



C263 Archaeology Late East

Post-excavation assessment and updated project design
 Limmo Peninsula (XRW10), Victoria Dock Portal
 (XSX11), Custom House (XTI13), Connaught Tunnel
 (XSY11), North Woolwich Portal (XSV11) and
 Plumstead Portal and Depot (XSW11) (CRL12)

Document Number: C263-MLA-T1-RGN-CRG03-50017 v3

Contractor Document Submittal History:

Revision:	Date:	Prepared by:	Checked by:	Approved by:	Reason for Issue:
3.0	08.10.2015	G.Spurr	Julian Hill	David Bowsher	Final report
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<input type="checkbox"/>	Code 4.	Received for information only. Receipt is confirmed

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Crossrail: Limmo Peninsula, Victoria Dock Portal, Custom House, Connaught Tunnel, North Woolwich Portal and Plumstead Portal

London EC16

Site codes XRW10, XSX11, XTI13, XSY11 and XSW11

Post-excavation report and updated project design

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Executive summary

This report is intended to provide an assessment and updated project design for the archaeological excavations and watching briefs took place at a series of six sites across the Crossrail Late East work area (site codes: XRW10; XSX11; XTI13; XSY11; XSV11 and XSW11). This work was commissioned by Crossrail Ltd and conforms with national and regional standards and advice (English Heritage 1991, 2006, 2009 and 2013). All field work and subsequent assessment was carried out further to the written schemes of investigation for each site.

This report will describe what was found on the sites, indicate what post-excavation work has been done so far and what work still needs to be completed and why, and provide an assessment of the potential and significance of the sites. The report is written and structured in a particular way to conform to the standards required of post-excavation analysis work as set out in Management of Archaeological Projects (English Heritage, 1991).

The Late East sites have provided an informative and corroborative addition to the geoarchaeological record of the lower Thames area providing insights into pivotal periods of environmental change, particularly during prehistory.

Situated across the wider Thames floodplain, all sites analysed were radiocarbon dated variously from the Late Mesolithic and the Neolithic periods through to the Bronze Age. Typically from the Late Mesolithic, pollen data indicated the area was dominated by oak and hazel woodland on the higher, drier ground, with alder carr (damp woodland) on the floodplain which formed thick peat deposits across nearly all sites. In the Late Neolithic/Early Bronze Age however, pollen and diatom evidence pointed toward an increasingly saline/open salt marsh environment developing which covered the peats under slowly accreting alluvial deposits up until the post-medieval period.

Diatom and ostracod analysis was thorough but poor preservation hindered results. Both analyses however supported other palaeoenvironmental assessments in adding detail to the picture of the evolving landscape across the Late East area. The wider ecological assessment recorded in the ostracod work showed that high areas of gravels and sands generally remained high and dry throughout the Mesolithic and Neolithic and diatom work frequently noted the first onset of hydrological changes (particularly changes toward encroaching tidal environments) across the lower Thames area during the Bronze Age and later.

Furthermore, across the Late East area, both direct and indirect evidence pointing toward anthropogenic activity was recorded. Direct evidence of human activity in terms of flint debitage has been found in the sands overlying the gravels (at North Woolwich) and analysed through soil micromorphology, plant macrofossil and lithic assessments to indicate a midden deposit dating to the Late Mesolithic or Neolithic. Much indirect evidence was discovered through the palaeoenvironmental assessments - particularly through the pollen and plant macrofossil assessments - where cereal production and possible clearance activity was clearly noted throughout the later prehistoric/historic periods.

The data gathered and evidence preserved in the samples collected from the sites should be regarded as having local significance in understanding the evolving prehistoric landscape across the Late East area. It is recommended that the palaeoenvironmental and topographic results from this group of sites is set in the context of a wider study area, including the first river gravel terrace, and the results published in the Crossrail book series. The remains of the medieval boat fragment found at Limmo Peninsula is worthy of a short detailed note in appropriate subject journal such as the International Journal of Maritime Archaeology

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1 Introduction

Site location

The excavations and watching briefs took place at a series of six sites across the Crossrail Late East work area (site codes: XRW10; XSX11; XTI13; XSY11; XSV11 and XSW11). The individual site backgrounds are outlined below going west to east across the Late East area. For the locations of the Late East sites across the area (Fig 1; Fig 2).

The scope of the project

The aim of the targeted watching brief at Limmo Peninsula (XRW10) was to record the presence of any archaeological activity identified during the excavation of the Main and Auxiliary Shafts. The Limmo Peninsula shaft site lies east of the lower part of the River Lea, and west of Victoria Dock Road/Silvertown Way/Dock Road. The centre of the site lies at National Grid reference 539480 180980.

As part of the Late East Crossrail works an archaeological evaluation and watching brief was carried out at the Victoria Dock portal site (XSX11). The Victoria Dock portal is a point of entry to the tunnelled section of the Crossrail route under the City to the west of the new overground station at Custom House, in Newham, London E16. It will be constructed on the current alignment of Network Rail's disused North London Line (NLL) and located opposite 245 Victoria Dock Road from where a ramp will be contained within a cut-and-cover box to the portal opposite 2 to 12 Bridgeland Road (western portal). From this point, Crossrail will run in a retained cut to join existing track levels immediately to the west of Custom House station (eastern portal). The Victoria Dock portal site centres approximately on National Grid Reference (NGR) 540460 180910.

At Custom House (XTI13) in Newham, London E16, archaeological trenches and boreholes were undertaken to assess the nature of the archaeological remains where a new station is required. Custom House is located south of Victoria Dock Road near its junction with Freemasons Road. It will replace the disused North London Line station of the same name. The centre of the site lies at National Grid reference 540773 180918.

