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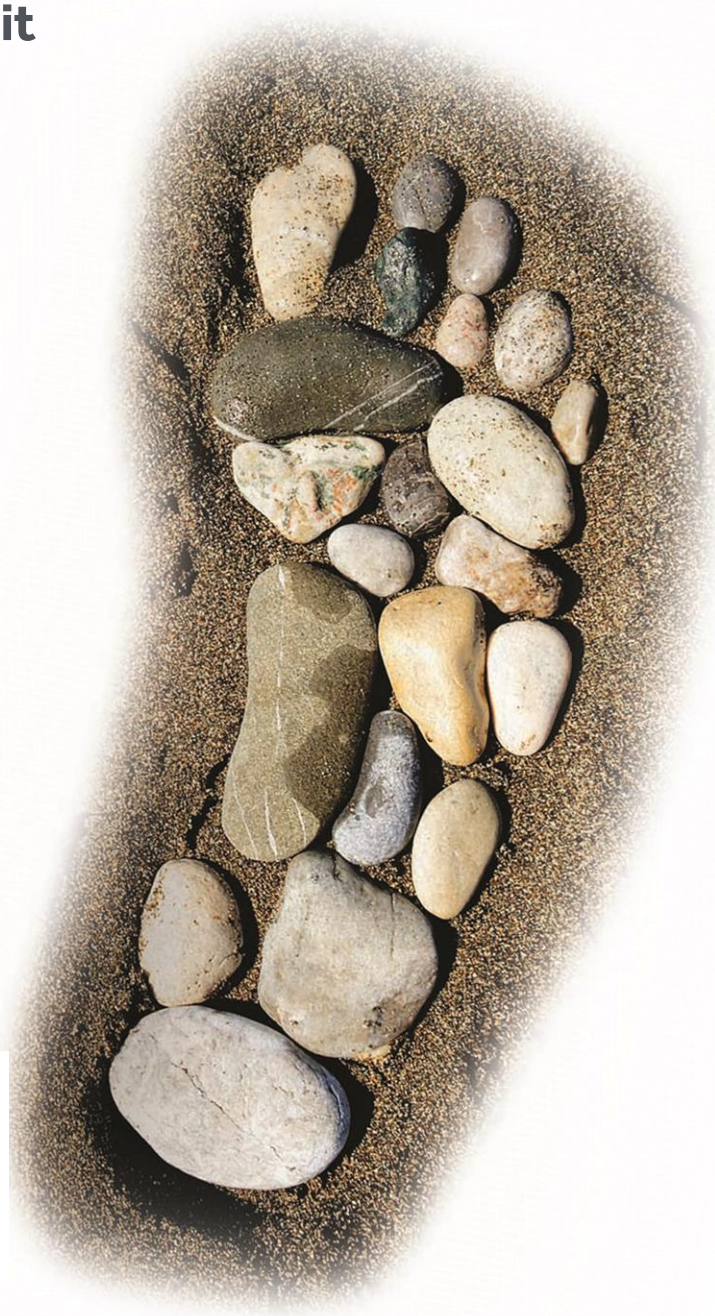
GREENWICH WHARF, ROYAL BOROUGH OF GREENWICH

Geoarchaeological Deposit Model Report



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Site Code: BNS16

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1. NON-TECHNICAL SUMMARY

A program of geoarchaeological fieldwork and deposit modelling was carried out by Quaternary Scientific (University of Reading) in connection with the proposed development of land at Greenwich Wharf, Royal Borough of Greenwich. The work was commissioned by CgMs Consulting. The aims of the investigation were: (1) to clarify the composition, nature and distribution of the sediments beneath the site, and (2) to evaluate the potential of these sediments for providing an insight into the environmental history of the site, and evidence of human activity.

In order to carry out the work, six geotechnical boreholes were monitored on site. The resultant records were combined with additional borehole and test-pit logs from the site which were inspected and evaluated, together with records from nearby archaeological/geoarchaeological investigations. The depth, thickness and nature of each major sedimentary unit was extracted and entered into geological modelling software, from which a series of topographic surface and thickness maps were produced.

The results reveal that the site is located on a high area of River Terrace Gravels (most likely the Kempton Park Gravel). Immediately to the north of the site, the gravel surface falls sharply into a major west-east aligned channel that traverses Greenwich Peninsula. A second, smaller depression (possible channel or glacial scour) is recorded immediately to the south of the site, again, orientated approximately west-east. Holocene deposits of Sand, Lower Alluvium, Peat and Upper Alluvium overlie the River Terrace Gravels. These tend to be relatively thin across the current Greenwich Wharf site and where the surface of the River Terrace Gravels is high, and thicker above the deep channels/depressions beyond the margins of the site.

The site is considered to have good archaeological potential for the following reasons: (1) the surface of the River Terrace Gravels is high, suggesting that it remained elevated above the floodplain through much of the prehistoric period and thus suitable for utilisation / occupation; (2) the situation of the site on the margins of a major channel traversing Greenwich Peninsula to the north, and a smaller channel to the south; (3) the occasional presence of Peat and organic-rich deposits at approximately the same elevation that the nearby Bellot Street trackways are recorded; (4) archaeological remains recently recovered elsewhere on the Greenwich Peninsula site by MoLA.

However, even in the absence of direct archaeological remains, the sediments recorded have the potential to contain a wealth of further information on the past landscape and evidence of human activities, through the assessment/analysis of palaeoenvironmental ecofact remains (e.g. pollen, plant macrofossils and insects) and radiocarbon dating. Not only will this work be of importance to understanding the history of the site, but it will contribute to our knowledge and understanding of the region as a whole.

The findings of the exercise therefore indicate that the site has archaeological, geoarchaeological and palaeoenvironmental potential and thus it is recommended that further field and laboratory-based investigations are carried out on the site.

2. INTRODUCTION

2.1 Site Context

This report summarises the findings arising out of the deposit modelling undertaken by Quaternary Scientific (University of Reading) in connection with the proposed development at Greenwich Wharf (NGR: centred on NGR TQ 39180 78580; site code: BNS16; Figures 1-3) site context. The site is located towards the south-western corner of Greenwich Peninsula, bounded to the west by the River Thames and to the east by Blackwall Lane (Figure 1). 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). This alluvium consists of fine-grained mineral-rich deposits and Peat, and is mapped to the south to approximately the position of the A206 where it meets higher drier ground. Beneath the alluvium, sand and gravel is present representing either the Pleistocene Kempton Park or Shepperton Gravel terraces. The bedrock beneath this is mapped as the Palaeogene Lambeth Group – Clay, Silt and Sand.

Formally, the Greenwich Wharf site encompassed land to the south and east of the present site (Figure 2). A geoarchaeological examination of historical geotechnical boreholes put down across this larger area was carried out by the Museum of London Archaeology Service (now MoLA) in 2007. This revealed the presence of five landscape zones (LZ1 to 5) which were largely determined by the underlying gravel topography:

LZ1: High gravels over 1m OD buried beneath clay/silt alluvium
LZ2: Gravels at 0-1m OD buried beneath clay/silt/sand alluvium
LZ3: Gravels below -4m OD overlain with thick sands and infilling glacial scour
LZ4: Gravels below -4m OD overlain by thick alluvial and peat deposits ca. 5m thick
LZ5: Low lying area – gravels below -2m OD overlain by alluvial silts, clays and organic deposits

The current site is almost entirely projected as being located within LZ1 and LZ2 – that is, above a relatively high gravel surface that dips southwards towards LZ's 3-5. Beyond this, LZ2 deposits are again recorded (Figure 2).

Since the MoLA desk-based investigation, detailed geoarchaeological and palaeoenvironmental investigations have been carried out on the adjacent Enderby Wharf (Batchelor et al., 2015) and Alcatel-Lucent (Young & Batchelor, 2015) sites. These reveal that the present Greenwich Wharf site is also located on the southern bank of a major west-east aligned palaeochannel that traverses Greenwich Peninsula. Within the channel, the basal River Terrace Gravels are recorded between -2.75 and -5.00m OD, and are overlain by alluvial and peat deposits, with the latter dated from *ca.* 5500 to 3000 cal BP (middle Neolithic to late Bronze Age).

