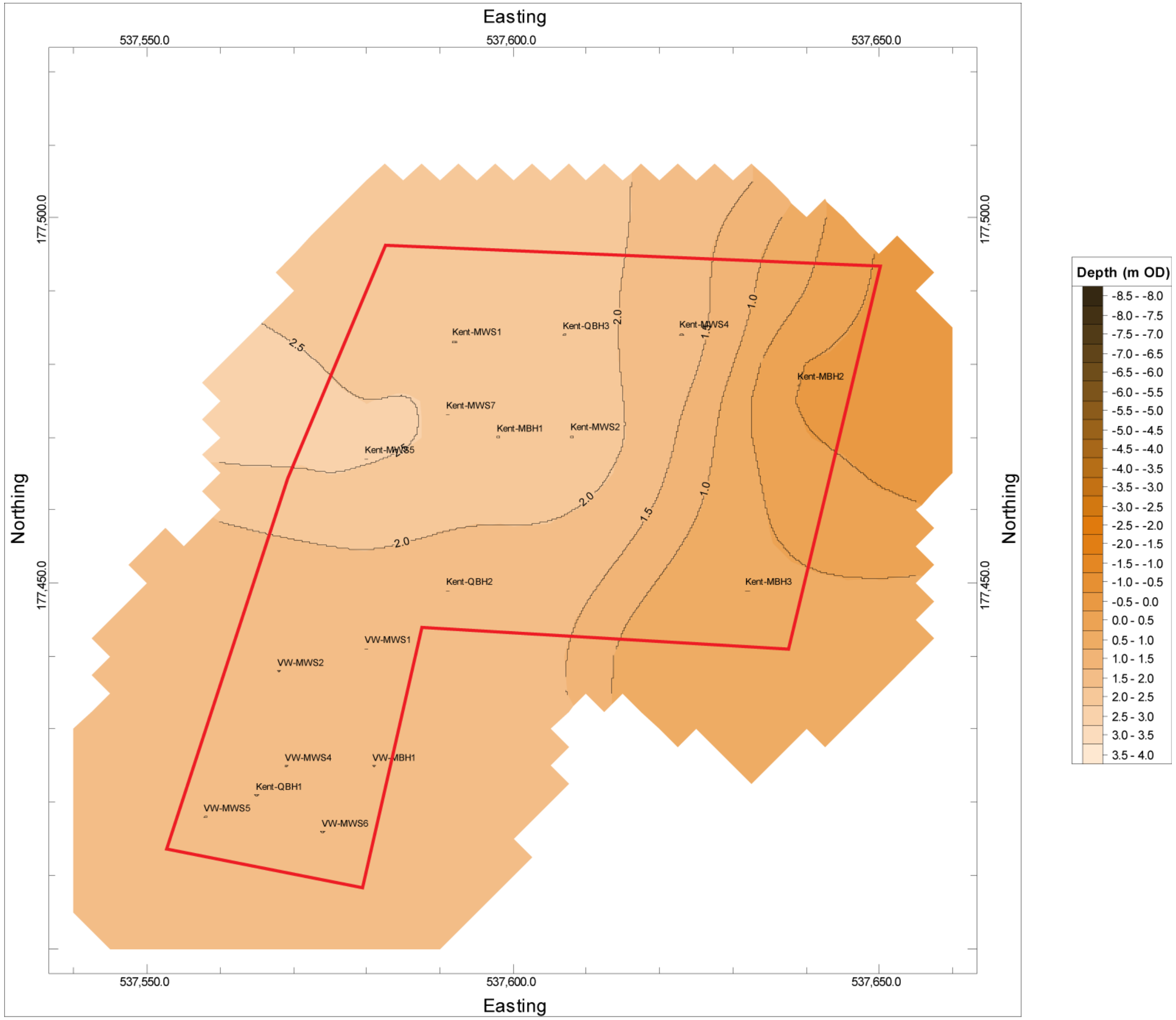

Figure 9: Top of the Upper Alluvium (m OD) (site outline in red)

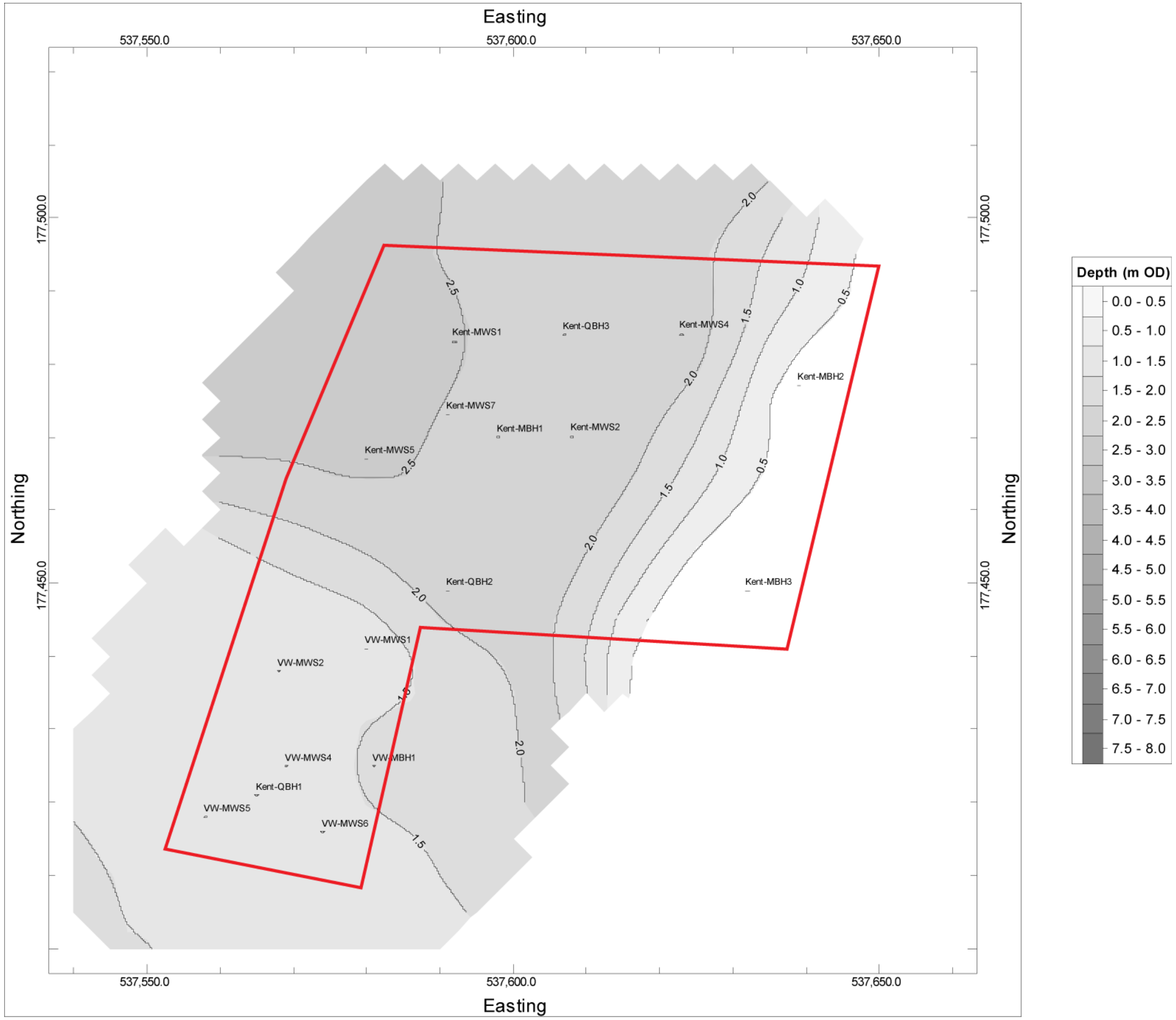

Figure 10: Thickness of the Upper Alluvium (m) (site outline in red)

