LBCL11
LNG11

LONDON BRIDGE STATION, PHASE II EVALUATION, GI STREET LEVEL TEST PITS

Archaeological Evaluation via Monitoring

for VINCI Soil Engineering (working on behalf of Network Rail)

July 2012

HEADLAND ARCHAEOLOGY Ltd

REGISTERED ORGANISATION IfA

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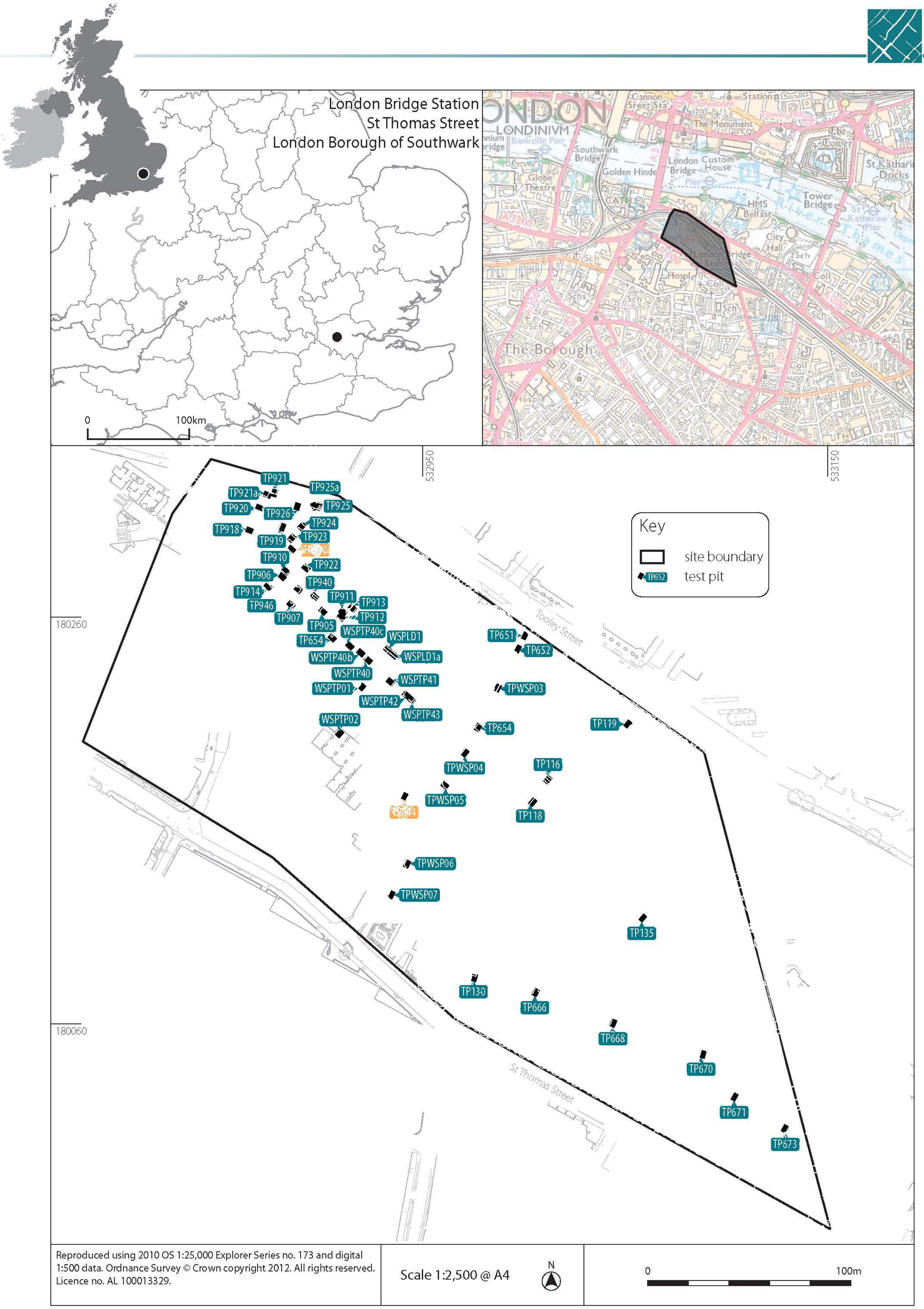


Illus 1

Site location

LONDON BRIDGE STATION, PHASE II EVALUATION, GI STREET LEVEL TEST PITS

Archaeological Evaluation via Monitoring

Headland Archaeology Ltd conducted archaeological evaluation (via monitoring of geotechnical works) at London Bridge Station. This was during the site investigation of GI street level test pits. The work was commissioned by Network Rail. No significant archaeological deposits were identified in the trial pits. However, geoarchaeological study of borehole logs and test pit data has revealed several distinct peat deposits within the alluvium. These indicate there is potential for cultural materials to be preserved within these deposits, especially organic materials such as wooden objects. The peats within the development area have been suggested to date from Mesolithic through to the Roman period and, therefore, have potential to contain archaeological finds, particularly for the later periods.

The recorded presence of archaeology from previous studies in the Thames within alluvial deposits highlights their own potential to contain cultural materials. The presence of organic clays within the boreholes indicates they have potential to contain organic materials such as wooden objects. Their location around the edge of the former (Guy's Channel) channel particularly in the south of the development area, suggests they also have medium to high potential to contain trackways and platforms extending into the channel, such as those recorded at St Christopher's House, particularly in those deposits relating to the Middle to Later Holocene (Neolithic to Roman).

1. INTRODUCTION

1.1 Origin and scope of the report

Headland archaeology (UK) Ltd was commissioned to conduct the Phase 2 archaeological evaluation (*via* monitoring of geotechnical works) at London Bridge Station. This work follows on from the Phase 1 investigations undertaken by the Museum of London (MOLA 2011). This was during the site investigation of GI street level test pits and a geoarchaeological study of the VINCI Soil Engineering borehole and test pit logs. The work was carried out in advance of major infrastructure works at London Bridge Station (National Grid Reference 533025 180105) (Illus 1).

The Specification for these works was supplied by Network Rail (2010) and provided detailed instructions on the methodology to be applied both in the field and during post-excavation reporting. The Specification stated that the archaeological contractor (Headland Archaeology) shall prepare a written report. The following points are derived from the Specification, and are those points which remained relevant to the results of our work:

- a non-technical summary
- data sources
- a location plan(s) of any exploratory holes and other fieldwork in relation to the proposed development. Plans will be at suitable scales and contain sufficient detail to allow the reader to locate the works in relation to the region (Greater London), the area (the immediate environs of the station site) and local features (topographic and/or built)
- presentation of results
- a summary statement of fieldwork findings
- plans and sections of features and significant archaeological/ palaeoenvironmental deposits and horizons located at an appropriate scale
- lithostratigraphic descriptions and facies interpretations
- transects (along appropriate axes) illustrating the sedimentary sequence as recorded by the investigations and incorporating historic site investigation data
- a table summarising per area the horizons, deposits, and features recorded, the classes and numbers of artefacts contained within them, spot dating of significant finds and an interpretation
- reproductions of appropriate historic maps and documents
- written and graphic representation of deposit survival
- predicted historic deposit survival
- assessment of significance:
  - an integrated interpretation of the archaeological findings and assessment of importance both within the site and within their wider landscape setting: to include a graphic based model integrating the findings to their topographic setting; and
- assessment of effects:
  - identify sources of impact on archaeological deposits
  - determine significance of effect.

This report adheres strictly to that specification and the costing which was agreed to fulfil its requirements.

1.2 Site location

The development area (DA) is located in the London Borough of Southwark (Illus 1). It is bounded to the north by Tooley Street, the west by Joiner Street, the south by St Thomas Street and the east by Holyroad and Shand Streets. The OS National Grid ref. for centre of site is 533025 180105.

1.3 Archaeological and historical background

A historic environment assessment, which covers the whole area of the site was covered in detail in MOLA (2011) and the Specification (Network Rail 2010) and is not repeated here. In summary, the development area is located on the south bank of the River Thames in an area where there were formerly a series of low-lying sand and gravel islands (eyots) in the prehistoric and early Roman period. Channels and wider expanses of water separated the eyots, with mudflats exposed at low tide. Archaeological excavations and borehole logs in the area have determined that two principal gravel eyots covering approximately 16 hectares are located to the west of the development area. The northern eyot is sometimes known as the Bridgehead Island and it extends east to approximately Joiner Street. Geotechnical and archaeological works have established 'highs' for the surface of the eyots at approximately 1.3m AOD. The majority of the development area is located on what would have been intertidal mudflats and water channels. Importantly, only the extreme west edge of the Site would have been located on Bridgehead island, which was occupied by part of the Roman settlement. The extreme east part of the site occupies the edge of another low-lying eyot (the Horselydown eyot).

The archaeological and palaeoenvironmental potential of the buried deposits within the Thames area is well known with palaeoecological studies having been carried out on the peat and organic clay sequences in areas such as the Kent Marshes and Medway (Barham et al 1995; Firth 2000). While the connectivity of the peat sequences present in the Thames has been discussed by authors Devoy (1979) and Allen (2005). The presence of cultural materials within these deposits has also been well documented (eg Dillon et al 1991; Bates and Barham 1995; Meddens 1996) and includes some important finds, such as Roman plank-built boats (Marsden 1994). Thus the Thames area is an important focus of study for both disciplines and the works at London Bridge provided a welcome opportunity to look at this area in detail. Headland Archaeology have built upon and referred to the previous stage of evaluative monitoring works (MOLA) in order to ensure our report took appropriate cognisance of those findings. That phase of work identified alluvial horizons, mud flats, intertidal zones and remains of Guy's Channel, a tributary of the Thames, as well as timber structures at 4.3m below ground level. The latter are likely to be associated with the colonisation and exploitation of the foreshore during the late medieval period. Excavations also revealed a variety of post-medieval masonry structures (17th–19th century in date; these included domestic structures such as garden walls (TP025, TP040, TP658, TP530), and brick lined cess/rubbish pits as well as larger structural walls and floors from buildings that may have been for industrial use (TP658, TP106, TP661 & TP665). In particular TP674 revealed phases of masonry building(s) dating from the 17th–18th century (MOLA 2011).