Palaeobotanical (pollen, seeds and wood) investigation of the peat deposits from the channel indicate significant local variations in floodplain vegetation: relatively open vegetation is indicated at the Alcatel-Lucent site, whilst at Enderby Wharf, a much stronger wetland woodland signal is recorded. These differences may reflect localised variations in environment and vegetation at the time the Peat was forming (consequent of the position of the different sites within the channel), or that the peat is of different ages at each site. The vegetation on the neighbouring dryland is dominated by mixed deciduous woodland of oak, lime and elm. The decline of each species is indicated at different times during the Neolithic and Bronze Age suggestive of environmental changes taking place such the loss of dryland habitat (consequent of relative sea level rise) or anthropogenic impact.

Most recently, MoLA have carried out geoarchaeological and archaeological investigations on the rest of the Greenwich Wharf site. The results of these investigations are forthcoming, but information is being disseminated between the two organisations (Quest and MoLA).

2.2 Geoarchaeological, Palaeoenvironmental and Archaeological potential

The existing records from the Greenwich Wharf, Enderby Wharf and Alcatel-Lucent sites therefore indicate a variable sequence of Holocene alluvial deposits resting on a highly variable River Terrace Gravel surface.

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; (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. At present, our understanding is that the Greenwich Wharf site under investigation is between two deep depressions on the floodplain: a west-east aligned channel to the north identified at Alcatel Lucent / Enderby Wharf and a glacial scour feature to the south identified by MoLA. 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.

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-decidious 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 Enderby Wharf (Batchelor et al., 2015), Alcatel-Lucent (Young & Batchelor, 2015) and Bellot Street (Branch et al., 2005).

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 structure) and palaeoenvironmental record (e.g. changes in vegetation composition). The Greenwich Wharf has the raised potential for recording such remains as it is located on an elevated Gravel surface adjacent to two deep channel features. The deposits overlying this high gravel surface may have been elevated above the floodplain at times during the Holocene and thus could contain evidence of soil formation. The same conclusion was made within the MOLA 2007 assessment of the site. More importantly, two Bronze Age trackways have been found within a few hundred meters to the east of the site, above a similarly high gravel surface within Peat at two sites on Bellot Street (Branch et al., 2015; McLean, 1993; Philp, 1993). A medieval mill has also recently been excavated on the MoLA Greenwich Wharf site between Banning Street and Christchurch Way (Ruddy, pers. comm.).

2.3 Aims and Objectives

On the basis of the geoarchaeological, palaeoenvironmental and archaeological potential of the site, further records are required to enhance our understanding of the sub-surface stratigraphy of the Greenwich Wharf site, and for any further assessment/analysis of the deposits (if necessary).). Five significant research aims were thus proposed within the geoarchaeological Written Scheme of Investigation (WSI; Batchelor, 2016) for the site as follows:

1. To clarify the nature of the sub-surface stratigraphy across the site;
2. To clarify the nature, depth, extent and date of any former land surfaces, alluvial 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 content of this report achieves the first two of these aims and considers the potential of addressing aims 3 to 5 through laboratory-based assessment and analysis. The following objectives were carried out in order to address aims 1 & 2:

1. To monitor select boreholes put down by Idom Merebrook Ltd as part of ongoing geotechnical site investigations
2. To utilise the stratigraphic data from new and existing records to produce a deposit model of the major depositional units across the site.

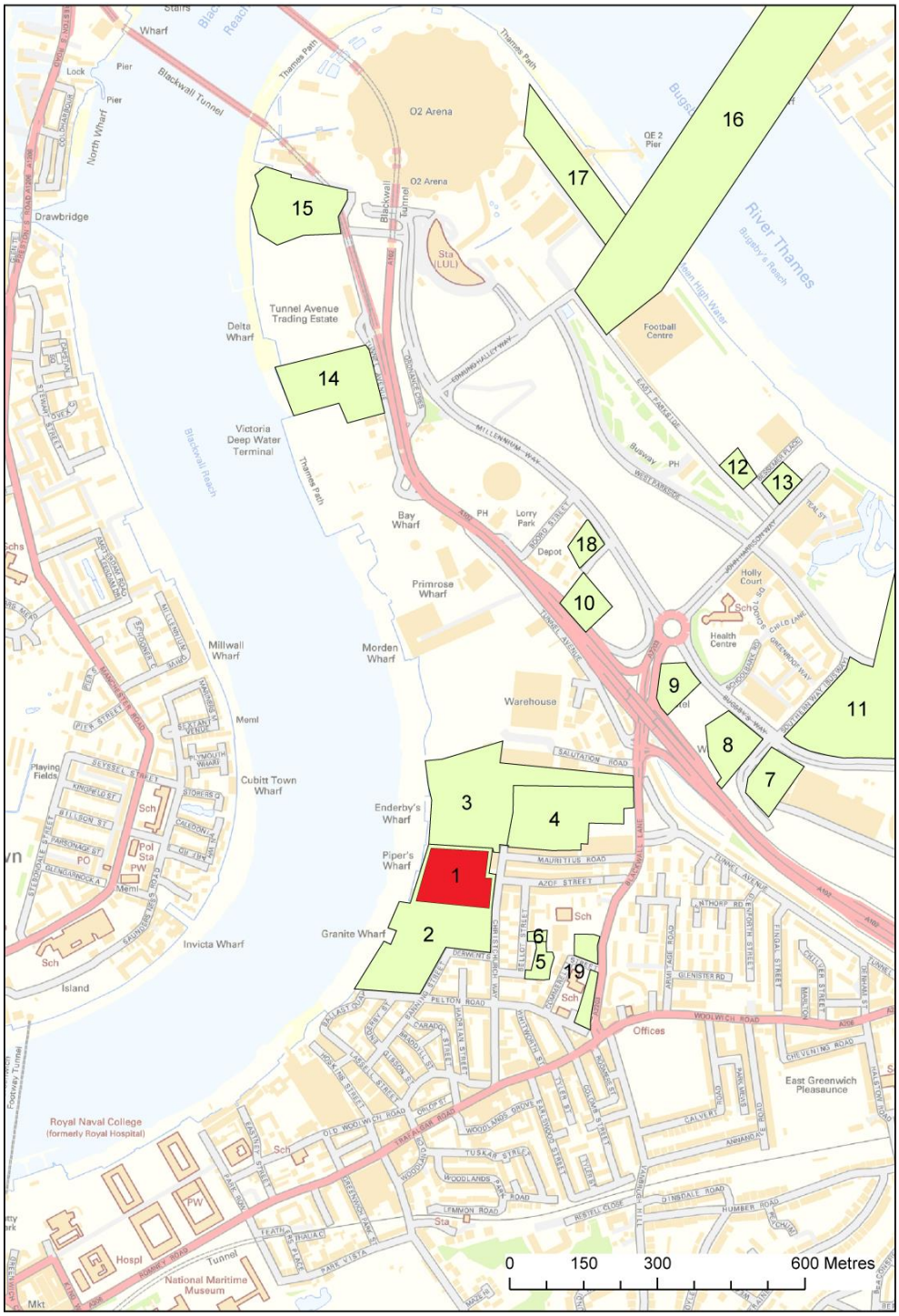

Figure 1: Location of (1) Greenwich Wharf (current site); (2) Greenwich Wharf (MoLA site); and selected nearby sites: (3) Enderby Wharf (Batchelor et al., 2015); (4) Alcatel-Lucent Telegraph Works (Young & Batchelor, 2015); (5) 72-88 Bellot Street (BSG93; McLean, 1993; Philp, 1993); (6) Bellot Street (GLB05; Branch *et al.*, 2005); (7) Land between A102 and Bugsby's Way; (MoLA) (8) BBW99 (MoLA); (9) Greenwich Peninsula Hotel (MoLA); (10) Plot MO401 (Batchelor, 2014); (11) Greenwich Millennium Village (Miller & Halsey, 2011);(12) Plot MO115 (Young & Batchelor, 2013b); (13) Plot MO117 (JHW13; Young & Batchelor, 2013a); (14) Victoria Deep Water Terminal (TUA02; Corcoran, 2002); (15) Tunnel Avenue (GPF12; Batchelor, 2013); (16) London Cable Car (CAB11; Batchelor *et al.*, 2015); (17) Greenwich Peninsula Central East (Young & Batchelor, 2015); (18) UKPN Proposed Substation (MoLA, 2015); (19) Blackwall Lane (MoLA) *Contains Ordnance Survey data © Crown copyright and database right [2016]*