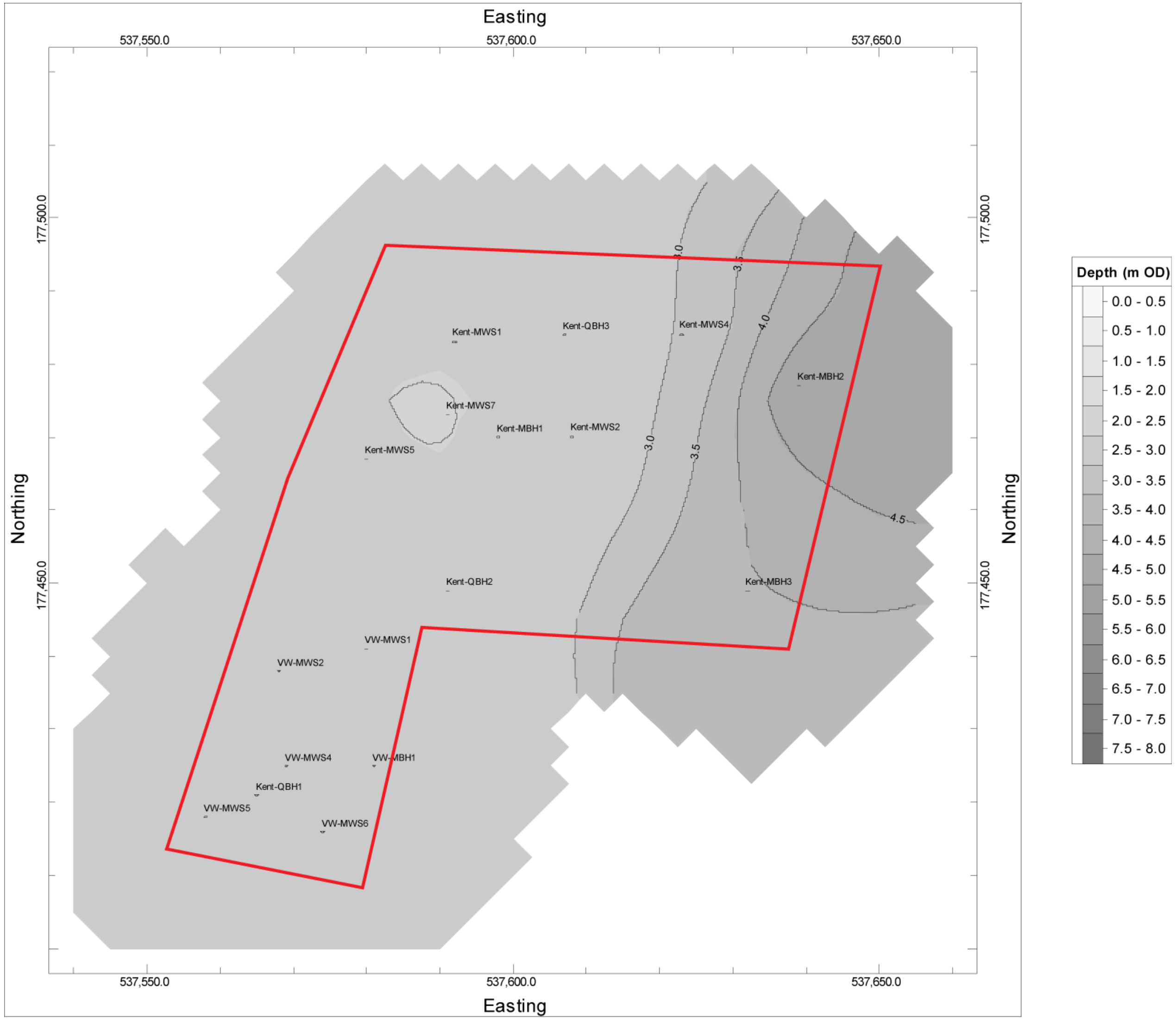

Figure 11: Thickness of Made Ground (m) (site outline in red)

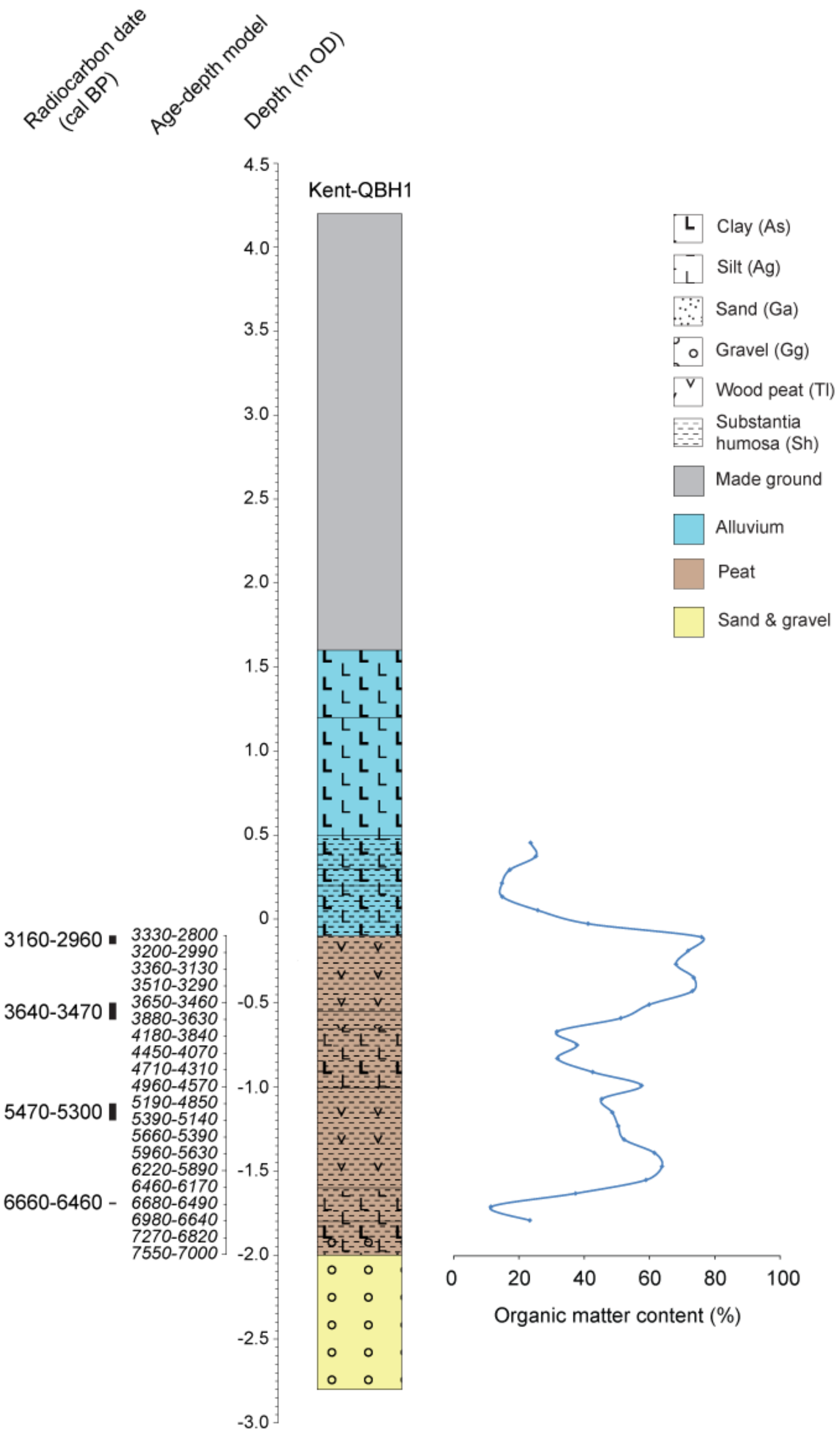

Figure 12: Detailed lithostratigraphy of Kent-QBH1, Kent Wharf, London Borough of Lewisham, incorporating organic-matter determinations and radiocarbon dating (ages are calibrated years before present).