1.4 General aims and objectives

The high level aims of this stage of evaluation was ultimately in assessing the significance, importance and extent of any historic assets below street level and thereby understanding the impact of the Thameslink works outlined below.

The general aims of the assessments/monitoring overall is to:

- identify the presence of any known or potential heritage assets that may be affected by the proposals
- describe the significance of such assets, as required by national planning policy
- assess the likely impacts upon the significance of the assets arising from the proposals.

1.5 Specific aims and objectives

The following aims were used in earlier stages of work (MOLA 2011) and have been considered during this stage of work in order to ensure consistency of approach:

- establish, as far as reasonably practicable, the presence, location extent, character, date and condition of any archaeological/cultural assets or palaeoenvironmental deposits
- assess the significance of assets and deposits and the need for further archaeological works
- reduce the risk of unforeseen archaeological remains being encountered during construction and provide datums for the surface of London Clay and Pleistocene deposits to assist with modelling the palaeotopography of the study area
- establish the vertical and horizontal extent of the main soil formations
- establish the extent and degree of modern truncation and disturbance of archaeologically significant deposits
- determine the environments of deposition (facies modelling) of the main soil formations
- establish the date of the main soil formations through the recovery of artefacts or by radiocarbon or other dating
- establish the vertical and horizontal sequence of deposits accumulation
- examine changes to the environment through all periods of time represented in the archaeological record
- provide data to allow more confident predictions of archaeological potential to be made
- establish the need and scope of any further archaeological works or other mitigation.

2. MONITORING OF GEOTECHNICAL WORK

James McNicoll-Norbury

2.1 Methodology

All contexts were given unique numbers and all recording was undertaken on *pro forma* record cards that conform to accepted archaeological standards in London. All stratigraphic relationships were recorded.

The slab/ground was broken out, cleared and monitored by an archaeologist. Further modern material within the trial pits was excavated initially by machine and then excavation by the contractors continued manually; all excavation was monitored by an archaeologist. The trial pits were shored at 1.2m intervals.

An overall site plan was drawn at an appropriate scale and tied to the National Grid. A full photographic record comprising colour slide and black and white print photographs was taken, supplemented with digital photography.

The final locations of the geotechnical trial pits and boreholes were surveyed and plotted on to a Basement Survey (Alan Baxter Drg. No. N231-ALB-DRG-SU-000098 Rev P01, dated June 2010). This information was then plotted onto the National Grid.

A written and drawn record of all archaeological deposits encountered was made in accordance with the principles set out in the Headland Archaeology (UK) Ltd site recording manual for London. The heights of observations and/or archaeological remains were recorded, where relevant, sections were drawn at a scale of 1:20; numbered contexts were allocated were appropriate. These records form part of the site archive.

2.2 Results

A total of 52 trial pits were excavated between the boundaries of Tooley Street, St Thomas Street, Joiner Street and Bermondsey Street (Illus 1). The work was undertaken by specialist ground investigation contractors (VINCI Soil Engineering). Trial Pits over 2m in depth were monitored by archaeologists (as specified by the Network Rail Project Archaeologist) and this resulted in two pits being monitored in this stage of evaluation. These were located within a service room adjacent to the entrance of the station off Joiner Street (TP917 – Illus 3 and 6) the other was in the Shunt Theatre (TP044 – Illus 2, 4 and 5).

Test Pit 044

TP044	
Location	Shunt Theatre
Dimensions	2x2m
Depth	2.5m

The pit was excavated to a depth of approximately 2.5m (Illus 2, 4 and 5) cutting through five deposits of made ground comprised of a variety of sandy clays with gravel inclusions with finds consisting of fragments of brick, flint and chalk. The requirement of the test pit was to identify the extent of the buildings footing depth and make up. No significant archaeological features were identified.

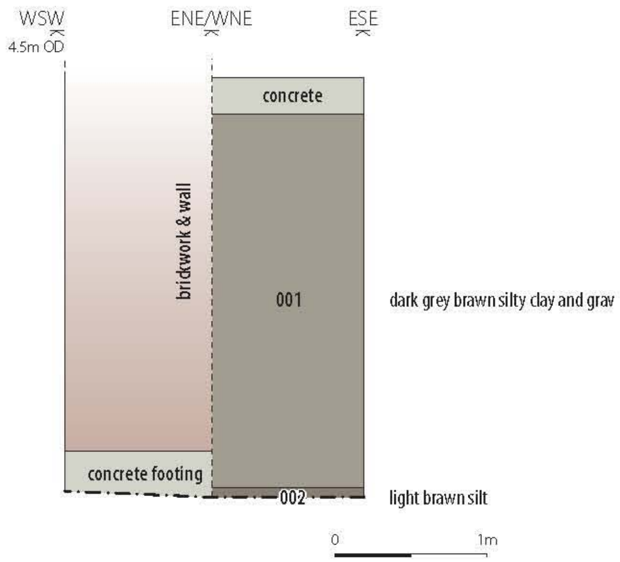
Test Pit 917

TP917	
Location	Joiner Street, inside station entrance by escalators
Dimensions	2x2m
Depth	2.8m deep

The test pit was located inside a small service room against a pre-existing wall of one of the archways (Illus 3 and 6). The deepest deposit identified consisted of brown silt and gravels. This was overlaid by 2.8m of dark grey silt clay and gravels from which fragments of brick and tile were recovered along with clay pipe, oyster shell and post-medieval green glazed pottery. The base of the wall was recorded at 2.5m below the modern ground level. No significant archaeological features were identified.

Illus 2

SE facing section of TP044



Illus 3

Section of TP917

Illus 4

Footing in TP044

Illus 5

Plan view of TP044

Illus 6

Plan view of TP917

3. GEOARCHAEOLOGICAL ASSESSMENT

Dr Scott Timpany

3.1 Introduction

This section presents a geoarchaeological assessment of borehole (dynamic window sampling) and test pit records from across the development area (Illus 7). The records derive from a programme of borehole and test-pitting undertaken by VINCI Soil Engineering (2011) in preparation of the developments at London Bridge Station and have been made available for this study. A total of 56 boreholes were investigated together with data from 29 test pits. The boreholes penetrated to a maximum depth of approximately -4.3m OD whilst the test pits had a maximum penetration to +0.3m OD. The archaeological and palaeoenvironmental implications of this data set are assessed below.