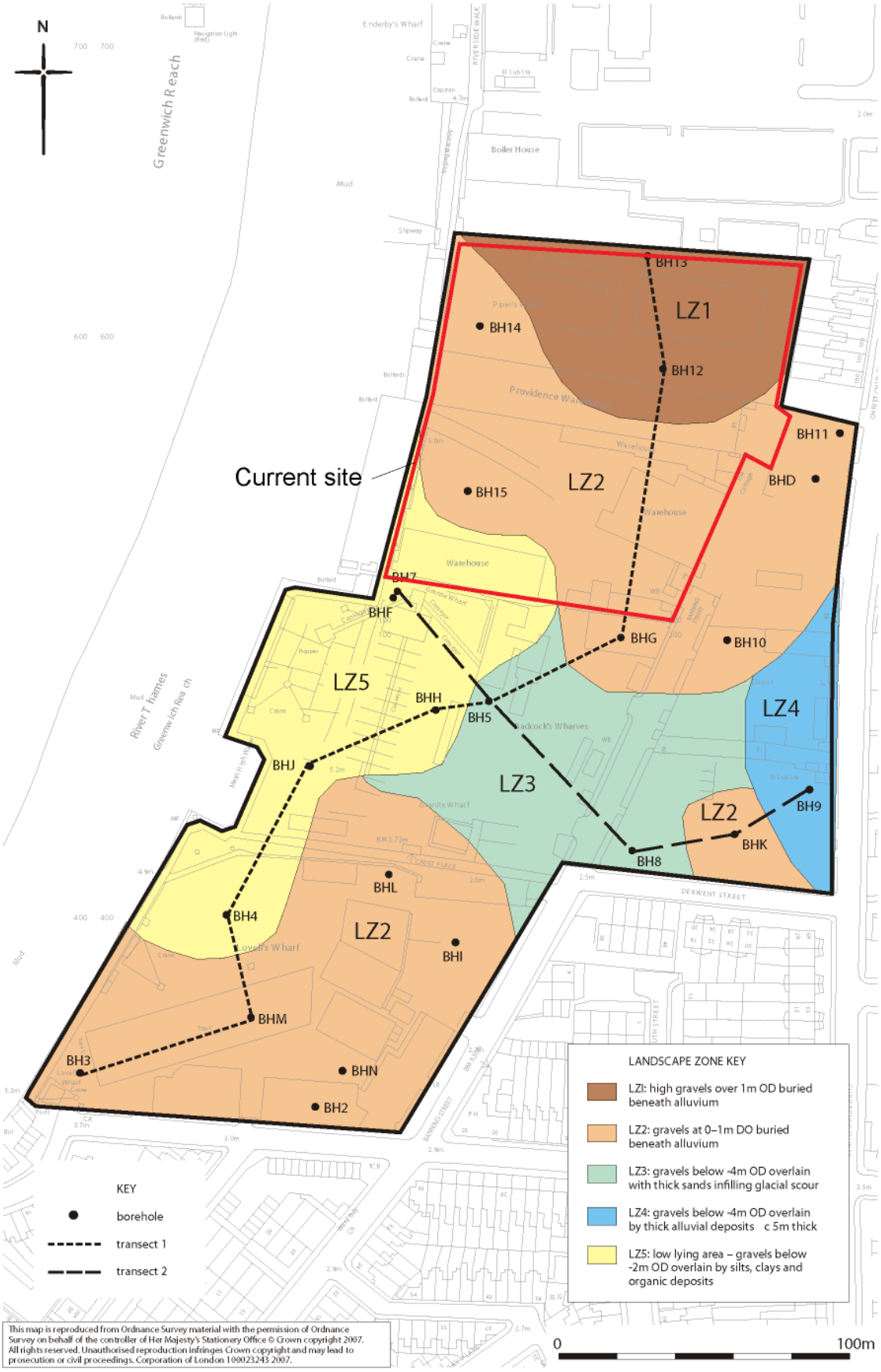

Figure 2: Greenwich Wharf landscape zones (reproduced from Halsey, 2007)

Figure 3: Location of recent and historic archaeological, geoarchaeological and geotechnical investigations carried out across Greenwich Wharf and neighbouring sites. Also illustrating the location of transects.

3. METHODS

3.1 Field investigations and lithostratigraphic descriptions

In April 2016, new geotechnical site investigations comprising 6 cable percussion boreholes and 13 test-pits were undertaken by Idom Merebrook Ltd. Monitoring of select cable percussion boreholes was carried out by Quaternary Scientific. The lithostratigraphy of the core samples was described in the field 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 of the geoarchaeological descriptions of the monitored boreholes are displayed in Tables 2 to 7. The locations (easting, northing and elevation) were estimated from plans and topographic surveys).

3.2 Deposit modelling

Combined, the new and existing archaeological, geoarchaeological and geotechnical records provide over 81 complete Holocene stratigraphic records for the site and its immediate surroundings which can be used for deposit modelling purposes (Table 1). In the present investigation, modelling was undertaken using RockWorks software. The term 'deposit modelling' describes any method used to depict the sub-surface arrangement of geological deposits, but particularly the use of computer programmes to create contoured maps or three dimensional representations of contacts between stratigraphic units. The first requirement is to classify the recorded borehole sequences into uniformly identifiable stratigraphic units. At the Greenwich Wharf site six stratigraphic units were recognised: (1) River Terrace Gravels; (2) Sand; (3) Lower Alluvium; (4) Peat; (5) Upper Alluvium and (6) Made Ground. Models of surface height were generated for the Gravel, Lower Alluvium, Peat and Upper Alluvium (Figures 4, 5, 6 & 8). Thickness of the Peat, Total Alluvium and Made Ground (Figures 7, 9 & 10) were also modelled (also using a nearest neighbour routine). A transect was also prepared from south-west to north-east across the site (Figure 11).

How effectively Rockworks portrays the relief features of stratigraphic contacts or the thickness of sediment bodies depends on the number of data points (e.g. boreholes) per unit area and the extent to which these points are evenly distributed across the modelled area. 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. Obviously the larger the chosen distance the less reliable the overall portrayal. In the present case the distance chosen for each data point has been set to a radius of 50m; thus for complete coverage across any given site, the boreholes must be spaced on a grid of approximately 100m intervals.

Because the boreholes are not uniformly distributed over the area of investigation, the reliability of the models is variable. In general, reliability improves from the boundaries of the modelled area,

where edge effects adversely influence the reconstructions, towards the core area of the site where mutually supportive data are likely to be available from several adjacent boreholes.

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. 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.