Table 2: Lithostratigraphic description of borehole Kent-QBH1, Kent Wharf, Deptford, London Borough of Lewisham

Depth (m OD)	Depth (m bgs)	Description
4.20 to 1.60	0 to 2.60	Made Ground
1.60 to 1.20	2.60 to 3.00	Gley 2 4/1; As3, Ag1, Dh+; Dark bluish grey silty clay with detrital plant remains. Diffuse contact into:
1.20 to 0.48	3.00 to 3.72	Gley 1 6/1; As3, Ag1, Dl+; Greenish grey silty clay with detrital wood remains. Diffuse contact into:
0.48 to 0.29	3.72 to 3.91	10YR 4/1; As2, Sh1, Ag1, Dl+; Dark grey organic-rich silty clay with detrital wood remains. Diffuse contact into:
0.29 to 0.20	3.91 to 4.00	10YR 4/1; As2, Sh1, Ag1, Dl+; Dark grey organic-rich silty clay with detrital wood remains; Diffuse contact into:
0.20 to 0	4.00 to 4.20	10YR 4/1; As2, Sh1, Ag1, Dl+, Dh+; Dark grey organic-rich silty clay with detrital wood and plant remains (sedges/reeds). Diffuse contact into:
0 to -0.10	4.20 to 4.30	10YR 4/1; As2, Sh1, Ag1, Dh+; Dark grey organic-rich silty clay with detrital plant remains (sedges/reeds). Diffuse contact into:
-0.10 to -0.54	4.30 to 4.74	10YR 2/1; $Tl^2$2, Sh2; Humo 3; Black well-humified wood peat. Diffuse contact into:
-0.54 to -0.64	4.74 to 4.84	10YR 2/1; $Tl^2$2, Sh1, As1; Humo 2; Black moderately-humified wood peat with clay. Diffuse contact into:
-0.64 to -0.98	4.84 to 5.18	10YR 4/1; As2, Sh2, Tl+; Dark grey very organic-rich clay with wood remains. Diffuse contact into:
-0.98 to -1.60	5.18 to 5.80	10YR 2/1; Sh3, $Tl^3$1; Humo 3; Black well-humified wood peat. Diffuse contact into:
-1.60 to -1.80	5.80 to 6.00	10YR 3/1; Sh3, As1, Gg+, Dl/Tl+; Very dark grey very organic-rich clay with occasional gravel clasts. Diffuse contact into:
-1.80 to -2.01	6.00 to 6.21	10YR 4/3; Sh2, Ag1, Gg1, Dl+; Brown very organic-rich gravely silt with detrital wood remains; sharp contact into: UNIT NOT RETAINED
-2.01 to -2.80	6.21 to 7.00	10YR 4/1; Gg3, Ag1, As+, Ga+; Dark grey silty gravel with traces of clay and sand. Gravel clasts of flint up to 30mm, sub-angular to well-rounded. UNIT NOT RETAINED

Table 3: Lithostratigraphic description of borehole Kent-QBH2, Kent Wharf, Deptford, London Borough of Lewisham

Depth (m OD)	Depth (m bgs)	Description
4.30 to 1.70	0 to 2.60	Made Ground
1.70 to 1.30	2.60 to 3.00	10YR 4/1; As2, Ag1, Dl1, Gg+; Dark grey silty clay with detrital wood and traces of gravel.
1.30 to 0.99	3.00 to 3.31	10YR 4/1; As2, Ag1, Ga1, Dl+; Dark grey gravelly silty clay with traces of detrital wood and brick/tile fragments. Diffuse contact into:
0.99 to -0.70	3.31 to 5.00	10YR 5/1; As3, Ag1; Grey silty clay. Unknown contact into:
-0.70 to -1.04	5.00 to 5.34	10YR 4/1; As2, Gg2; Dark grey gravelly clay. Gravel clasts of flint up to 30mm, sub-angular to well-rounded. Sharp contact into:
-1.04 to -1.66	5.34 to 5.96	10YR 5/1; As3, Ag1, Dl+; Grey silty clay with detrital wood remains. Diffuse contact into:
-1.66 to -1.70	5.96 to 6.00	10YR 4/1; Gg3, As1, Ga+; Dark grey clayey gravel. Gravel clasts of flint up to 30mm, sub-angular to well-rounded.

Table 4: Lithostratigraphic description of borehole Kent-QBH3, Kent Wharf, Deptford, London Borough of Lewisham

Depth (m OD)	Depth (m bgs)	Description
4.80 to 2.80	0 to 2.00	Made Ground
2.80 to 2.30	2.00 to 2.50	Made Ground / Disturbed Alluvium
2.30 to 2.21	2.50 to 2.59	10YR 5/1; As3, Ag1; Grey silty clay; sharp contact into:
2.21 to 1.42	2.59 to 3.38	10YR 4/1; Ga2, Ag1, Gg1; Dark grey silty gravelly sand. Sharp contact into:
1.42 to 0.92	3.38 to 3.88	10YR 5/1; As3, Ag1; Grey silty clay. Diffuse contact into:
0.92 to 0.80	3.88 to 4.00	10YR 5/4; As3, Ag1, Dh+; Yellowish brown silty clay with traces of detrital plant remains. Diffuse contact into:
0.80 to 0.19	4.00 to 4.61	10YR 5/1; As3, Ag1, Dh+; Grey silty clay with traces of detrital plant remains. Diffuse contact into:
0.19 to -0.20	4.61 to 5.00	10YR 4/1; As2, Ag2, Dh+, Sh+; Grey silty clay with traces of detrital plant remains, organic material and Mollusca. Diffuse contact into:
-0.20 to -1.20	5.00 to 6.00	10YR 5/1; As2, Ag2, Dl+, Gg+, Sh+; Grey silty clay (sometimes appearing laminated) with traces of gravel, detrital wood, organic remains and Mollusca. Unknown contact into:
-1.20 to -1.95	6.00 to 6.75	10YR 5/1; Gg3, Ga1, Ag+; Grey sandy gravel with traces of silt. Gravel clasts of flint up to 30mm, sub-angular to well-rounded. Sharp contact into:
-1.95 to -2.10	6.75 to 6.90	10YR 5/1; As4, Ag+; Grey clay with traces of silt. Sharp contact into:
-2.10 to -2.20	6.90 to 7.00	10YR 5/1; Gg3, Ag1, Sh+, Dl+; Grey silty gravel with traces of organic remains and detrital wood. Gravel clasts of flint up to 30mm, sub-angular to well-rounded.