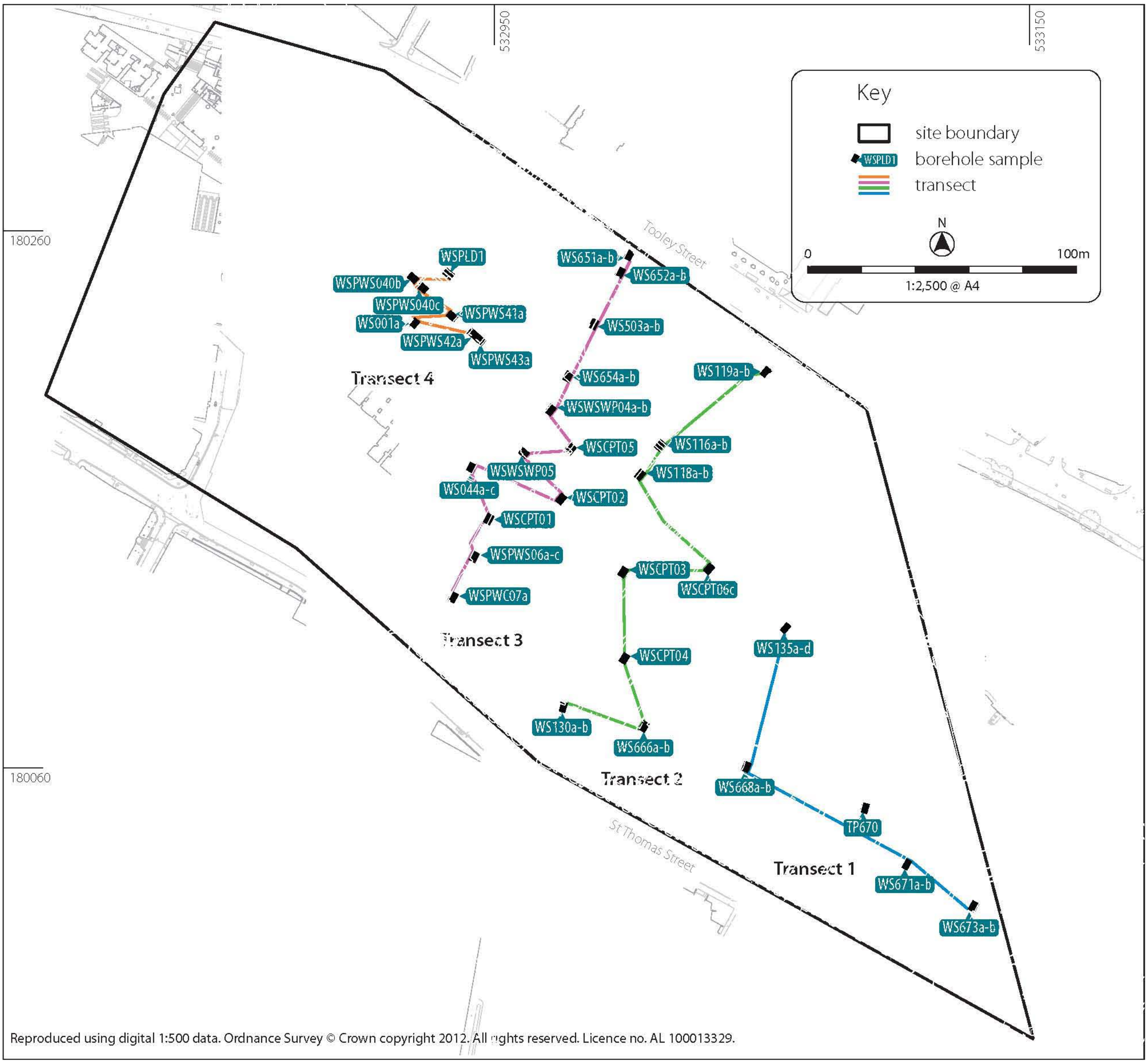
3.2 Methodology

In order to assess the palaeoenvironmental and the archaeological potential of the sediments in the development area, the borehole and test pit logs from the geotechnical report by Soil Engineering (2011) was consulted in order to distinguish the different sediment types present. In particular, sediments containing organic materials such as peats and organic clays were targeted as such deposit types have a high potential to contain waterlogged plant materials such as pollen and plant macrofossils, together with insect remains, which are important for reconstructing past landscapes and informing on human activity. Such sediments also have the potential to contain cultural material such as wooden objects and structures (*eg* fish traps).

Data from the borehole logs were used to construct transect diagrams across the DA in order to show in detail the sediments present and the changes in the deposition sequence. The boreholes were split into four transects going from south to north across the DA and are presented in Illus 8–11. Transects have been colour coded to show the four main facies present across this area, together with denoting the occurrence of peat deposits. The location of transects in respect to the DA is shown in Illus 7.

The levels of the Gravel (River Terrace Deposits) in the borehole logs together with the basal levels of the made ground were entered into a digital surface mapping and contouring program (Surfer 10). Data from all of the available boreholes from the Phase 2 works were entered into the program in order to produce a series of 2D and 3D deposit models (Illus 12–14). These models build on the work that has been previously done in the DA as part of the Phase 1 works by MOLA (MOLA 2011).

The data for the top of the Gravel layers has been used to produce 2D and 3D models of the topography of the Pleistocene Gravels, thus giving an approximate representation of how the DA would have looked prior to the deposition of Holocene sediments *c*10,000 years ago. This data is presented in Illus 12.



Illus 7

Location plan of boreholes showing transects

The data for the base of the made ground layer has been used to produce 2D and 3D models of the surviving upper surface of the Holocene alluvium and shows the impact that previous developments have had in the DA upon these deposits, which would have accumulated over the last 10,000 years ago. This data is presented in Illus 13.

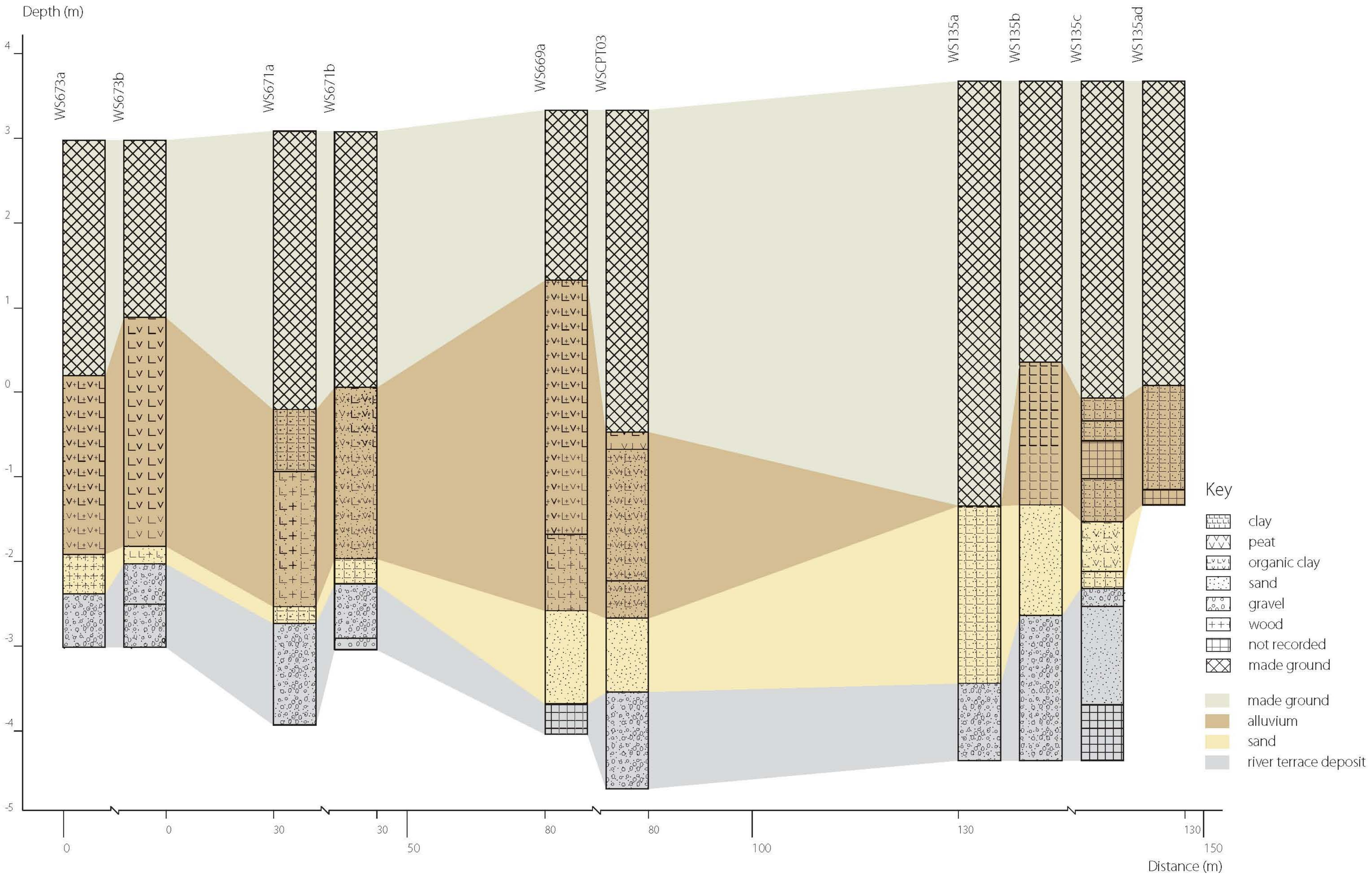
Data from the borehole logs has also been entered in order to show the thickness of the surviving alluvium across the DA; presented in Illus 14. This model is useful in presenting the expected thickness of alluvium that may be encountered for any further borehole or test-pitting in the DA. This can then be used to calculate where the main areas of archaeological and palaeoenvironmental potential are located within the DA.

3.3 Results

The deposition sequence of the sediments present within the DA in respect to the borehole and test pit records is evaluated below in chronological order; from the oldest to the youngest sediments. The sedimentary sequence across the DA is illustrated from south to north through a series of transect drawings presented in Illus 8–11.

3.3.1 *River terrace deposits (Facies 1)*

The boreholes generally penetrated to a depth that reached the upper layers of the Sand and Gravel unit, which comprise the River Terrace Deposits (Illus 8–11). In no locations did the boreholes bottom these deposits so their thickness remains unknown within the DA. This sand and gravel unit is known as the 'Shepperton Gravels' and were deposited during a phase of lowered sea-level in the late Pleistocene some 18,000 to 10,000 years ago (Milne *et al* 1997; Wilkinson *et al* 2000a). The topography of the surface of these gravels represents how the area would have looked during the Early Holocene prior to its inundation by rising sea-level following the melting of ice at the end of the last glacial period 'The Devensian' (Illus 12). During the Early



Illus 8

Borehole Transect 1 drawing

Holocene a braided freshwater river environment would have been in existence in this area of the Thames (MOLA 2011).

The shifting nature of the braided river channel during this period is shown by the undulating surface of the gravel deposits (Illus 12) caused as gravels were laid down and then reworked and redeposited by channels incising these gravels. It is likely this former braided channel environment which fed into the Thames was part of the former 'Guys Channel' (MOLA 2011).

The River Terrace Deposits within the Phase 2 boreholes were encountered within the DA at depths of between +0.76m (borehole WS651B) to -3.44m OD (borehole WS118B). This data compares favourably with the Phase 1 boreholes, which recorded the top of the River Terrace Deposits at heights of between +0.35m and -3.2m OD. A 2D and 3D representation of the River Terrace Surface is provided in Illus 12. The contoured surface of this deposit shows these deposits are at the highest elevations to the north and southeast of the DA and shallowest through the middle, particularly in the eastern and central areas. The contour map shows these elevations are particular steep to the southeast and north where it rises quickly. It is likely this represents a former channel cutting through the sand and gravel River Terrace Deposits. This differs slightly to the deposit model constructed from the Phase 1 evaluation report (MOLA 2011), which showed the steep sloping gravels to the south east of the site but not to the north (MOLA 2011). This in turn emphasises the greater accuracy that can be shown by the models with the more data that can be inputted.