Table 1: Borehole / Test-pit details integrated into the Greenwich Wharf deposit models

Name	Easting	Northing	Elevation	Total Depth
Greenwich Wharf (Quest)				
GW/MBH101	539129	178619	7.50	16.00
GW/MBH102	539116	178529	2.63	16.00
GW/MBH103	539160	178602	5.44	12.00
GW/MBH104	539146	178563	2.40	20.00
GW/MBH105	539221	178589	2.80	25.00
GW/MBH106	539183	178521	1.91	23.00
GW/MTP101	539194	178542	2.10	4.00
GW/MTP102	539152	178519	2.40	3.50
GW/MTP103	539112	178548	2.77	3.50
GW/MTP104	539137	178584	2.37	3.10
GW/MTP105	539198	178573	2.29	2.50
GW/MTP107	539194	178592	2.70	3.40
GW/MTP108	539208	178610	2.90	2.30
GW/MTP109	539222	178622	2.60	2.80
GW/MTP110	539175	178619	2.80	3.50
GW/MTP111	539127	178569	2.47	3.50
GW/MTP112	539130	178601	5.66	4.50
GW/MTP113	539142	178532	2.40	3.20
Greenwich Wharf (MoLA, 2007)				
GWW07-BH12	539195	178588	3.05	4.00
GWW07-BH13	539189.5	178626	3.60	4.00
GWW07-BH4	539041	178404	3.60	6.00
GWW07-BH5	539132.5	178475.5	2.50	6.00
GWW07-BHG	539179	178497	2.20	4.00
GWW07-BHH	539114	178472.5	5.45	8.00
GWW07-BHJ	539070	178454.5	5.15	7.00
GWW07-BHM	539048.5	178369	3.60	5.00
Alcatel Lucent (Young & Batchelor, 2015)				
ALQBH1	539351	178714	1.80	6.00
ALQBH2	539417	178711	1.80	6.00
ALQBH4	539344	178651	2.02	6.00
MWS1	539292	178761	1.40	3.00
MWS2	539327	178757	1.50	3.00
MWS3	539320	178716	1.80	4.00
MWS4	539294	178701	2.00	0.90
MWS5	539346	178635	2.10	3.00
MWS6	539346	178669	1.90	3.00
MWS7	539314	178660	2.10	4.00
Blackwall Lane (MoLA)				
BLL12-BH1	539461	178441	1.90	4.00

BLL12-BH2	539433.6	178410.9	1.53	4.00
BLL12-BH3	539454.5	178402.2	1.95	4.00
BLL12-BH4	539459	178372.9	1.80	4.00
BLL12-BH5	539453.5	178351.4	2.10	4.00
BLL12-BH6	539448.3	178327.2	2.03	4.00
BLL12-BH7	539444.7	178307.8	2.50	4.00
Enderby Wharf (Batchelor *et al.*, 2015)				
EWBH3	539149	178692	2.77	29.46
EWBH4	539201	178717	2.16	30.00
EWBH5	539271	178740	2.05	20.00
EWBH6	539261	178689	2.05	30.18
EWBH7	539215	178657	2.44	20.00
EWQBH1	539270.4	178740	1.84	6.00
EWQBH2	539216	178659.4	2.32	7.00
EWQBH3	539428.3	178765.3	1.59	5.00
Bellot Street (Branch *et al.*, 2005)				
GBL05/Tr1	539330	178442	1.50	2.50
GBL05/Tr2	539347	178448	1.55	3.50
72-82 Bellot Street (McLean, 1993; Philp, 1993)				
BSG93-TR1E	539365	178405	1.00	2.00
BSG93-TR1W	539365	178405	1.00	2.00
Miscellaneous				
CW/TR1	539250	178380	2.46	1.20
PR/TR1	539200	178300	2.04	2.50
British Geological Survey (NERC)				
TQ37NE1756	539450	178580	1.33	15.00
TQ37NE1757	539420	178570	1.27	15.00
TQ37NE1947	539495	178575	1.34	6.10
TQ37NE1948	539255	178525	1.19	6.10
TQ37NE2157	539430	178630	1.57	7.60
TQ37NE577	539120	178440	4.88	11.00
TQ37NE578	539140	178440	2.51	7.50
TQ37NE579	539160	178450	2.10	7.50
TQ37NE580	539150	178470	1.95	8.50
TQ37NE583	539110	178500	0.73	5.00
TQ37NE585	539120	178480	5.12	11.50
TQ37NE586	539100	178480	5.10	11.00
TQ37NE587	539130	178460	2.30	8.00

4. RESULTS, INTERPRETATION AND DISCUSSION OF THE LITHOSTRATIGRAPHIC DESCRIPTIONS & DEPOSIT MODELLING

The results of the geoarchaeological borehole descriptions are shown in Tables 2-7. The results of the deposit modelling are displayed in Figures 4 to 11; Figures 4 to 10 are surface elevation and thickness models for each of the main stratigraphic units. Figure 11 is a 2-Dimensional transect across the Greenwich Wharf and Enderby Wharf sites from south-west to north-east. The results of the deposit modelling indicate that the number and spread of the logs is sufficient to permit modelling with a high level across the entire area under investigation.

The full sequence of sediments recorded in the boreholes comprises:

Made Ground
Upper Alluvium – widely present
Peat – locally present
Lower Alluvium – widely present
Sand – locally present
Gravel (Kempton Park / Shepperton Gravel)

4.1 River Terrace Gravels

Coarse sand and gravel deposits were present in all sequences that penetrated to the bottom of the Holocene sequence. The surface of these deposits is generally recorded between 0 and -1m OD across the current site, and is clearly higher than that recorded across the surrounding area. Immediately to the north of the site, a steep-sided and deep depression is recorded in the area of Enderby Wharf and Alcatel-Lucent, reaching depths of -3.5 to -4.5m OD; to the south on the MoLA Greenwich Wharf site, another, slightly shallower depression is recorded, this time reaching -2.5m OD; to the south-east, in the area of the two Bellot Street sites and Blackwall Lane, the sand and gravel surface is recorded between -2 and +1m OD, becoming shallower in a southwards direction.

The sands and gravels are representative of deposition within a high-energy braided river system during the Pleistocene. Two periods of deposition are thought to be represented across the modelled area: those sequences with a surface height above -2m OD (i.e. the current site, Blackwall Lane and the two Bellot Street sites) probably represent the Kempton Park Gravel laid down during the middle Devensian (*ca.* 120,000 to 30,000 BP), whilst the deeper depressions with a surface height >-2m OD most likely represent the infilling of two deep depressions by the later Shepperton Gravel which cut through the Kempton Park Gravel during the late Devensian (30,000 to 11,500 BP). Towards the southern edge of the current site, a deeper sand and gravel surface in GW/BH102 is indicative of the northern edge of the shallower depression (e.g. GW/MBH102), which MoLA interpret as a Glacial scour feature (MoLA, 2007).

4.2 Sands

In certain boreholes, a horizon of Sand can be distinguished overlying the River Terrace Gravels, indicative of the fluvial deposition of coarse-grained sediment, most likely during the early Holocene (Figures 4 & 11). On the site itself, this includes boreholes GW/MBH101, GW/MTP101, GW/MTP103, GW/MTP110 and GW/MTP113. Distinct horizons are also recorded in certain locations on the MoLA Greenwich Wharf site to the south and on the southern part of the Alcatel-Lucent site. It therefore appears that there is little correlation between the presence of the sand and the topographic height of the underlying River Terrace Gravels. It should be noted however that the distinction between the Gravel and overlying Sand is sometimes problematic in geotechnical logs, and thus may have been present in other boreholes.

4.3 Soil formation

The height of the River Terrace Gravels and overlying sands across the majority of the current Greenwich Wharf site is between 0 and -1m OD. Such elevated surfaces would have remained as dry ground through much of the prehistoric period, with the potential for mature soils to develop. No definitive evidence of soil formation was recorded during the monitoring of the boreholes; however, the nature of geotechnical borehole investigations is not conducive to the recording of such sediments, and thus the potential for their occurrence still remains on the site.

4.4 Lower Alluvium

The Lower Alluvium is commonly recorded in records from the two deep depressions beyond the confines of the current site, and on the Blackwall Lane / Bellot Street sites, overlying the River Terrace Gravels and/or Sands. On the current site itself, the Lower Alluvium is absent with the exception of GW/MBH102 and GW/MBH106, which are located towards the south (Figures 5, 6 and 11). The deposits of the Lower Alluvium are described as a predominantly silty or clayey unit tending to become increasingly sandy downward in most sequences. The Lower Alluvium occasionally contains detrital wood or plant remains, and in many cases is described as organic rich. Where present, the surface of the Lower Alluvium varies between 0 and -3m OD.

The sediments of the Lower Alluvium are indicative of deposition during the early to middle Holocene, when the main course of the Thames was probably confined to a single meandering channel. During this period, former channels surface and low levels of River Terrace Gravels were progressively buried beneath the sandy and silty flood deposits of the river. The occasionally richly-organic nature of the Lower Alluvium, with evidence of localised and short-lived, probably episodic, peat accumulation suggests that this was a period during which the valley floor was occupied by a network of actively shifting channels, with a drainage pattern on the floodplain that was still largely determined by the relief on the surface of the underlying gravel surface.