Table 5: Results of the borehole Kent-QBH1 organic matter determinations, Kent Wharf, Deptford, London Borough of Lewisham

Depth (m OD)		Organic matter content (%)
From	To	
0.45	0.46	23.56
0.37	0.38	25.14
0.29	0.30	17.16
0.21	0.22	14.77
0.13	0.14	14.88
0.05	0.06	25.69
-0.03	-0.02	41.17
-0.11	-0.10	75.93
-0.19	-0.18	71.84
-0.27	-0.26	68.10
-0.35	-0.34	73.52
-0.43	-0.42	73.14
-0.51	-0.50	59.86
-0.59	-0.58	51.20
-0.67	-0.66	31.64
-0.75	-0.74	37.78
-0.83	-0.82	31.76
-0.91	-0.90	42.56
-0.99	-0.98	57.55
-1.07	-1.06	45.36
-1.15	-1.14	48.58
-1.23	-1.22	50.37
-1.31	-1.30	52.20
-1.39	-1.38	61.53
-1.47	-1.46	63.80
-1.55	-1.54	58.94
-1.63	-1.62	37.32
-1.71	-1.70	11.40
-1.79	-1.78	23.28

Table 6: Results of the borehole Kent-QBH1 radiocarbon dating, Kent Wharf, Deptford, London Borough of Lewisham

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-427665 AMS	Twig wood; top of Peat	-0.11 to -0.16	2910 ± 30 BP	1210-1010 cal BC (3160-2960 cal BP)	-28.0
BETA-461558 AMS	Twig wood; centre of Peat	-0.50 to -0.60	3330 ± 30 BP	1690-1520 cal BC (3640-3470 cal BP)	-28.2
BETA-461557 AMS	Twig wood; centre of Peat	-1.10 to -1.20	4630 ± 30 BP	3520-3350 cal BP (5470-5300 cal BP)	-26.4
BETA 427666 AMS	Twig wood; base of Peat	-1.69	5770 ± 30 BP	4710-4540 cal BC (6660-6490 cal BP)	-28.6

Table 7: Results of the age-depth modelling, Kent-QBH1 radiocarbon dating, Kent Wharf, Deptford, London Borough of Lewisham

Boundary / 14C Date / Modelled Depth (m OD)	Unmodelled date (cal BP)		Modelled date (cal BP)		Individual Agreement Index
	95.4%		95.4%		
	from	to	from	to	
Boundary : Top of sequence (0.20)			*2980*	*-5610*	
0.10			*2990*	*-2520*	
0.00			*3000*	*20*	
Boundary : Top of Peat (-0.10)			*3030*	*2800*	
BETA-427665 (-0.13)	3160	2960	*3070*	*2880*	78.4
-0.20			*3200*	*2990*	
-0.30			*3360*	*3130*	
-0.40			*3510*	*3290*	
-0.50			*3650*	*3460*	
BETA-461558 (0.55)	3640	3470	*3700*	*3550*	62.9
-0.60			*3880*	*3630*	
-0.70			*4180*	*3840*	
-0.80			*4450*	*4070*	
-0.90			*4710*	*4310*	
-1.00			*4960*	*4570*	
-1.10			*5190*	*4850*	
-1.20			*5390*	*5140*	
BETA-461557 (1.25)	5470	5300	*5470*	*5300*	100.5
-1.30			*5660*	*5390*	
-1.40			*5960*	*5630*	
-1.50			*6220*	*5890*	
-1.60			*6460*	*6170*	
BETA-427666 (1.69)	6660	6490	*6650*	*6480*	96.7
-1.70			*6680*	*6490*	
-1.80			*6980*	*6640*	
-1.90			*7270*	*6820*	
Boundary : Base of Peat (-2.00)			*7550*	*7000*	
Agreement index of model - A = 66.6%					
Overall Agreement Index = 69.2%					

NB – italicised numbers are modelled dates

5. RESULTS & INTERPRETATION OF THE POLLEN & NON-POLLEN PALYNOMORPH ANALYSIS

5.1 Results of the pollen & non-pollen palynomorph analysis

Pollen concentration and preservation was variable through the sequence, with a full count of 300 reached in only 6 of the samples; a further 9 samples reached over 100 grains, and the remaining seven only key taxa could be noted. A percentage pollen diagram was consequently produced with these variable counts (Figure 13). The diagram has been divided into five local pollen assemblage zones (LPAZ) as follows:

LPAZ KWF-1 -1.79 to -1.68m OD *Pinus – Quercus - Alnus*
6980-6440 to 6650-6480 cal BP

This zone is characterised by high values of tree (75%) and shrub (15%) pollen: *Pinus* dominates (40%) with *Quercus* (20%), *Alnus*, *Corylus* type (15%), *Ulmus* (5%) and *Tilia* (<5%). Herbs (10%) are dominated by Cyperaceae with Poaceae, Lactuaceae and Apiaceae. Aquatics are absent. Spores comprise *Filicales monoletes* (15%) and *Pteridium aquilinum* (5%). Non-pollen palynomorphs (NPP) are restricted to an occurrence of *Spirogyra*. Total pollen concentration varied between 12,000 and 89,000 grains/cm^3. Microcharcoal concentration varied between 1700 and 34,500 fragments/cm^3.

LPAZ KWF-2 -1.68 to -1.28m OD *Alnus – Tilia - Quercus*
6650-6480 to *5580-5350* cal BP

This zone contains variable pollen concentrations, moderate to high values were recorded at the top and base, but were very low between -1.56 and -1.40m OD. The upper and lowermost samples are characterised by high values of tree (80%) and shrub (15%) pollen; *Alnus*, *Quercus* and *Tilia* dominate (20%) with *Pinus* and *Ulmus* (both <5%). *Calluna vulgaris* is also recorded at -1.32m OD (10%). Herbs (5%) comprise Cyperaceae, Poaceae, Asteraceae, Lactuceae, *Chenopodium* type and Apiaceae. Aquatics are limited to single grains of *Sparganium* type. Spores remain dominated by *Filicales monoletes* and *Pteridium aquilinum*. NPP are limited to sporadic occurrences of *Spirogyra* and *Sordaria*. Total pollen concentration varies between 20,000 and 90,000 grains/cm^3. Microcharcoal concentrations reduce from 26,000 to 0 fragments/cm^3.

LPAZ KWF-3 -1.28 to -0.64m OD *Alnus – Quercus - Tilia*
5580-5350 to *4000-3720* cal BP

This zone is characterised by high values of tree (75%) and shrub (20%) pollen. *Quercus*, *Alnus* and *Tilia* continue to dominate (20-30%) with *Corylus* type (20%). *Pinus*, *Ulmus* and *Hedera* are all sporadically present (<3%). Herbs (5%) comprise Cyperaceae, Poaceae, Asteraceae, Lactuceae, *Chenopodium* type and Apiaceae. Aquatics are limited to single grains of *Sparganium* type. Spores remain dominated by *Filicales monoletes, Pteridium aquilinum, Dryopteris type* and *Polypodium vulgare*. NPP are limited to sporadic occurrences of *Spirogyra* and *Cercophora*. Total pollen concentration varies between 5000 and 350,000 grains/cm^3. Microcharcoal concentrations are minimal varying between 0 and 2000 fragments/cm^3.

LPAZ KWF-4 -0.64 to -0.11m OD Minimal pollen
ca. 4000-3720 to *3030-2800* cal BP

This zone is characterised by very low pollen values; only one sample from the top of the zone reached a percentage count. The samples are characterised by high values of tree (80%) with shrub (5%) pollen; *Alnus* dominates (50%) with *Quercus* and sporadic occurrences of *Tilia, Pinus* and *Corylus* type. Herbs (5%) comprise Cyperaceae, Poaceae, Asteraceae, Lactuceae, *Chenopodium* type, Caryophyllaceae and *Ranunculus* type. Aquatics are limited to single grains of *Sparganium* type. Spores remain dominated by *Filicales monoletes, Pteridium aquilinum, Dryopteris type* and *Polypodium vulgare*. NPP are limited to sporadic occurrences of *Spirogyra, Sordaria* and *Dicrocoelium*. Total pollen concentration is 150,000 grains/cm^3. Microcharcoal is largely absent.