3.3.2 *Sands (Facies 2)*

Overlying the River Terrace Deposits in some locations (*eg* WS044A and WSCPT04) a sand layer was observed in the borehole deposits. This sand layer was recorded at between +0.36m (WS654A) and -3.85m OD (WS044A) and is shown to vary in thickness across transects (Illus 8–11). This layer was also recorded in two of the Phase 1 boreholes, where it was noted as occurring at between -2.5m to -2m OD (MOLA 2011) and highlights the variation in this deposits thickness and presence across the DA.

This sand layer has been noted as being early Holocene in date from the radiocarbon dating of overlying and underlying deposits, indicating it was deposited some time between 12,000 to 6,400 cal BC (Wilkinson *et al* 2000b). MOLA (2011) suggest this sand was deposited as the channel, seen cutting through the gravel became established, with constant steady flow of water depositing thick units of sand in some areas of the DA. Transects show that this sand layer has a fragmented presence in the south and central areas of the DA but appears to shallow out to the north of the DA where alluvium (Facies 2) can be seen to directly overlie the River Terrace Deposits (Facies 4). This is shown in Transects 2 and 3 (Illus 9–10).

Wood fragments within the sand layer were recorded in four borehole locations in the western area of the DA with Transect 1; WS673A-B and WS671A-B (Illus 8). Organic material was also recognised within the Phase 1 borehole, R1 in the northern part of the DA (MOLA 2011). Illus 12 suggests that these locations would have been at the edge of the former channel and indicates the wood fragments within the sand may represent the development of vegetation and presence of trees fringing this channel. Pollen diagrams from Thames deposits have shown that during the Early Holocene and Mesolithic the area would have been a freshwater riverine environment and that developing soils supported woodland of pine fringed by birch woodland (Wilkinson *et al* 2000a). Mesolithic flints have been recovered from sand units overlying the River Terrace Deposits, such as in the Erith Marshes (Sidell *et al* 1997) and highlight the potential of this layer to contain cultural materials.

3.3.3 *Alluvium (Facies 3)*

The main sediment unit present across the DA is a layer of alluvium, which consists of intercalated clays, including organic clays, sandy clays, gravelly clays and clays containing wood fragments (Illus 8–11). Also present within this sediment unit are layers of peats (see below) and occasional layers of sand. This alluvium is suggested to have been deposited from the Early Holocene through to the Late Holocene. The deposit varies in thickness across the DA and is recorded as occurring between +2.71m (WS044A) and -2.7m OD (WSPWS43A). The thickness of the alluvium across the DA is shown in Illus 14 and shows the thickest deposits occur within the central area of the former channel.

The alluvium sequence varies across transects, highlighting the differing nature of the depositional environments even across short distances. Within borehole Transect 1, which runs across the eastern part of the DA, the alluvium sequence is recorded as organic clays, which grade into clays and then sandy clays as the transect goes northwards (Illus 8). These organic clays from boreholes WS673A to WS668B are seen to have accumulated above sand and organic sand deposits (Facies 2) and underlie made ground deposits (Facies 4) indicating continuous deposition throughout the Holocene. The organic clay layers within this area lie on the edge of the channel area and indicate the continuation of the presence of vegetation on the channel edge that was recorded in the organic sands of Facies 2. Despite the presence of organic materials within the clays it is interesting that no peat deposits formed in this area, suggesting that conditions in this area were never stable enough for a terrestrial surface to develop. As the transect goes northwards and into the course of the channel the clays become sandier with organic material absent. This increase in sand content of the clays reflects the nature of the deposition environment within the channel with an increase in fluvial sediments (sands) being deposited.

Borehole Transect 2 shows a complex sequence of alluvium deposits formed from south to north across this area of the DA through the Holocene (Illus 9). In the southern part of Transect 2 from borehole WS130A through to WSCPT04 the alluvium consists of a mix of clays, sandy clays and organic clays. The organic clays are located on the edge of the former channel, similar to those within Transect 1. The presence of sandy clays in boreholes WS666A-B but absent in the boreholes to the either side shows the varying nature of the depositional fluvial environment within this area and suggests these two boreholes are located in an area more susceptible to sand deposition (*eg* a possible cut in the channel bank). This is also shown by the deposition of a sand layer at between -0.76m to -0.26m OD within these boreholes. Interestingly conditions did become stable enough in this location for peat to form at between -0.06m to +0.09m OD (see below). The presence of organic clays in this part of the DA again suggests the presence of vegetation along the edges of the former channel. Wood fragments recorded in the alluvium within the basal sandy clays of borehole WS666B also suggests the former presence of trees along the river margins during the Early to Middle Holocene.

Moving northwards along Transect 2 the clays become sandier indicating the increased deposition of fluvial sand in these locations, of the channel middle and northern edge. The exception to this is borehole WS118B where organic clay is recorded (see Illus 9). At this location the underlying River Terrace Deposits begin to rise at the channel margins (Illus 12). The underlying sand deposit (Facies 2) in this location also rises above the layer of alluvium deposition seen in the other boreholes suggesting organic clay at this location may have developed on an elevated surface at a time when the rate of water level rise had declined. The presence of a peat layer at this height, *c*-0.9 m OD in borehole WSCPT06C also suggests the development of stable terrestrial surfaces at this time (see below).

A similar complex sedimentary sequence is present in borehole Transect 3 (Illus 10). The alluvial deposits at the southern end of Transect 3 between boreholes WSPWS07A and WS044C is largely unknown as these boreholes only occasionally bottomed the made ground deposits. Where the alluvium is exposed in this part of the DA it shows the presence of sandy clays. Wood fragments are recorded in the sandy clay at borehole WSCPT01 indicating the former presence of trees in this location which is seen to be at the edge of the channel where the underlying River Terrace Deposits decline steeply (Illus 12). This is likely to be a continuation of the organic clays with wood fragments seen along the channel edge in Transects 1 and 2. Two peat layers are also present in this part of the DA in the basal and upper parts of the alluvium (see below) indicating periods of terrestrialization.

Sandy, organic clays, together with occasional peats are also present in the middle part of the sequence through the central area of the former channel in boreholes WSCPT02 to WSWSP04A. These clays are also recorded containing wood fragments in borehole WSCPT02 (Illus 10). The presence of peats and organic layers within this part of the central area indicates vegetation was present including trees in this part of the DA, which suggests there may have been a former 'island' or eyot in this location. The alluvium is then seen to become sandy clay from borehole WSWPS04B to WS651B for the remainder of Transect 3. Again, as at the beginning of the transect the alluvium is only glimpsed in the north of the site where a thin layer is present in borehole WS651 between the River Terrace Deposits (Facies 1), which rise up in this part of the DA and the overlying made ground (Facies 4).

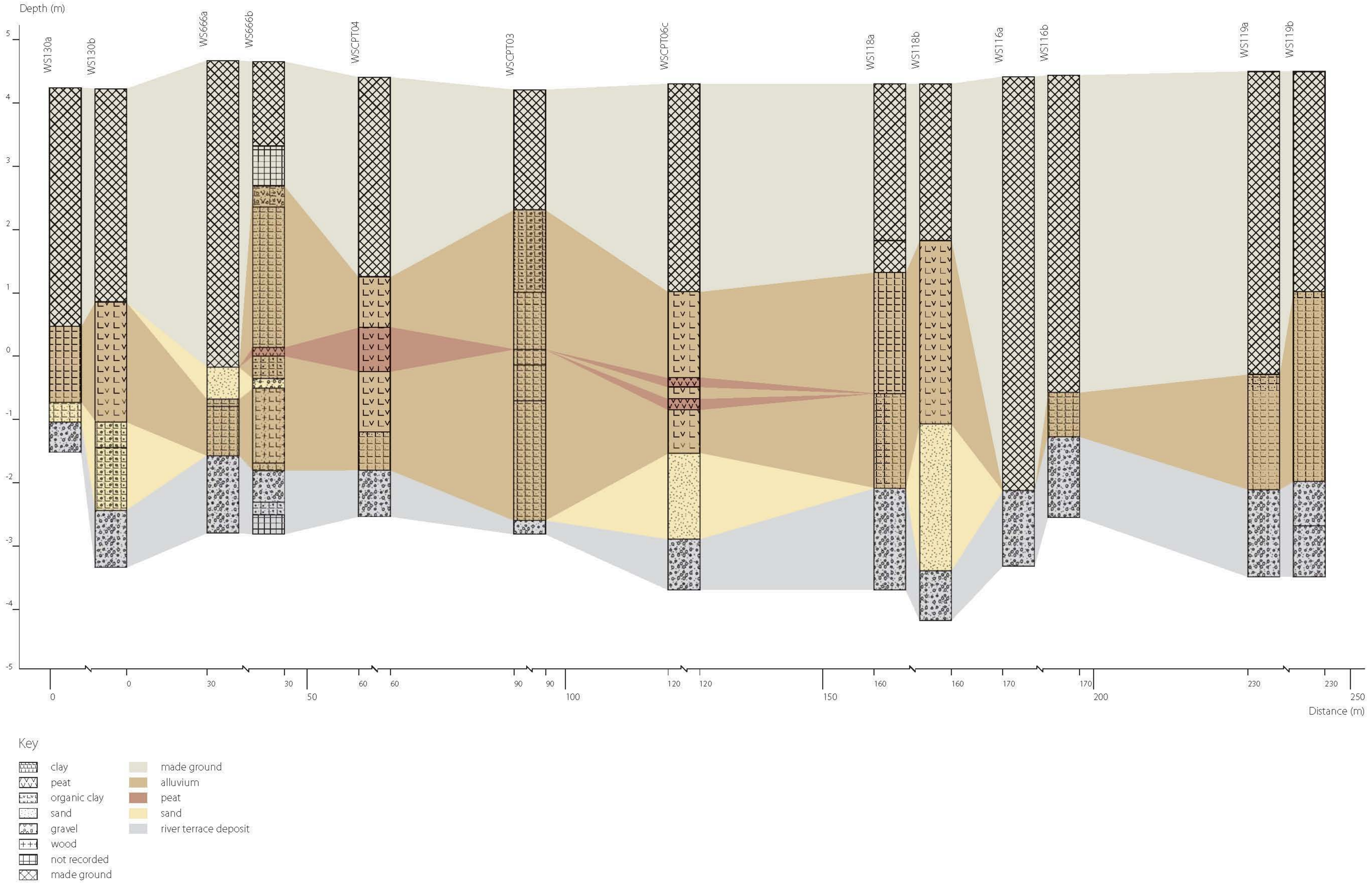
Transect 4 goes across the north east area of the site and the alluvium here can be seen to have formed on top of the sand unit (Facies 2) or in two locations (borehole WSPWS43A and WSPWS41A) overlying the River Terrace Deposits (Facies 1). Within this transect the alluvium is dominated by sandy clays, indicating that this area in the northeast of the former channel was an active area of fluvial deposition from the Early through the Middle Holocene. The presence of thin peat layers in borehole WSPWS43A and WSPWS42A, which are located at the channel edge before the steep rise in River Terrace Deposits to the north (Illus 12) indicates terrestrialization. This peat development again indicates that water level rise in these locations slowed enough for vegetation to colonise and soils to develop. The thinness of the peats, however, indicates this phase was short-lived (see below) and the clayey sands overlying the peats suggest these areas were subsequently flooded as water levels rose once more. The upper clays in this transect and particularly to the north of the site are recorded as sandy, gravelly clay and indicate high energy deposition of fluvial sands and gravels. The presence of two peat bands within this alluvium in boreholes WSPWS40C and WSWSPLD1 suggest breaks in the deposition of this material allowing stable surfaces to develop during the Later Holocene.