4.5 Peat

Peat formed across the majority of the modelled area, but is largely absent across the current Greenwich Wharf site with horizons recorded only towards the south-eastern corner in borehole GW/MBH106 and test-pit GW/MTP113; peaty clay is also recorded in GW/MBH105 (Figures 6, 7 &

11). In each case, the Peat is thin (<50cm) and woody, suggesting a relatively short transition to semi-terrestrial conditions supporting the growth of wetland vegetation including trees. At the nearby Bellot Street sites, the surface on which the Peat formed is similarly high (-1 to 0m OD) and it varied up to *ca.* 1m in thickness. Significantly, it was within this Peat that two Bronze Age trackway sites were recorded at 0.55 to 0.65m OD, dating to around 3700 cal BP (Branch *et al.*, 2005). On the basis of elevation and location, the Peat on the current site could be expected to be of approximately the same age and has the potential to contain archaeological remains.

Within the two deep depressions/channels, thicker and more complex horizons of Peat and organic-rich deposits are recorded, frequently ranging between 1 and 2m in thickness. Within the deeper channel to the north, these deposits have been radiocarbon dated in sequences from the Alcatel-Lucent and Enderby Wharf sites, as accumulating between approximately 5500 and 3000 cal BP (middle Neolithic to late Bronze Age). The surface of the Peat across the modelled area tends to range between 0 and -2m OD.

4.6 Upper Alluvium

The uppermost unit in the Holocene alluvial sequence is the Upper Alluvium. These deposits tend to comprise largely sterile clays and silty clays, but across the current Greenwich Wharf site are often described as organic or highly organic (e.g. GW/MTP101 to GW/MTP104 & GW/MTP109). The Upper Alluvial deposits generally range between 0.75 and 1.5m across the current site, and tend to vary up to 3m in thickness across the entire modelled area. The deposition of the Upper Alluvium had the effect of infilling the remaining inequalities in the relief of the floodplain, so that the surface of the Upper Alluvium (Figure 9) is relatively level between 0 and 2.5m OD (Figure 8).

The Upper Alluvium is typical of the mineral-rich sediments that are present as the uppermost element of the Holocene sequence beneath most floodplains in southern and south-east England. It is generally considered to reflect increased sediment loads resulting from intensification of agricultural land use from the later prehistoric period onward, combined with the effects of rising sea level.

The total thickness of the Holocene alluvial units at the site, incorporating the Sand, Lower Alluvium, Peat and Upper Alluvium is shown in Figure 9. Unsurprisingly, areas of high gravel topography (i.e. the current site) have the least total alluvium thickness and vice versa.

4.7 Made Ground

Between 1 and 5m of Made Ground caps the Holocene alluvial sequence (Figure 10); across much of the current site, it rarely exceeds 1.5m, but in certain areas (particularly the north-west of the site) it reaches over 4m due to ground raising.

5. CONCLUSIONS AND RECOMMENDATIONS

The aims of the geoarchaeological investigations at the Greenwich Wharf site were: (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, and (3) to evaluate the potential for reconstructing the environmental history of the site and its environs (aims 3 to 5 of the project). In order to achieve these aims, a programme of deposit modelling of the surface elevation and thickness of the major stratigraphic units at the site was carried out, incorporating previous new and existing records from the site and surrounding areas.

The results have confirmed that the site is located on a high area of River Terrace Gravels (most likely the Kempton Park Gravel) generally resting at approximately 0 to -1m OD. Immediately to the north of the site, the gravel surface falls sharply into a west-east aligned channel that traverses Greenwich Peninsula. This channel reaches depths of -5m OD in places, and appears to be >100m wide, thus representing a substantial feature. A second, smaller depression (possible channel or glacial scour) is recorded immediately to the south of the site, again orientated approximately west-east; this reaches depths of up to -2m OD and appears to <100m in width. Holocene deposits of Sand, Lower Alluvium, Peat and Upper Alluvium overlie the River Terrace Gravels. These tend to be relatively thin across the current Greenwich Wharf site and where the surface of the River Terrace Gravels is high, rarely exceeding 2m in thickness. Conversely, above the deep channels/depressions, the total alluvium thickness can exceed 5m.

The site is considered to have good archaeological potential for the following reasons: (1) the surface of the River Terrace Gravels is high, suggesting that it remained elevated above the floodplain through much of the prehistoric period and thus suitable for utilisation / occupation; (2) the situation of the site on the margins of a major channel traversing Greenwich Peninsula to the north, and a smaller channel to the south; (3) the occasional presence of Peat and organic-rich deposits at approximately the same elevation that the nearby Bellot Street trackways are recorded, and (4) archaeological remains recently recovered elsewhere on the Greenwich Peninsula site by MoLA.

However, even in the absence of the archaeological remains, the occasional occurrence of Peat and organic-rich deposits has been demonstrated, and the potential presence of mature soils remains. These sediments have the potential to contain a wealth of further information on the past landscape, through the assessment/analysis of palaeoenvironmental remains (e.g. pollen, plant macrofossils and insects) and radiocarbon dating. So called environmental archaeological or palaeoenvironmental investigations can identify the nature and timing of changes in the landscape, and the interaction of different processes (e.g. vegetation change, human activity, climate change, hydrological change) thereby increasing our knowledge and understanding of the site and nearby area. In the case of human activity, palaeoenvironmental evidence can include: (1) decreases in tree and shrub pollen suggestive of woodland clearance; (2) the presence of herbs indicative of disturbed ground, pastoral and/or arable agriculture; (3) charcoal/microcharcoal suggestive of anthropogenic or natural burning, and (4) insect taxa indicative of domesticated animals.

The findings of the exercise therefore indicate that the site has archaeological, geoarchaeological and palaeoenvironmental potential and thus it is recommended that further work is carried out. With regards to the geoarchaeological and palaeoenvironmental works, it is recommended that this comprises the recording and sampling of archaeological trenches and/or the collection of targeted borehole samples. Working from archaeological trenches is by far the more preferable option as it will enable collection of the best sequence(s), and a greater amount of material to be sampled for the recovery of macrofossil remains. Following fieldwork, a program of radiocarbon dating and laboratory-based palaeoenvironmental assessment/analysis works will also be undertaken (if necessary).

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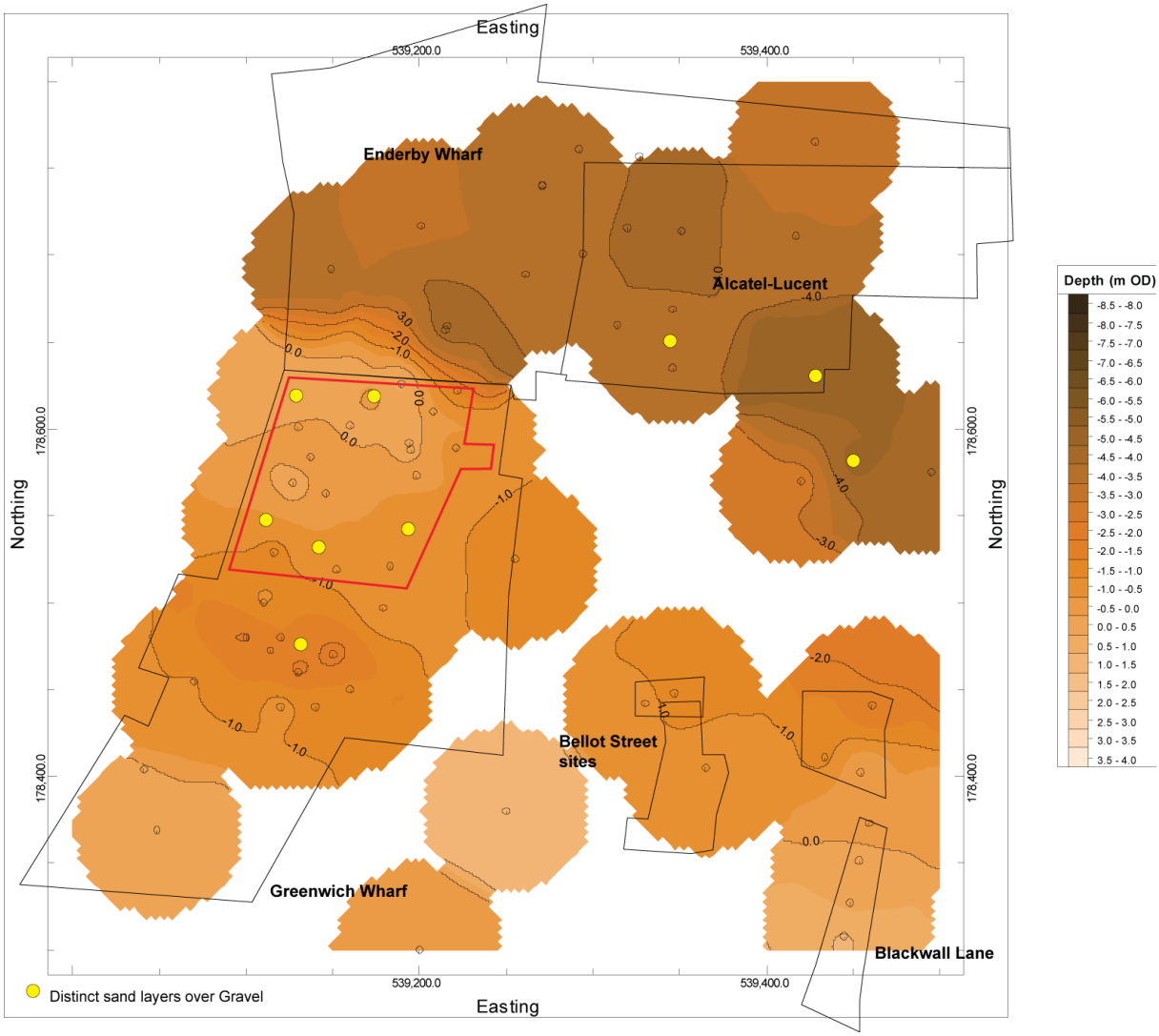