LPAZ KWF-5 -0.11 to 0.04m OD Cyperaceae – *Quercus* - Poaceae
After *ca. 3030-2800* cal BP

This zone is characterised by high values of herbaceous pollen (90%); Cyperaceae dominates (70%) with Poaceae, Lactuceae, *Chenopodium* type, *Ranunculus* type, *Galium* type, *Solanum nigra* type, *Plantago lanceolata/media/major* (all <5%). Trees and shrubs are dominated by *Quercus* (10%) with *Alnus*, *Ulmus*, *Calluna vulgaris*, *Vibernum* and *Salix* (all <5%). Aquatics are represented by single grains of *Typha latifolia*. Aquatics are dominated by *Pteridium aquilinum* with *Filicales monoletes* and *Polypodium vulgare*. NPP are absent. Total Pollen concentration is around 50,000 grains/cm^3. Microcharcoal concentrations are minimal (<1000 fragments/cm^3).

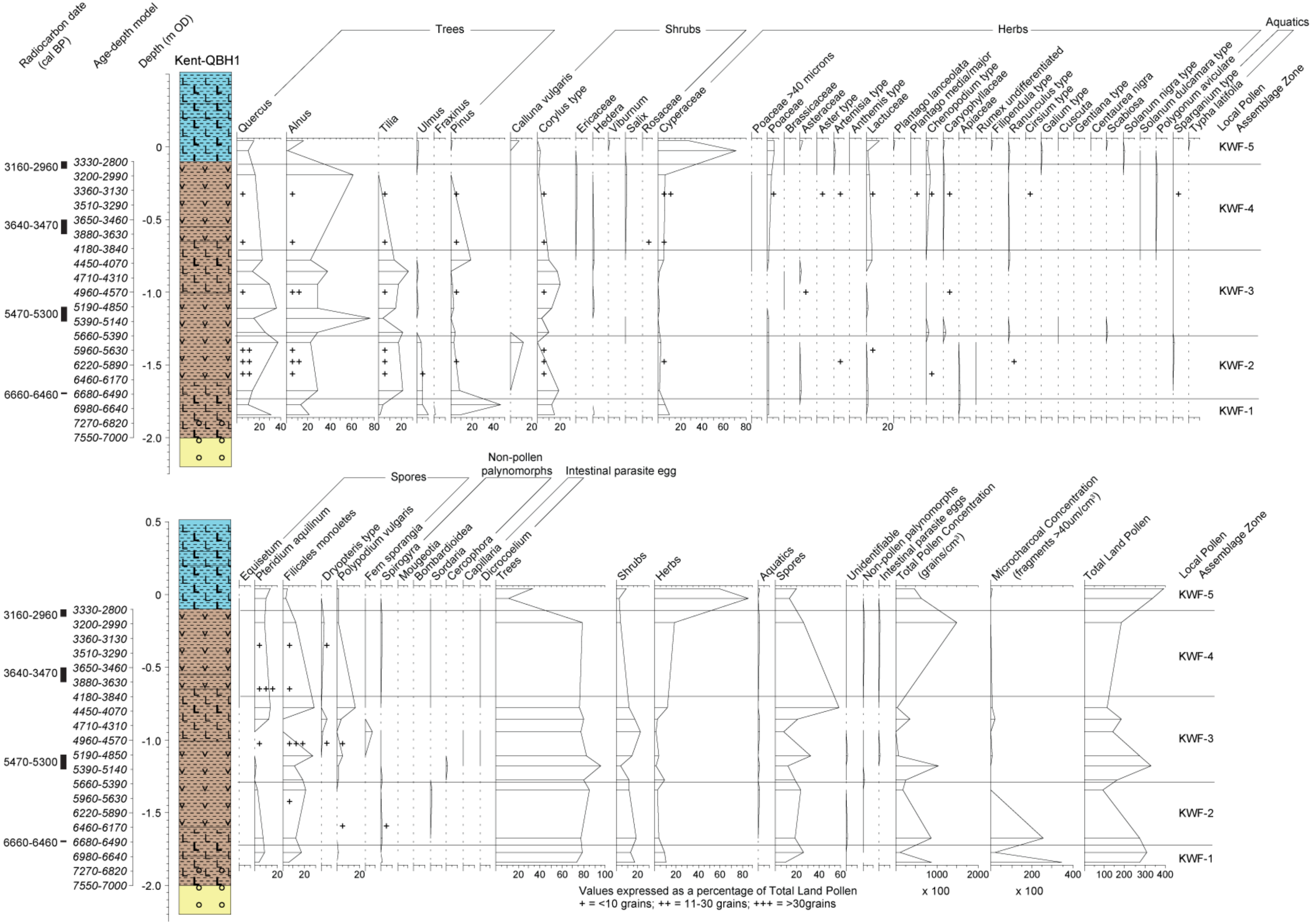

Figure 13: Percentage pollen diagram, Kent Wharf, Deptford, London Borough of Lewisham

5.1 Interpretation of the pollen & non-pollen palynomorph analysis

LPAZ KWF-1 -1.79 to -1.68m OD *Pinus – Quercus - Alnus*
6980-6440 to 6650-6480 cal BP

During LPAZ KWF-1, the results of the analysis indicate that mixed coniferous-deciduous woodland occupied the dryland environment, dominated by pine (*Pinus*) with oak (*Quercus*), elm (*Ulmus*), lime (*Tilia*) and hazel (*Corylus* type) with a ground flora most likely including grasses (Poaceae) and ferns (Filicales monoletes) and bracken (*Pteridium aquilinum*). Due to the entomophilous (insect pollinated) nature of *Tilia*, it is likely that lime formed a more substantial component of the vegetation than indicated by the relatively limited pollen values. Alder (*Alnus*), sedges (Cyperaceae) and grasses (Poaceae) most likely including reeds (*Phragmites australis*) occupied the floodplain environment either forming alder carr and sedge fen / reed swamp communities. The high microcharcoal values towards the base of the zone are indicative of nearby burning, though whether this is of natural or anthropogenic origin is unknown, particularly since no other definitive evidence of human activity was recorded during this period.

LPAZ KWF-2 -1.68 to -1.28m OD *Alnus – Tilia - Quercus*
6650-6480 to *5580-5350* cal BP

Pollen values were very low during this period; there at least three potential reasons for this: (1) since pollen is best preserved in anaerobic and anoxic conditions, it is possible that this zone represents a period of dry peat surface conditions; (2) the rate of peat formation may have been very high during this period, resulting in less grains/cm of peat (though the age-depth model suggests the rate of peat formation was fairly constant throughout the period of peat formation), and (3) post-depositional processes may have acted more prominently on certain peat horizons resulting in the subsequent decay of grains.

However, the levels that reached a sufficiently high count indicate a decline in pine whilst other deciduous arboreal taxa increase; particularly lime. This decline is pronounced and occurs around the time of a change in lithostratigraphy, as such it is possible that a hiatus occurred between the two local pollen assemblage zones. Nevertheless, the transition to LPAZ KWF-2 represents an important change in woodland composition on the dryland. Lime expanded to dominate with oak, and to a lesser extent hazel, elm and pine. Indeed, the values of lime and oak are sufficiently high to indicate that the dryland is located very close to the site (perhaps unsurprisingly given the location of the site within a relatively small tributary valley).