3.3.4 Peats (Facies 3)

Within the alluvium bands of peats were observed. There are broadly four main periods of peat accretion across the DA recorded in the borehole Transects 2–4 (Illus 8–11). These peats would have accumulated during periods of relative stableness, when increases in water levels caused by Global sea-level rise in the post glacial period slowed sufficiently for peat and associated vegetation cover to colonise and develop terrestrial surfaces. These periods were often short-lived in comparison to periods of alluvial deposition, becoming buried by clays as water level rose and flooded these areas.

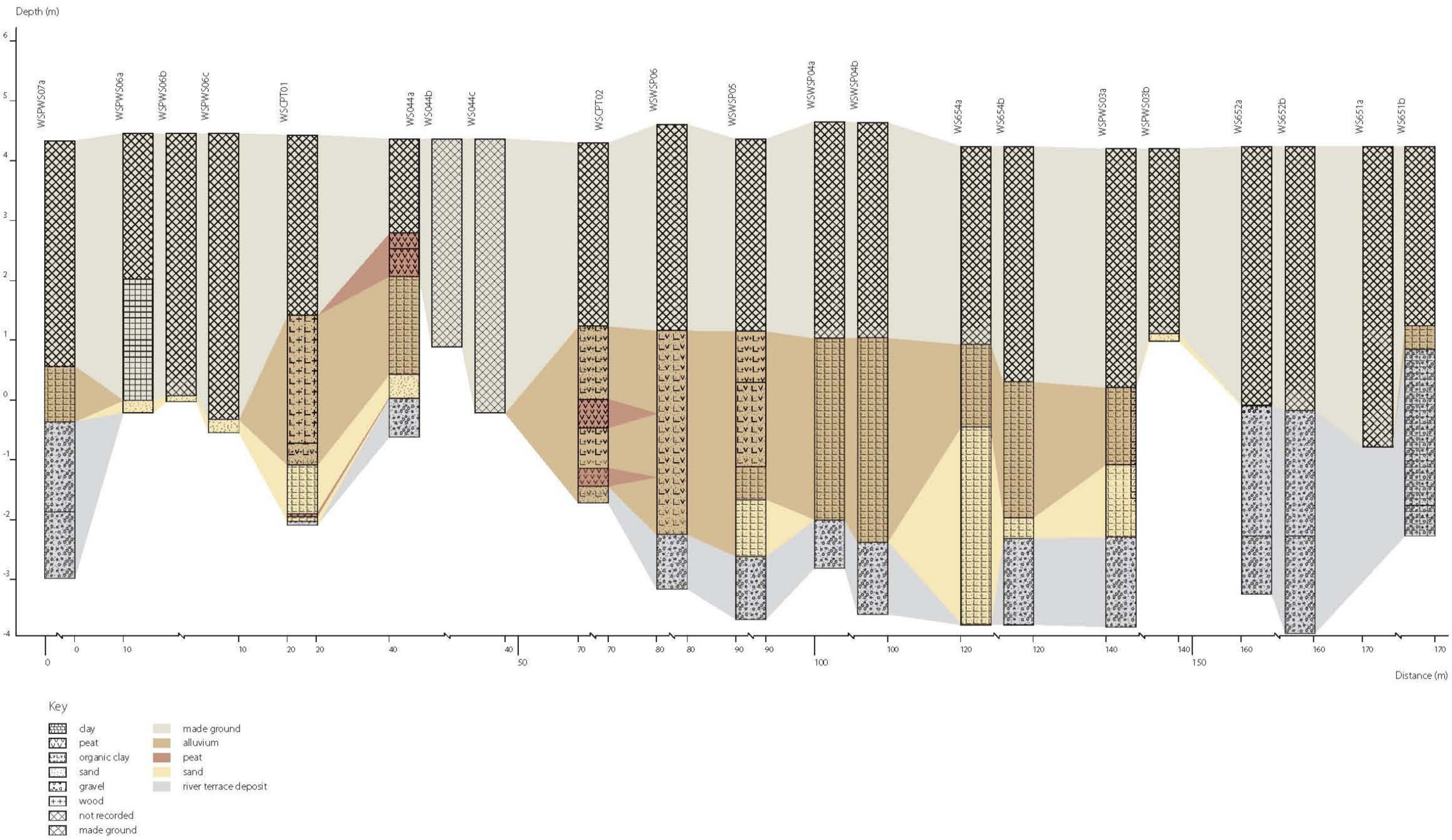
The first peat layer is present at between -2.02m to -1.9m OD within borehole WSCPT01 (Illus 9) indicating peat formation here dates to the Early Holocene. This peat band is still above the lowest peat deposit recorded in the DA during the Phase 1 investigation, where peat was recorded at a depth of approximately -2.7m OD. MOLA (2011) note that peats were recorded at similar positional heights at St Christopher's House, Southwark, where they were dated to between 8500 and 5500 cal BC. These basal peats are also likely to correspond with Devoy's (1979) Tilbury II peats, which have been dated as forming between 7500 to 5900 cal BC in the middle and outer Thames sequences. Sidell *et al* (2000) notes that during this period the valley floor was relatively dryland with streams and valley pools present. Pollen studies also show that during this phase of stability carr woodland of alder was present along the valley (Devoy 1979).

The second phase of peat accretion recorded across the DA was noted as between -1.55m to -0.1m OD, where a series of peat bands are recorded in Transects 2–4 (Illus 9–11). The thickness of these peat bands is seen to vary from between 0.1m to 0.45m across transects. These peat bands correspond with peat in Phase 1 boreholes recorded at -0.8m OD (MOLA 2011). The series of peats within this phase indicate changing conditions across the area with no uniform periods of peat development and then flooding. This would suggest a dynamic environment was present of shifting channels allowing terrestrial surfaces to develop, which subsequently became inundated once more as channels shifted and water levels rose and fell. These peat