Figure 4: Surface of the River Terrace Gravels (m OD). Also displaying those sequences with a distinct horizon of overlying Sand

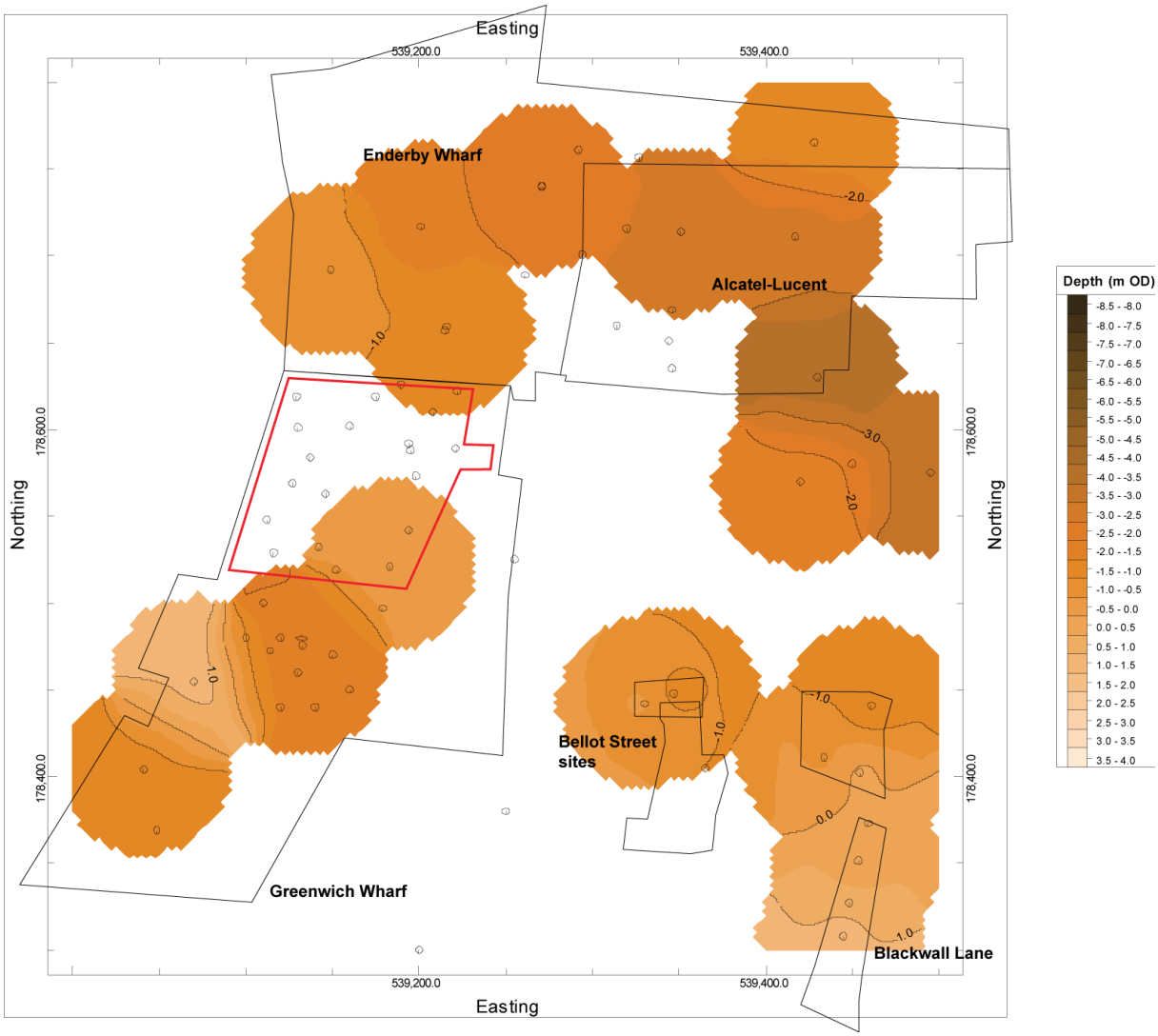

Figure 5: Surface of the Lower Alluvium (m OD)