On the peat surface itself, the increase of *Alnus* and decline of Cyperaceae is suggestive of an expansion of alder dominated woodland. Areas of still/standing freshwater are however indicated by the presence of bur-reed (*Sparganium* type) and algae (Spirogyra). The presence of Chenopodium type (goosefoot family) is also of note here, since genera of the Chenopodiaceae family can occur 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. It is possible that hazel, elm and oak occupied the alder dominated woodland, but as above are more likely to have grown on the dryland with lime. Towards the top of the zone, a small peak in heather (*Calluna vulgaris*) is recorded, suggesting a possible temporary transition towards acidic peat surface conditions. It is of note however, that the pollen count was relatively low in this sample, and heather may be over-represented due to the distinctive nature of the pollen grain.

No definitive indications of human activity are recorded, though the peak in microcharcoal values towards the base of the zone is once again of note. Furthermore, the presence of non-pollen palynomorph Sordaria is indicative of herbivore dung, upon which the fungus grows, and intestinal parasite eggs are also recorded.

LPAZ KWF-3 -1.28 to -0.64m OD *Alnus – Quercus - Tilia*
5580-5350 to *4000-3720* cal BP
This zone has been defined to represent the decline of elm woodland. Distinguishing the precise point at which the decline actually occurred is difficult due to the limited pollen values recorded in the preceding LPAZ KWF-2 and the spike in alder pollen values that happens in the basal level of LPAZ KWF-3 which mask the decline. However, it is at the transition into LPAZ KWF-2 that Ullmus pollen values only sporadically occur. Defining the decline of elm is important as it is an occurrence recorded in records from across the Lower Thames Valley (Batchelor *et al*., 2014) and north-western Europe (Parker et al., 2002) between ca. 6300 and 5300 cal BP, representing the most important changes in vegetation at this time. There are no other major changes in pollen stratigraphy during this period, or indications of human activity.

LPAZ KWF-4 -0.64 to -0.11m OD Minimal pollen
ca. 4000-3720 to *3030-2800* cal BP
This zone is once again in part defined by very low pollen values, which as above maybe suggestive of dry peat surface conditions, rapid peat accumulation and/or post depositional processes. The uppermost sample however, records minimal *Tilia* values despite a relatively high pollen count. This represents a substantial decline in lime woodland, that must have taken place at somepoint during the zone (4000-3720 to 3030-2800 cal BP). This would therefore appear to be representative of the well-documented lime decline that is generally recorded in pollen diagrams across the British Isles during the late Neolithic / early Bronze Age as a consequence of deforestation (e.g. Grant *et al*., 2011). Whilst not definitive a greater range of herbaceous taxa including large grass grains (which could represent coastal grasses of cereals; Andersen, 1979), knotgrass (Polygonum aviculare), thistles (Cirsium type), could be suggestive of disturbed ground following clearance.

On the floodplain, the expansion of alder together with willow (Salix) woodland is indicated. Rather than representing a real change in vegetation, it is however possible that the increase in pollen values is a consequence of the decline in dryland woodland pollen. Conversely, it is possible that the decline of dryland woodland is in part the result of an expansion of wetland woodland, masking the dryland pollen signal.

LPAZ KWF-5 -0.11 to 0.04m OD Cyperaceae – *Quercus* - Poaceae

After *ca. 3030-2800* cal BP

The transition to LPAZ KWF-5 (after 3030-2800 cal BP) is characterised largely by changes on floodplain; a large increase in sedges, dandelions (Lactuceae), *Chenopodium* type and various herbs and aquatics are recorded. This assemblage is suggestive of a shift towards sedge fen, reed swamp and salt-marsh communities with an estuarine influence, most likely as a consequence of an increase in relative sea level rise (RSL). On the dryland, the continued decline of woodland is indicated by a reduction in oak. The increase of a large array of herbaceous taxa could suggest that this decline was a consequence of woodland clearance for settlement and agricultural purposes, which took place from the Bronze Age onwards. Whether the decline of the floodplain and dryland woodland is linked is uncertain, but does seem to be a common feature of woodland within pollen-stratigraphic records from the Lower Thames Valley.

6. RESULTS OF THE DIATOM ASSESSMENT

The samples derive from units with from low organic-matter content values within the Peat (-1.72 & -0.76m OD) and at the upper interface between the Peat and overlying Upper Alluvium (-0.12 & -0.08m OD). All samples were organic, with occasional minerogenic content. A minimum of four slide traverses were undertaken across each slide sample. However in all cases, diatoms were found to be absent and hence no results are presented within this report.

7. RESULTS OF THE MACROFOSSIL ASSESSMENT

A total of six small bulk samples from borehole QBH1 were extracted for the recovery of macrofossil remains, including waterlogged plant macrofossils, waterlogged wood, insects and Mollusca (Table 8). The samples were focussed on the Peat horizon in borehole QBH1. The results of the macrofossil rapid assessment indicate that waterlogged wood is present in moderate to high concentrations in four of the six samples assessed, between -0.20 and -0.80m OD and in the sample from -1.40 to -1.50m OD, and in low concentrations in the samples from -1.10 to -1.20 and -1.70 to -1.80m OD. Waterlogged seeds were recorded in low to moderate concentrations in three of the six samples (-0.20 to -0.30, -1.10 to -1.20 and -1.40 to -1.50m OD). No insects, charred plant remains, Mollusca, bone or artefacts were recorded during the assessment.

The three samples from borehole Kent-QBH1 in which waterlogged seeds were recorded underwent a more detailed assessment (Table 9). The seed assemblage included *Alnus glutinosa* (alder) catkins in all three samples, with *Rubus* cf. *fruticosus* (e.g. bramble) and *Chenopodium album* (fat hen) recorded in the sample from -0.20 to -0.30m OD. Although the assemblage recorded in these samples is too small to attempt a full environmental interpretation, the taxa recorded are typical of an alder carr wetland environment.

Table 8: Results of the macrofossil assessment of borehole Kent-QBH1, Kent Wharf, Deptford, London Borough of Lewisham

				Charred					Waterlogged		Mollusca		Bone				
Depth (m OD)	Volume sampled (ml)	Volume processed (ml)	Fraction	Charcoal (>4mm)	Charcoal (2-4mm)	Charcoal (<2mm)	Seeds	Chaff	Wood	Seeds	Whole	Fragments	Large	Small	Fragments	Insects	Artefacts
-0.20 to -0.30	60	60	>300µm	-	-	-	-	-	3	2	-	-	-	-	-	-	-
-0.50 to -0.60	90	90	>300µm	-	-	-	-	-	4	-	-	-	-	-	-	-	-
-0.80 to -0.90	50	50	>300µm	-	-	-	-	-	2	-	-	-	-	-	-	-	-
-1.10 to -1.20	60	60	>300µm	-	-	-	-	-	1	1	-	-	-	-	-	-	-
-1.40 to -1.50	50	50	>300µm	-	-	-	-	-	3	1	-	-	-	-	-	-	-
-1.70 to -1.80	50	50	>300µm	-	-	-	-	-	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+

Table 9: Results of the waterlogged plant macrofossil (seeds) assessment of borehole Kent-QBH1, Kent Wharf, Deptford, London Borough of Lewisham

Depth (m OD)	Waterlogged seeds		
	Latin name	Common name	Number
-0.20 to -0.30	*Alnus glutinosa* (catkin) *Rubus* cf. *fruticosus* *Chenopodium album*	alder e.g. bramble fat hen	1 1 13
-0.50 to -0.60			1
-0.80 to -0.90	-	-	-
-1.10 to -1.20	*Alnus glutinosa* (catkin)	alder	1
-1.40 to -1.50	*Alnus glutinosa* (catkin)	alder	2
-1.70 to -1.80	-	-	-