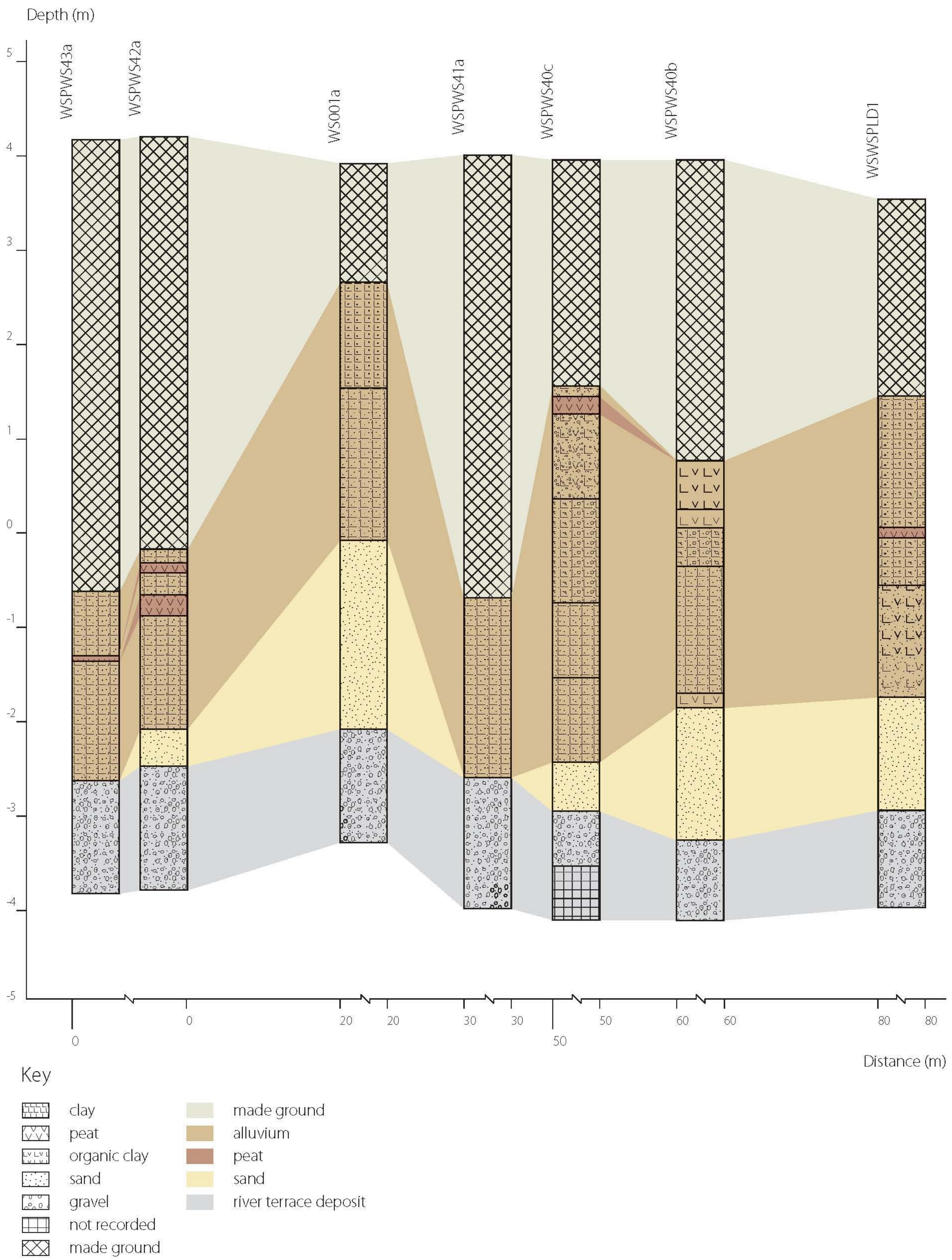
Illus 9

Borehole Transect 2 drawing



Illus 10

Borehole Transect 3 drawing



Illus 11

Borehole Transect 4 drawing

deposits appear to correspond with the Tilbury III sequences, which have been recorded as up to 2.5m at thick at Barking Level and Erith Marshes and occurring between -5 to -1m OD by Devoy (1979). This peat sequence has been dated as forming between 4300 to 2550 cal BC. Developments of peats at approximately 3500 to 2200 cal BC have also been identified at Joan Street, Southwark (Wilkinson *et al* 2000c). Pollen sequences showing the initial formation of reed and sedge swamp through to alder dominated carr woodland, fringed by more regional oak-hazel woodland (Devoy 1979; Wilkinson *et al* 2000c).

A third peat band is located at +1.21m to +1.36m OD in borehole WSPWS40C within Transect 4 (Illus 11). No peat bands of a similar height were recorded in the Phase 1 boreholes (MOLA 2011). At these heights over much of the transects the sediments are predominantly sandy clays and suggests localised development of peat in this area. This peat layer overlies sediments (again sandy clays) recorded at +0.5m OD within the Phase 1 boreholes, which have been suggested to relate to the Roman period (MOLA 2011) indicating a possible post-Roman to historic date for this deposit. During the Roman period the landscape changes from one of predominantly freshwater to a brackish water environment, affected by wider sea-level change (Devoy 1979). Pollen records from this period also show a landscape dominated by herbaceous taxa with woodland representation poor, indicating a very open environment existed during this period (Wilkinson *et al* 2000a). The increase of saline and brackish conditions is also shown by the retrogressive sequence at Joan Street, Southwark where alder carr woodland is replaced by reedswamp in the pollen record as brackish conditions developed (Wilkinson *et al* 2000c; Scaife 2000).

The fourth peat recorded in the deposits is located between +2.01m and +2.71m OD within borehole WS044A in Transect 3 (Illus 10). Peat recorded in the Phase 1 boreholes at +2.5m OD is likely to be of a similar date to these peats (MOLA 2011). The description of this peat as silty monocot peat indicates development within a probable saltmarsh or mud flat environment, similar to the third peat and has been suggested to be historic or medieval in date (MOLA 2011).

3.3.5 *Made ground (Facies 4)*

The borehole sequences are capped in each transect by modern made ground deposits (Illus 8–11). This deposit directly impacts the alluvium (and peats) below, which were removed during the construction of this layer. The made ground was recorded as being present between +4.64m (borehole WS66A) to -2.19m OD (borehole WS116A). The thickness of the made ground unit is shown in Illus 13 and can be seen to be thickest across the central area of the DA, through the area of the former channel. Unfortunately, the construction of this deposit masks the former height of the alluvium and has also led to the destruction of upper peat deposits, such as those seen in Transect 3 (Illus 10).

3.4 Evolution of the development area

Based on the above data and comparisons with other sites along the Middle Thames area the following text is summarises how the DA has evolved during the Holocene.

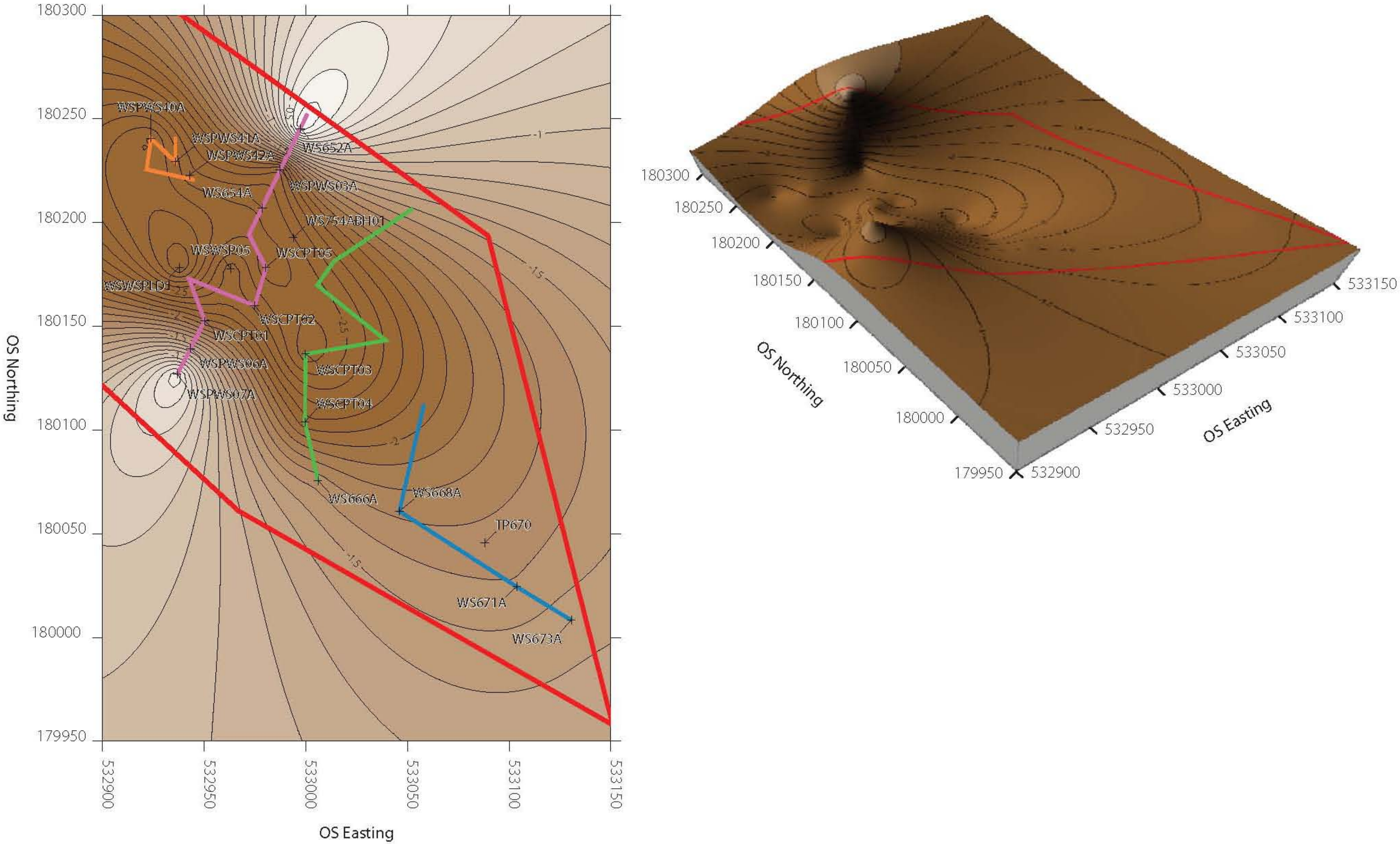
Following the end of the last Glacial period a high energy braided freshwater river environment existed across the development area, which deposited gravels and coarse to medium sands; the River Terrace Deposits (Facies 1). Across the DA a channel can be seen to have incised into these gravels as a result of a shift in one part of the braided river system, which has then shaped this part of the Thames system, prior to the deposition of later alluvium. This channel can be seen cutting through the River Terrace Deposits from northwest to southeast (Illus 12).

As river levels began to rise in the Early Holocene following the melting of the preceding ice sheets of the Last Glacial, so the channel system cutting through the DA changed from a high energy braided river system to a slower meandering river system, similar to that of the current River Thames. This change in energy led to a shift from the deposition of gravels and coarse sands to the deposition of a medium to fine sand layer (Facies 2). During this period the surrounding landscape would have been largely pine woodland fringed with birch carr woodland on developing soil systems.