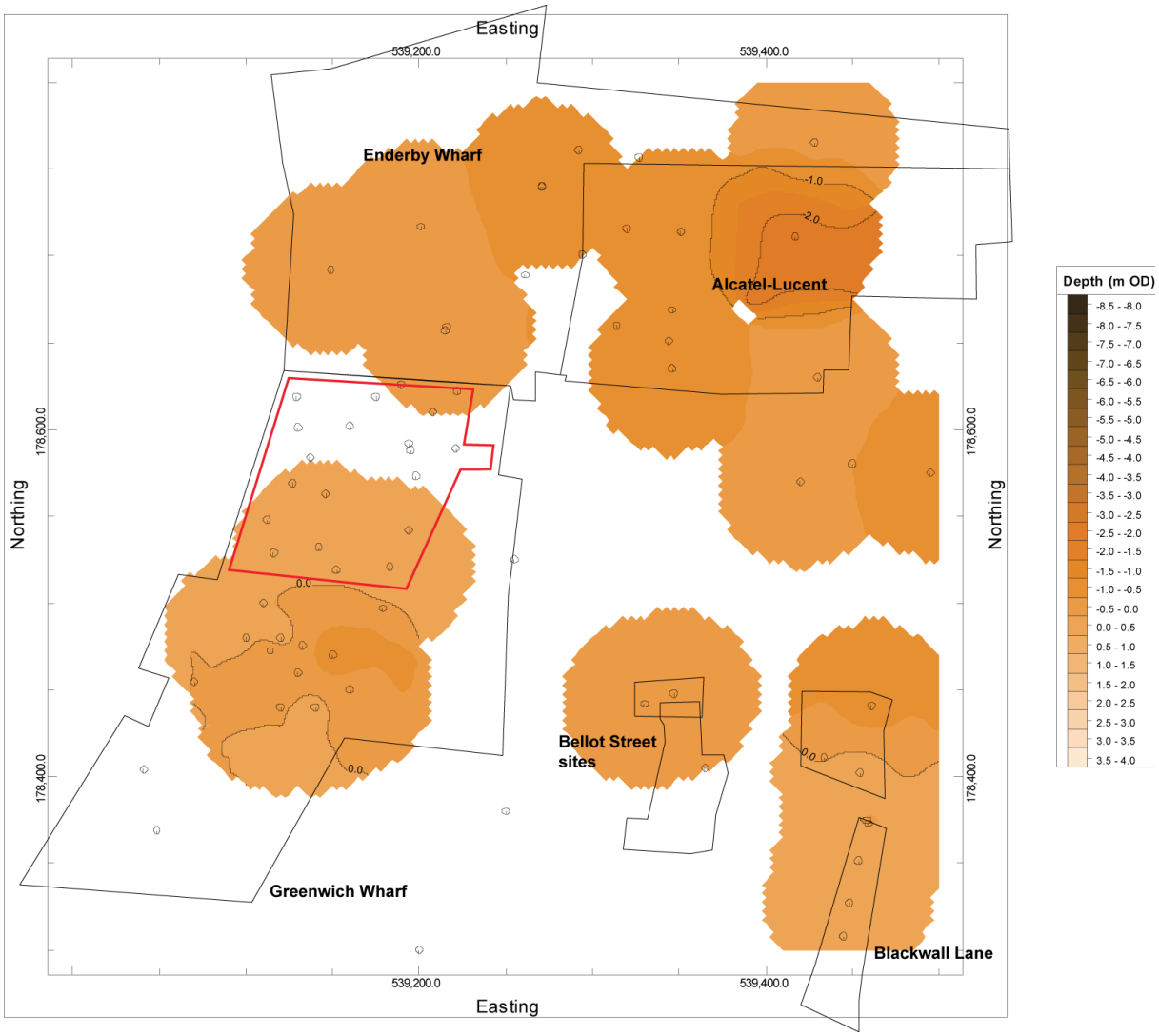

Figure 6: Surface of the Peat (m OD)

Figure 7: Thickness of the Peat (m)

Figure 8: Surface of the Upper Alluvium (m OD)

Figure 9: Thickness of the Total Alluvium (m)

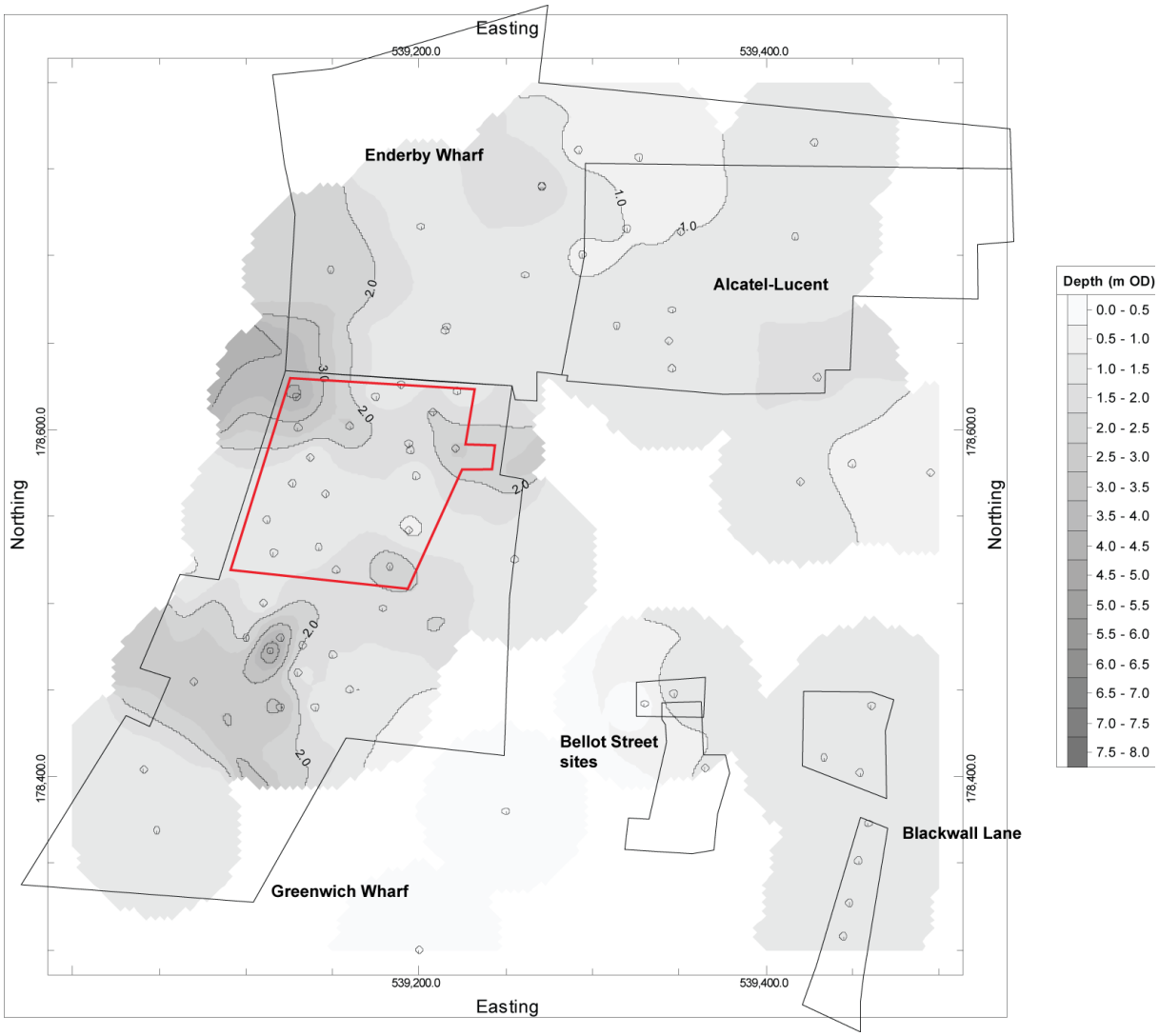

Figure 10: Thickness of the Made Ground (m)