8. DISCUSSION

8.1 Sedimentary and hydrological history

The results of the geoarchaeological investigations have demonstrated a Shepperton Gravel surface resting between -1.64 and -2.23m OD across the majority of the site. This is overlain by 0.96-2.2m of Lower Alluvium, representing Holocene floodplain sedimentation in a moderate to low energy fluvial or estuarine environment. Towards the south of the site, the Lower Alluvium is not present, and appears either: (a) to have been eroded by a former channel or tributary of the Deptford Creek, which was subsequently abandoned and infilled by a 2m thick horizon of Peat; or (b) removed during the formation of a tree-throw hollow, which was subsequently infilled by Peat. Both the Peat and Lower Alluvium were succeeded by the deposition of Upper Alluvium, representative of an overbank floodplain or estuarine environment. The Kent Wharf sequence was capped by *ca.* 3m of Made Ground deposits, which in places truncated the Upper Alluvium.

Radiocarbon dating and age-depth modelling of the Peat in Kent-QBH1 indicates that it accumulated between at least *7550-7000* and *3330-2800* cal BP; a period of nearly 4000 years spanning the late Mesolithic to late Bronze Age cultural periods. It is possible however, that a hiatus in deposition occurred towards the base of the sequence, on the basis of both a change in lithostratigraphy and pollen assemblage, just below the lowermost radiocarbon date of 6660-6460 cal BP. If this is the case, it could be that the lowermost pollen assemblage dates to an earlier period than 7550-7000 cal BP.

No diatoms were preserved within the sequence from which it might be possible to reconstruct the hydrological history of the site. However, the pollen assemblage contains no definitive saltmarsh plants, though certain taxa may occupy either saltmarsh or freshwater / disturbed ground communities (e.g. Chenopodium type). The pollen assemblage therefore appears to indicate a freshwater or predominantly freshwater signal throughout the period of peat accumulation. Whilst the overlying Upper Alluvium also contains no definitive saltmarsh taxa, it is likely that the change in lithostratigraphy was caused by the well-documented increase in the rate of relative sea level rise that occurred around the Bronze Age period (Sidell, 2003).

8.2 Vegetation history

Three important events were recorded during within the palaeobotanical record from Kent Wharf:

8.2.1 The late Mesolithic expansion of pine

The new radiocarbon dated palaeoenvironmental record from Kent Wharf indicates that LPAZ KWF-1 can be equated to the end of the Mesolithic period (*6980-6440* to 6650-6480 cal BP). During this period pine dominated the dryland woodland with oak, elm, lime, hazel and a ground flora most likely including grasses and ferns and bracken. The high values of pine are of interest as pine tends to dominate earlier during the colder late Glacial / early Holocene (early Mesolithic) period at most sites in the Lower Thames Valley (e.g. West Silvertown – Wilkinson et al., 2000); Bramcote Green - Thomas and Rackham, 1996). As above, it is possible that a hiatus in deposition occurred between LPAZ KWF-1 and KWF-2, in which case the dominance of pine at Kent Wharf could be earlier than that indicated in the pollen diagram. However, at present, Kent Wharf is considered to join an increasing number of sites that similarly indicate an expansion of pine during the warmer late Mesolithic: Cable Car North Tower (75% TLP; 6850-6670 cal BP; Batchelor *et al*., 2012), Surrey House (75% TLP; 8490-7490 to 7360-7060 cal BP; Batchelor et al., 2012) and Monier Road (Batchelor & Hill, 2017). These dates potentially indicate the expansion of pine within the Lower Thames Valley during the Late Mesolithic cultural period.

8.2.1 The early Neolithic elm decline

Following the decline of pine and expansion of lime-dominated mixed deciduous woodland from 6650-6480 cal BP (LPAZ KWF-2), the next most significant change in vegetion is the decline of elm. As outlined above, defining the precise timing of the event is hampered by poor pollen preservation in the samples below, and the potential over-representation of *Alnus* pollen in the sample above the transition from LPAZ KWF-2 to KWF-3. Nevertheless, the decline of elm is identified around 5580-5350 cal BP (though could have occurred as early as 6660-6480 cal BP). This broadly synchronous, event was arguably the most significant change in woodland composition and structure during around this time, and started in the British Isles between ca. 6343 and 6307 cal yr BP (a period of 36 years), and ended between ca. 5420 and 5290 cal yr BP (Parker et al., 2002, Batchelor et al., 2014). Whilst the date of the decline at Kent Wharf is uncertain, it does appear to occur towards the end of this date range.

The reasons for the decline of elm have been of great debate over the years with the following hypotheses made: (1) climate change to cooler conditions (e.g. Smith, 1981); (2) soil deterioration due to e.g. Mesolithic burning (Peglar and Birks, 1993), or waterlogging and peat formation (paludification; Waller, 1994); (3) competitive exclusion (e.g. Huntley and Birks, 1983; Peglar and Birks, 1993); (4) human interference with natural vegetation (e.g. Scaife, 1988; Lamb and Thompson, 2005), and (5) Dutch elm disease (e.g. Perry and Moore, 1987; Girling, 1988). More recently, a multicausal model has been widely accepeted as the cause of the widespread decline (Parker et al., 2002; Batchelor et al., 2014).

At Kent Wharf, the cause of the decline is uncertain since there are no other major changes in pollen or lithostratigraphy during this period, indications of human activity or presence of the elm bark beetle (which might have caused disease). The site therefore fits within category 10 of the categorisation of the causes of the elm decline in the Lower Thames Valley and London as defined by Batchelor *et al*. (2014). However, Kent Wharf is approximately 500m downstream of Old Seager Distillery; here an apparent decline is recorded sometime between 6790-6550 and 5580-5320 cal BP, coinciding with the occurrence of both:

1. <u>Elm bark beetles</u>

The insect assemblage contained *Scolytus scolytus* and *S. multistriatus*, which significantly increased the number of sites recording their presence during the Neolithic in the Lower Thames Valley and UK (Girling and Grieg, 1985; Batchelor *et al*., unpublished data); Old Seager Distillery also contains the remains of another elm bark beetle: *Pteleobius vittatus*. The occurrence of *S. scolytus* and *P.*

vittatus provides unequivocal evidence for the presence of elm, either dying, or growing under stressed conditions. Similarly to other lines of evidence (e.g. Perry and Moore, 1987; Peglar and Birks, 1993; Rasmussen and Christensen, 1997), the presence of *S. scolytus* and *S. multistriatus* does not prove the existence of disease but, when combined with the decline of pollen and wood macrofossils of elm, the argument for fungal infection becomes more persuasive.

2. Evidence of human activity

This was recorded in the form of late Mesolithic/early Neolithic lithic artefacts. It is uncertain whether these artefacts represent one or multiple episodes of activity, but they are first recorded in the stratigraphic record before the decline. The relatively common occurrence of dung beetles after the decline of elm may also indicate the presence of nearby grazing animals, potentially associated with early Neolithic animal husbandry. Whilst Kent Wharf has not provided further evidence for the cause of the decline, it does identify a wide date range, that could be enhanced with extended pollen counting.