The increase in water level continued in the Early to Middle Holocene but a slower rate leading to the deposition of minerogenic material or alluvium (Facies 3) within the course of the former channel and the surrounding floodplain area of the DA. The transect information shows that even in a relatively small area there is no uniformity in the depositional sequences. This highlights how much of a dynamic fluvial system was in existence throughout this period, with areas where higher fluvial activity led to the deposition of sandy clays such as in the main channel and northern areas of the site. Whereas on the southern fringe of the channel organic clays often containing wood fragments are located indicating vegetational communities, including shrub or woodland communities were able to form in the ley of the channel. Small sand islands or eyots may also have been present in this area such as that signalled in Transect 3 where vegetation communities were able to exist for periods, shown by the presence of peats.

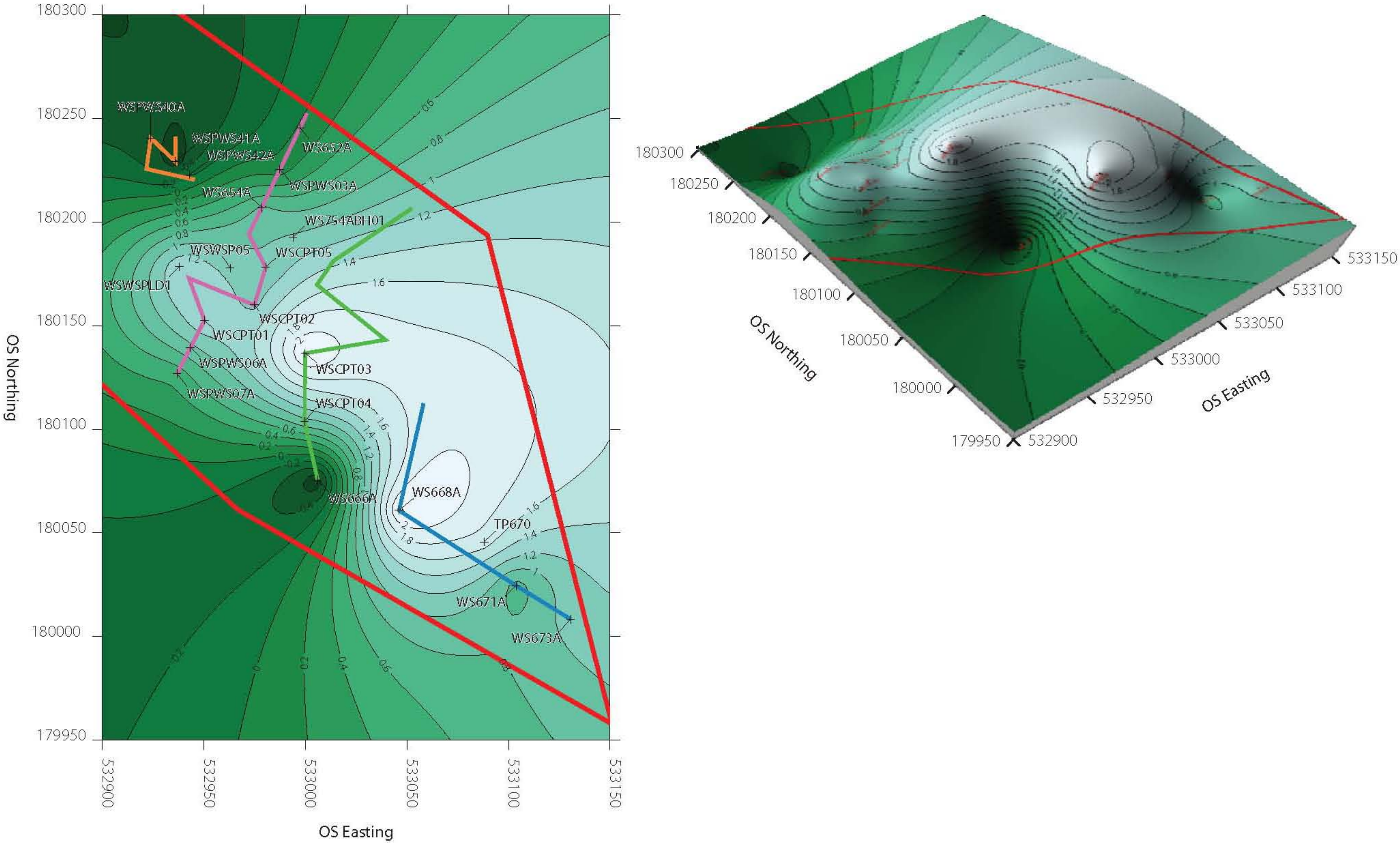
The presence of four peat layers within the alluvium highlights how during the Early to Middle Holocene vegetation communities were able to colonise areas and form terrestrial surfaces. Peat would have developed in areas where sediment deposits accumulated at a higher rate than water level rise or where the channel had shifted allowing vegetation the opportunity to colonise new areas. The peats broadly date to a period where sea level rise in the Thames is seen to have slowed and are suggested to have accumulated during the Mesolithic to Roman periods (see above). However, the peats would need dating to confirm their chronological sequence. Archaeological evidence from flint deposits to boats from sites in the Thames Valley shows people were active in the landscape throughout these periods. Pollen studies show that as these peats developed they were colonised by first sedge and reedswamp communities and then alder dominated carr woodland with oak-hazel woodland present in the more regional landscape. By the Iron Age period much of the woodland had been cleared to make way for agriculture in the land surrounding the channel.

An increase in sea-level rise during the Later Holocene and Roman period saw the DA change from an essentially freshwater environment to a brackish environment as it became affected by tidal systems. This higher energy environment is seen through the deposition of sandy and gravelly clays in the upper parts of the alluvium in transects. This shift would have seen the area become a mudflat and brackish salt marsh landscape. Pollen diagrams also show a predominantly tree-less environment dominated by herbaceous pollen, while the presence of a silty peat layer in the upper units of the alluvium indicate that reedswamp may have formed across some parts of the DA.



Illus 12

2D and 3D contour maps of the river terrace deposit surface



Illus 13

2D and 3D contour maps of the made ground thickness

4. STATEMENT OF POTENTIAL – PALAEOENVIRONMENTAL AND ARCHAEOLOGICAL

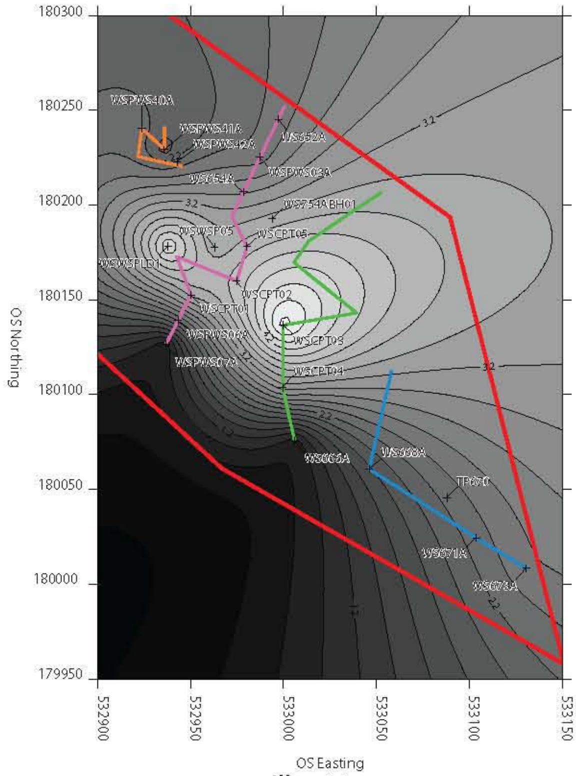
The presence of waterlogged deposits across the DA indicates that there is great potential for the preservation of palaeoenvironmental materials within the sediments. Previous studies (*eg* Sidell *et al* 2000) have evidenced the presence of microfossils (*eg* pollen and diatoms) and macrofossils (*eg* seeds and wood timbers) within both the alluvium and peat layers showing they have high palaeoenvironmental potential and value.

The presence of four distinct peat units within the borehole logs for the DA indicates there is good potential to increase our understanding of the development and evolution of this part of the Thames Valley. Peats not only have an intrinsic value in reconstructing former vegetation communities on a local (using plant macrofossils) and regional scale (such as through pollen), but can also provide benchmarks for former sea-level rise. Thus the peats within the DA have a medium potential to inform on environmental and sea-level change at a landscape level.

Although no archaeological finds were recorded within the borehole logs the DA as a whole still has the potential to contain materials of cultural significance. The stratigraphic sequence suggests that sediments have been deposited in the DA from the Mesolithic through to at least the Later Holocene (Roman times).

Mesolithic flints have been recorded in basal sand (Facies 2) deposits elsewhere in the Middle Thames and thus there is some potential for such materials to be present within the DA.

The presence of peats within the alluvium (Facies 3) indicates there is high to medium potential for cultural materials to be preserved within these deposits, especially organic materials such as wooden objects. The peats within the DA have been suggested to date from Mesolithic through to the Roman period and, therefore, have high potential to contain archaeological finds, particularly for the later periods.



Illus 14

2D contour map of the alluvium thickness

The recorded presence of archaeology from previous studies in the Thames within alluvial deposits highlights their own potential to contain cultural materials. The presence of organic clays within the boreholes indicates they have potential to contain organic materials such as wooden objects. Their location around the edge of the former channel particularly in the south of the DA, suggests they also have potential to contain trackways and platforms extending into the channel, such as those recorded at St Christopher's House, particularly in those deposits relating to the Middle to Later Holocene (Neolithic to Roman).