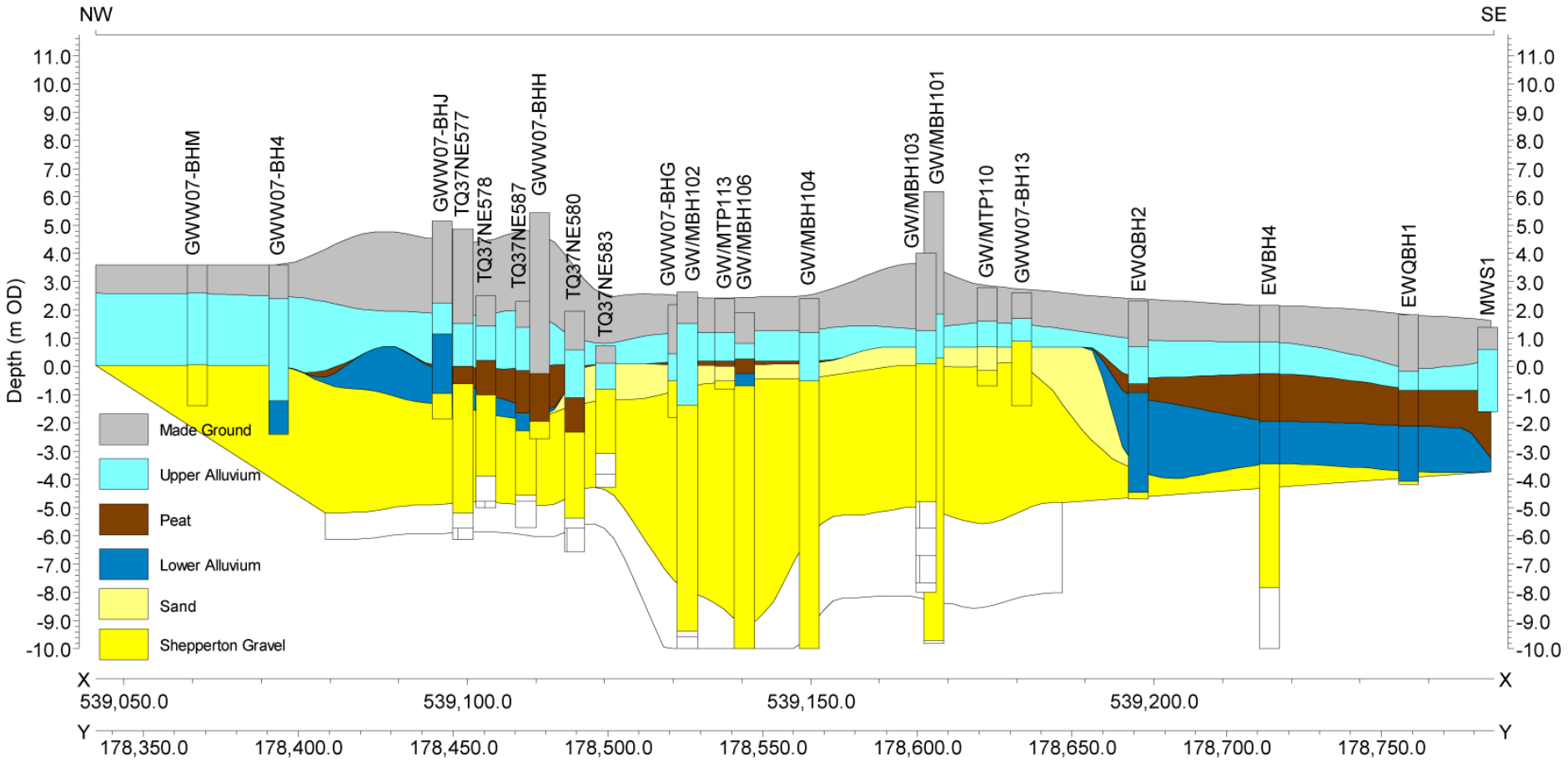

Figure 11: South-west – North-east transect across the Greenwich Peninsula and Enderby Wharf sites

Table 2: Lithostratigraphic description of borehole GW-MBH101, Greenwich Wharf, Royal Borough of Greenwich

Depth (m OD)	Depth (m bgl)	Description	Stratigraphic group
7.50 to 3.10	0 to 4.40	Made Ground	MADE GROUND
3.10 to 2.40	4.40 to 5.10	10YR 5/1; As3 Ag1; Grey mottled brown silty clay	UPPER ALLUVIUM
2.40 to 1.60	5.10 to 5.90	10YR 5/1; Ga4; Grey coarse sands	SAND
<1.60	>5.90	10YR 5/1; Ga2, Gg2; Grey sand & gravel	RIVER TERRACE GRAVELS

Table 3: Lithostratigraphic description of borehole GW-MBH102, Greenwich Wharf, Royal Borough of Greenwich

Depth (m OD)	Depth (m bgl)	Description	Stratigraphic group
2.63 to 1.43	0 to 1.20	Made Ground	MADE GROUND
1.43 to -0.67	1.20 to 3.30	10YR 4/1 to 10YR 5/1; As2, Ag2; Dark grey becoming grey silty clay; possibly reworked above 2.00m bgs.	UPPER ALLUVIUM
-0.67 to -1.37	3.30 to 4.00	10YR 4/1; Gg2, Ga1, As1; Dark grey sandy gravel with clay	LOWER ALLUVIUM
<-1.37	>4.00	10YR 5/1; Ga3, Gg1; Grey sand with fine gravel becoming coarser gravel from 5.50m bgl	RIVER TERRACE GRAVELS

Table 4: Lithostratigraphic description of borehole GW-MBH103, Greenwich Wharf, Royal Borough of Greenwich

Depth (m OD)	Depth (m bgl)	Description	Stratigraphic group
5.44 to 2.69	0 to 2.75	Made Ground	MADE GROUND
2.69 to 2.44	2.75 to 3.00	10YR 5/1; As3, Ag1; Grey silty clay	UPPER ALLUVIUM
2.44 to 1.74	3.00 to 3.70	10YR 5/1; As3, Ga1, Gg+; Grey sandy clay with traces of gravel	LOWER ALLUVIUM
1.74 to 1.54	3.70 to 3.90	10YR 5/1; As3, Ag1; Grey silty clay	
<1.54	>3.90	10YR 5/1; Ga2, Gg2; Grey sand and gravels	RIVER TERRACE GRAVELS

Table 5: Lithostratigraphic description of borehole GW-MBH104, Greenwich Wharf, Royal Borough of Greenwich

Depth (m OD)	Depth (m bgl)	Description	Stratigraphic group
2.40 to 1.40	0 to 1.00	Made Ground	MADE GROUND
1.40 to 0.20	1.00 to 2.20	10YR 4/3; As3, Ga1; Brown sandy clay	UPPER ALLUVIUM
0.20 to -0.50	2.20 to 2.90	10YR 5/1; As3, Ga1; Grey sandy clay	
<-0.50	>2.90	10YR 5/1; Ga2, Gg2; Grey sand and gravels	RIVER TERRACE GRAVELS

Table 6: Lithostratigraphic description of borehole GW-MBH105, Greenwich Wharf, Royal Borough of Greenwich

Depth (m OD)	Depth (m bgl)	Description	Stratigraphic group
2.80 to 0	0 to 2.80	Made Ground	MADE GROUND
0 to -0.40	2.80 to 3.20	10YR 2/1; Sh2, Ag1, As1; Black silty clayey peat	PEAT
-0.40 to -0.70	3.20 to 3.50	10YR 5/1; As3, Ag1, Gg+; Grey sandy silt with traces of gravel	LOWER ALLUVIUM
<-0.70	>3.50	10YR 5/1; Ga2, Gg2; Grey sand and gravels	RIVER TERRACE GRAVELS

Table 7: Lithostratigraphic description of borehole GW-MBH106, Greenwich Wharf, Royal Borough of Greenwich

Depth (m OD)	Depth (m bgl)	Description	Stratigraphic group
1.91 to 0.81	0 to 1.10	Made Ground	MADE GROUND
0.81 to 0.26	1.10 to 1.65	10YR 5/1; As3, Ga1; Grey sandy clay	UPPER ALLUVIUM
0.26 to -0.24	1.65 to 2.15	10YR 2/1; Sh2, Ag1, As1; Black silty clayey peat	PEAT
-0.24 to -0.69	2.15 to 2.60	?	LOWER ALLUVIUM
<-0.69	>2.60	10YR 5/1; Ga2, Gg2; Grey sand and gravels	RIVER TERRACE GRAVELS

7. APPENDIX 1: OASIS

OASIS ID: quaterna1-252842

Project details

Project name	Greenwich Wharf
Short description of the project	A program of geoarchaeological monitoring and deposit modelling was carried out on the site. The results reveal that the site is located on an upstanding area of River Terrace Gravels adjacent to two major west-east alligned channels, at least one of which traverses Greenwich Peninsula. Thin deposits of sand, peat and alluvium are recorded above the Gravels. The site is considered to have good archaeological and geoarchaeological potential; further work is recommended.
Project dates	Start: 18-04-2016 End: 25-05-2016
Previous/future work	Yes / Yes
Any associated project reference codes	BNS16 - Sitecode
Any associated project reference codes	GWW07 - Sitecode
Type of project	Field evaluation
Site status	None
Monument type	PEAT Uncertain
Significant Finds	PEAT Uncertain

Project location

Country	England
Site location	GREATER LONDON GREENWICH GREENWICH Greenwich Wharf, Banning Street, Royal Borough of Greenwich
Postcode	SE10
Study area	100 Square metres
Site coordinates	TQ 3918 7858 51.488512809265 0.00488898031 51 29 18 N 000 00 17 E Point

Project creators

Name of Organisation	Quaternary Scientific (QUEST)
Project brief originator	Quaternary Scientific (QUEST)
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 Exists?	No
Digital Archive Exists?	No
Paper Archive recipient	LAARC
Paper Media available	"Report"

Project bibliography 1

Publication type	Grey literature (unpublished document/manuscript)
Title	Greenwich Wharf, Royal Borough of Greenwich: Geoarchaeological Deposit Model Report
Author(s)/Editor(s)	Batchelor, C.R.
Other bibliographic details	Quaternary Scientific (QUEST) Unpublished Report May 2016; Project Number 028/16
Date	2016
Issuer or publisher	Quaternary Scientific
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Entered on	25 May 2016