8.2.1 The Bronze Age decline of woodland

Lime declined at somepoint during LPAZ KWF-4 (4000-3720 to 3030-2800 cal BP); an occurrence that occurs in tandem with potential evidence of disturbace and cultivation. This decline continues into LPAZ KWF-5 (after 3030-2800 cal BP), which records the decline of other floodplain and dryland tree taxa. The decline in woodland on the dryland does therefore appear to precede but continue during the decline of wetland woodland. This occurrence is analogous with many other sites across the Lower Thames Valley. Problems related to the taphonomy of pollen from wetland and dryland environments all inhibit the interpretation of pollen data, and our ability to confidently reconstruct vegetation succession and causes of environmental change on dryland, however, the occurrence of an array of herbaceous pollen taxa that most likely originate from the dryland, and other taxa (such as Poaceae, *Chenopodium* type and Lactuceae) which may originate from a number of different environments, including the dryland, suggest Bronze Age land clearance for settlement and/or farming purposes was taking place at this time.

However, the contemporaneous nature of the decline in woodland on both the wetland and dryland is striking and suggests a strong link between the two environments and possible causes. Indeed, it is considered probable that the increased rate of relative sea level (RSL) rise that brought about environmental change on the wetland, also contributed to the decline of mixed deciduous woodland on the dryland in two different ways. Firstly, RSL rise may have caused the expansion of wetland onto areas of former dryland, and/or the saturation of dryland soils. This would have caused the retreat of dryland woodland away from the sampling point. Secondly, the wetter conditions and estuarine inundation that caused the eventual abandonment of the wetland by Bronze Age people, most likely led to the concentration of anthropogenic activity (and thus clearance) on the neighbouring dryland edge. There seems little doubt that these RSL driven processes could have influenced the rate of woodland decline on the dryland; however, the precise temporal and spatial relationships between RSL change, soil deterioration, human activity and dryland woodland decline remain very difficult to measure.

9. CONCLUSIONS

The geoarchaeological and palaeoenvironmental analysis report was aimed at fully addressing the following original project aims, with particular emphasis on comparing the results with those from nearby Old Seager Distillery.

1. To clarify the nature of the sub-surface stratigraphy across the site;
2. To clarify the nature, depth, extent and date of any alluvium and peat deposits
3. To investigate whether the sequences contain any artefact or ecofact evidence for prehistoric or historic human activity
4. To investigate whether the sequences contain any evidence for natural and/or anthropogenic changes to the landscape (wetland and dryland)
5. To integrate the new geoarchaeological record with other recent work in the local area for publication in an academic journal

The Shepperton Gravel surface rests between -1.64 and -2.23m OD across the majority of the site. This is overlain by 0.96-2.2m of Lower Alluvium, representing Holocene floodplain sedimentation in a moderate to low energy fluvial or estuarine environment. Towards the south of the site, the Lower Alluvium is absent, and appears either: (a) to have been eroded by a former channel or tributary of the Deptford Creek, which was subsequently abandoned and infilled by a 2m thick horizon of Peat; or (b) removed during the formation of a tree-throw hollow, which was subsequently infilled by Peat.. Both the Peat and Lower Alluvium were succeeded by the deposition of Upper Alluvium, representative of an overbank floodplain or estuarine environment, finally capped by *ca*. 3m of Made Ground, which in places truncates the Upper Alluvium. Radiocarbon dating and age-depth modelling of the Peat in Kent-QBH1 indicates it accumulated between at least 7550-7000 and 3160-2960 cal BP; a period of nearly 4000 years spanning the late Mesolithic to late Bronze Age cultural periods.

The sequences contain no definitive evidence of human activity. However, peaks in microcharcoal towards the base of the peat suggest nearby burning during the late Mesolithic that may be of natural or anthropogenic origin. Further up the sequence, certain pollen taxa may indicate disturbance and/or cultivation; herbivore dung and intestinal parasite eggs are also sporadically recorded. No evidence such as the lithic artefacts recorded at Old Seager Distillery were recorded.

Pollen and NPP analysis has provided a partially complete vegetation history for the site, which adds to that from Old Seager Distillery and therefore for the Deptford Channel as a whole. The record highlights three key vegetation events: (1) the apparent late Mesolithic expansion of pine; evidence for which appears to be increasing across the Lower Thames Valley as a whole; (2) the early Neolithic decline of elm, and (3) the Bronze Age decline of woodland on the floodplain and dryland.

The aims and objectives of the project are considered to have been successfully achieved, as above, providing an important record from this area of the Lower Thames Valley. The results from the investigation do not warrant publication in isolation, but the findings are of importance, enhancing those from the published Old Seager Distillery site. It is recommended that the findings are integrated into a future publication that integrates the findings from multiple sites and has a key central theme (e.g. vegetation history of the Lower Thames Valley).

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11. APPENDIX 1: OASIS FORM

Project details

Project name	Kent Wharf, Deptford, London Borough of Lewisham
Short description of the project	Three geoarchaeological boreholes were put down across the site. The resultant sequences were combined with historical borehole records to produce a deposit model for the site. The deposit model revealed a sequence of Late Glacial Shepperton Gravel, overlain by early-middle Holocene Lower Alluvium. Towards the south of the site, the Lower Alluvium appears to have been truncated by either a palaeochannel or tree-throw hollow. This depression was infilled by wood Peat. Upper Alluvium covered both the Peat and Lower Alluvial deposits. Made Ground capped the sequence. The Peat was radiocarbon dated from the late Mesolithic to late Bronze Age period. Pollen analysis revealed three key vegetation changes: (1) a late Mesolithic expansion of pine; (2) an early Neolithic decline in elm, and (3) a Bronze Age decline in wetland and dryland woodland
Project dates	Start: 12-10-2015 End: 27-09-2017
Previous/future work	No / No
Any associated project reference codes	KWF15 - Sitecode
Type of project	Environmental assessment
Monument type	PEAT Neolithic
Monument type	PEAT Mesolithic
Monument type	PEAT Bronze Age
Significant Finds	POLLEN Mesolithic
Significant Finds	POLLEN Neolithic
Significant Finds	POLLEN Bronze Age
Survey techniques	Landscape

Project location

Country	England
Site location	GREATER LONDON GREENWICH GREENWICH Kent Wharf
Postcode	SE8
Study area	5500 Square metres
Site coordinates	TQ 537600 177450 50.938046258208 0.188670401284 50 56 16 N 000 11 19 E Point

Project creators

Name of Organisation	Quaternary Scientific (QUEST)
Project brief originator	Consultant
Project design originator	Dr C.R. Batchelor
Project director/manager	C.R. Batchelor
Project supervisor	C.R. Batchelor

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	Kent Wharf, Deptford, Royal Borough of Greenwich: Geoarchaeological Deposit Model
Author(s)/Editor(s)	Batchelor, C.R.
Other bibliographic details	Quaternary Scientific (QUEST) Unpublished Report September 2015; Project Number 004/15
Date	2015
Issuer or publisher	Quaternary Scientific
Place of issue or publication	University of Reading

Project bibliography 2

Publication type	Grey literature (unpublished document/manuscript)
Title	Kent Wharf, London Borough of Lewisham: Environmental Archaeological Assessment Report
Author(s)/Editor(s)	Batchelor, C.R.
Other bibliographic details	Quaternary Scientific (QUEST) Unpublished Report January 2016; Project Number 004/14
Date	2016
Issuer or publisher	Quaternary Scientific
Place of issue or publication	University of Reading

Project bibliography 3

Publication type	Grey literature (unpublished document/manuscript)

Title	KENT WHARF DEPTFORD LONDON BOROUGH OF LEWISHAM: Environmental Archaeological Analysis Report
Author(s)/Editor(s)	Batchelor, C.R.
Author(s)/Editor(s)	Young, D.S.
Author(s)/Editor(s)	Hill, T.
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