Table 1 summarises the known or likely assets within the site, their significance, and the impact of the proposed scheme on asset significance.

Asset	Potential Asset Significance	Impact of proposed scheme
		Precise details of construction impacts are not yet known. Construction of new foundations, or other works below current ground/slab level, may truncate the asset, but are unlikely to remove it completely. Given the incomplete understanding of construction activities at this time, the Impacts suggested below are limited in detail.
Identified via geo-archaeological works		
Palaeoenvironmental remains	High	Significance of asset possibly reduced
Peat containing pollen	Medium	Significance of asset possibly reduced
Mesolithic-Holocene deposits containing prehistoric flints	Low	Significance of asset possibly reduced
Holocene deposits containing archaeological artefacts	Medium-high	Significance of asset possibly reduced
Organic clay deposits associated with former channel which could preserve platforms, trackways or other wooden items (*eg* boats)	Medium-High	Significance of asset possibly reduced

Table 1

Impact upon Heritage Assets (prior to mitigation)

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APPENDICES

Appendix 1 – Planning framework

A1.1 Introduction

This project took place while PPS5 was in place with regard to cultural heritage. This section sets out the Planning Framework relevant at the time the project took place.

A1.2 Statutory protection

Planning (Listed Buildings and Conservation Areas) Act 1990

The Act sets out the legal requirements for the control of development and alterations which affect buildings, including those which are listed or in conservation areas. Buildings which are listed or which lie within a conservation area are protected by law. Grade I are buildings of exceptional interest. Grade II* are particularly significant buildings of more than special interest. Grade II are buildings of special interest, which warrant every effort being made to preserve them.

A1.3 National planning policy

The Government issued Planning Policy Statement 5 (PPS5) in March 2010 (DCLG 2010). PPS5 integrates planning strategy on 'heritage assets' – bringing together all aspects of the historic environment, below and above ground, including historic buildings and structures, landscapes, archaeological sites, and wrecks. The significance of heritage assets needs to be considered in the planning process, whether designated on not, and the settings of assets taken into account. PPS5 requires using an integrated approach to establishing the overall significance of the heritage asset using evidential, historical, aesthetic and communal values, to ensure that planning decisions are based on the nature, extent and level of significance. Key paragraphs from PPS5 are set out below:

Policy HE6.1

'Local planning authorities should require an applicant to provide a description of the significance of the heritage assets affected and the contribution of their setting to that significance. Where an application site includes, or is considered to have the potential to include, heritage assets with archaeological interest, local planning authorities should require developers to submit an appropriate desk-based assessment and, where desk-based research is insufficient to properly assess the interest, a field evaluation.'

Policy HE6.3

'Local planning authorities should not validate applications where the extent of the impact of the proposal on the significance of any heritage assets affected cannot adequately be understood from the application and supporting documents.'

Policy HE7.7

'Where loss of significance is justified on the merits of new development, local planning authorities should not permit the new development without taking all reasonable steps to ensure the new development will proceed after the loss has occurred by imposing appropriate planning conditions or securing obligations by agreement.'

Policy HE9.1

'There should be a presumption in favour of the conservation of designated heritage assets and the more significant the designated heritage asset, the greater the presumption in favour of its conservation should be… Significance can be harmed or lost through alteration or destruction of the heritage asset or development within its setting. Loss affecting any designated heritage asset should require clear and convincing justification. Substantial harm to or loss of designated heritage assets of the highest significance…should be wholly exceptional.'

Policy HE9.6

'There are many heritage assets with archaeological interest that are not currently designated as scheduled monuments, but which are demonstrably of equivalent significance…The absence of designation for such heritage assets does not indicate lower significance.'

Policy HE12.3

'Where the loss of the whole or a material part of a heritage asset's significance is justified, local planning authorities should require the developer to record and advance understanding of the significance of the heritage asset before it is lost, using planning conditions or obligations as appropriate. The extent of the requirement should be proportionate to the nature and level of the asset's significance. Developers should publish this evidence… Local planning authorities should…ensure such work is undertaken in a timely manner and that the completion of the exercise is properly secured.'

A1.4 Regional policy

The London Plan

The overarching strategies and policies for the whole of the Greater London area are contained within the London Plan of the Greater London Authority (GLA Feb. 2008). This includes an archaeological statement:

Policy 4B.15 Archaeology

The Mayor, in partnership with English Heritage, the Museum of London and boroughs, will support the identification, protection, interpretation and presentation of London's archaeological resources. Boroughs in consultation with English Heritage and other relevant statutory organisations should include appropriate policies in their DPDs (Development Plan Documents) for protecting scheduled ancient monuments and archaeological assets within their area.

Draft Replacement London Plan, 2009
A draft replacement plan (GLA 2009) is currently undergoing consultation. Policy 7.8 relates to Heritage Assets and Archaeology:

- **Strategic**
  - **A** London's historic environment, including natural landscapes, conservation areas, heritage assets, World Heritage Sites, Scheduled Ancient Monuments and memorials should be identified, preserved and restored.
  - **B** Development should incorporate measures that identify; record, interpret, protect and, where appropriate, present, the site's archaeology.
- **Planning decisions**
  - **C** Development should preserve, refurbish and incorporate heritage assets, where appropriate.
  - **D** New development in the setting of heritage assets, and conservation areas should be sympathetic to their form, scale, materials and architectural detail.
  - **E** New development should make provision for the protection of archaeological resources and significant memorials. Where the artefact or memorial cannot be moved from the site without damaging its cultural value, the assets should where possible be made available to the public on-site.
- **LDF preparation**
  - **F** Boroughs should, in LDF policies, seek to maintain and increase the contribution of built heritage to London's environmental quality and economy while allowing for London to accommodate change and regeneration.
  - **G** Boroughs, in consultation with English Heritage, Natural England and other relevant statutory organisations, should include appropriate policies in their LDFs for identifying and protecting heritage assets scheduled ancient monuments, archaeological assets, memorials and natural landscape character within their area.

A1.5 Local planning policy

The Southwark Unitary Development Plan (UDP) was adopted in July 2007 and, along with the London Plan, it makes up the current Development Plan for Southwark (Southwark Council, 2007). Following the Planning and Compulsory Purchase Act 2004, the planning policies in the UDP are currently being reviewed and will be replaced with a new system of Local Development Frameworks (LDFs) over the coming years. As a result the current UDP is now a part of the Local Development Framework (LDF) and some policies were 'saved'.

The relevant policy in relation to archaeology is set out below:

Policy 3.19 Planning applications affecting sites within Archaeological Priority Zones (APZs), as identified in Appendix 8, shall be accompanied by an archaeological assessment and evaluation of the site, including the impact of the proposed development. There is a presumption in favour of preservation *in situ*, to protect and safeguard archaeological remains of national importance, including scheduled monuments and their settings. The *in situ* preservation of archaeological remains of local importance will also be sought, unless the importance of the development outweighs the local value of the remains. If planning permission is granted to develop any site where there are archaeological remains or there is good reason to believe that such remains exist, conditions will be attached to secure the excavation and recording or preservation in whole or in part, if justified, before development begins.

Reasons
Southwark has an immensely important archaeological resource. Increasing evidence of those peoples living in Southwark before the Roman and medieval period is being found in the north of the borough and along the Old Kent Road. The suburb of the Roman provincial capital (Londinium) was located around the southern bridgehead of the only river crossing over the Thames at the time and remains of Roman buildings, industry, roads and cemeteries have been discovered over the last 30 years. The importance of the area during the medieval period is equally well attested both archaeologically and historically. Elsewhere in Southwark, the routes of Roman roads (along the Old Kent Road and Kennington Road) and the historic village cores of Peckham, Camberwell, Walworth ad Dulwich also have the potential for the survival of archaeological remains.

Additionally, the council has introduced Supplementary Planning Documents (SPDs) and Supplementary Guidance Documents (SPGs) which are used to provide more information and guidance on the policies in the UDP. The Southwark SPG relating to Archaeology was adopted in 1997:

- Objective E.5
  To assist in the preservation, protection, investigation, display and recording of the archaeological heritage Sites of Archaeological Importance.
- Policy E.5.1
  The Council will seek to conserve and protect the borough's archaeological heritage and to enhance the knowledge of its historical development. The policy will apply to sites of potential archaeological Importance, where ancient remains are threatened by development.
  - The Council will expect the applicant to provide Information to enable an assessment of the Impact of a proposed development on the potential archaeology of the site. This would usually be desk based Information and would be expected prior to the determination of a planning application.
  - Where there are likely to be Important remains on a site, which may merit preservation *In situ*, then results of an archaeological field evaluation will, If feasible, be required prior to the determination of a planning application.
  - Where the evaluation reveals important remains their protection and preservation will be the primary objective. This can be achieved by redesigning the proposed development and by foundation modification.

- Where important archaeological remains cannot be preserved, or where remains do not merit preservation, then the Council will use planning conditions to ensure excavation and recording of the remains prior to redevelopment, *ie* preservation by record.
- Archaeological Investigations are to be undertaken by a recognised archaeological field unit to a written specification. These will need to be approved by the Council prior to commencement of any work.

The council's Core Strategy was approved by government in February 2011. Strategic Policy 12 – Design and conservation, states that development is expected to:

- conserve or enhance the significance of Southwark's heritage assets, their setting and wider historic environment, including conservation areas, archaeological priority zones and sites, listed and locally listed buildings, registered parks and gardens, world heritage sites and scheduled monuments (Southwark Council 2011).

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