Archaeological trenches were undertaken to assess the archaeological potential across the Connaught Tunnel site (XSY11) in areas of track lowering across the surface rail. The Connaught Tunnel is located in the London Borough of Newham, between Prince Regent Station and Victoria Dock Road at its northern end and Silvertown Station and Connaught Road/Factory Road at its southern end (NGR 541050 180945 to 542060 180110). The Connaught Tunnel passes beneath Connaught Passage, with Royal Victoria Dock to the west and Albert Dock to the east.

As part of the Late East Crossrail works an archaeological evaluation and a targeted watching brief was carried out in the North Woolwich Portal site (XSV11). The North Woolwich Portal is located within the existing railway corridor of the former NLL, between Factory Road and Albert Road in the London Borough of Newham, National Grid Reference 542864 179955.

An investigation was undertaken at the Plumstead Portal and Depot site (XSW11) – the only Crossrail site of the Late East sites to be on the southern bank of the Thames (in the London Borough of Greenwich) - to assess the archaeological potential across the area and mitigate its impact on any archaeological remains encountered. The Portal area of the works is comprised of two construction compounds to the north of the existing North Kent Line (NKL). To the west of White Hart Road lies the 'West Worksite', also known as the Plumstead/Old Goods Yard worksite, and to the east lies the 'East Worksite'. The portal site falls within the 'East Worksite', situated between White Hart Road and Church Manor Way. It is within this part of the site that the archaeological evaluation trenches were undertaken. Investigations were also carried out at Plumstead Depot which is situated to the immediate north east of the Plumstead portal site. The works consisted of monitoring of geotechnical boreholes and the drilling of three geoarchaeological boreholes. The portal site centres approximately on National Grid Reference 545546 178885.

All levels in this document are quoted in metres Above Tunnel Datum (m ATD). To convert Tunnel Datum to Ordnance Datum subtract 100m, ie 101m ATD = 1m OD.

Planning background

This post-excavation assessment and updated project design has been carried out in accordance with the Archaeological Method Statements for each site: Document numbers: C261-MLA-X-RGN-CR140-50092 (Limmo Peninsula); C263-MLA-X-RGN-CRG07-50003 (Victoria Dock Portal); C263-MLA-X-RGN-CRG07-50023 (Connaught Tunnel); C263-MLA-X-GMS-CR146_PT004-50001 (North Woolwich Portal); C263-MLA-X-GMS-CR145-50001 (Custom House); C263-MLA-T1-GMS-CRG03-50001 (Plumstead Depot). The MOLA method statements were prepared in line with the Principal Contractor's method statement.

The legislative and planning framework in which all archaeological work took place was summarised in the Site Specific Written Scheme of Investigation (SS-WSI) for each site: Document numbers C261-MLA-X-RGN-CR140-50066 (Limmo Peninsula), C520-XRL-T1-RGN-CR145 -50001; C154-HYD-T1-JLT-CR144_PT003-00001 (Victoria Dock Portal). Revision 5.0 (Custom House); C122-OVE-T1-RGN-CR146_WS158-00002. (Connaught Tunnel); CRL1-PDP-T1-TPL-CR146_WS160-00001 (North Woolwich Portal); C156-CSY-T-RGN-CR148_PT005-00028 (Plumstead Portal).

An archaeological excavation as defined by the Chartered Institute for Archaeologists is 'a programme of controlled, intrusive fieldwork with defined research objectives which examines, records and interprets archaeological deposits, features and structures and, as appropriate, retrieves artefacts, ecofacts and other remains within a specified area or site on land, inter-tidal zone or underwater. The records made and objects gathered during fieldwork are studied and the results of that study published in detail appropriate to the project design' (CIfA, 2014).

The overall framework within which archaeological work will be undertaken is set out in the Environmental Minimum Requirements (EMR) for Crossrail (<http://www.crossrail.co.uk/railway/getting-approval/environmental-minimum-requirements-including-crossrail-construction-code>). The requirements being progressed follow the principles of Planning Policy Guidance Note 16 (PPG16)(DoE, 1990), and its replacements Planning Policy Statement 5 (PPS5)(DCLG, 2010) and the National Policy Planning Framework (NPPF)(DCLG, 2012), on archaeology and planning. The requirements being progressed follow the principles of Planning Policy Guidance Note 16 on archaeology and planning (1990). Accordingly the nominated undertaker or any contractors will be required to implement certain control measures in relation to archaeology before construction work begins.

Schedules 9, 10 and 15 of the Crossrail Bill (2008) concern matters relating to archaeology and the built heritage and allows the dis-application by Crossrail of various planning and legislative provisions including those related to listed building status, conservation areas and scheduled ancient monuments (Schedule 9). Schedule 10 allows certain rights of entry to English Heritage given that Schedule 9 effectively dis-applied their existing rights to the Crossrail project, and Schedule 15 allows Crossrail to bypass any ecclesiastical or other existing legislation relating to burial grounds.

Organisation of the report

This post-excavation assessment describes the results of the palaeo-environmental assessment which seeks to assess the potential of the sediments sampled and recorded within the archaeological trenches and window samples at the individual sites to reconstruct the depositional history and changing past environments across the Late East area as a whole. The remains of the Thames Iron Works recorded at Limmo Peninsula are subject of a separate report in the Crossrail book series (Harrison in prep)

The principles underlying the concept of post-excavation assessment and updated project design were established by English Heritage in the Management of Archaeological Projects 2 (MAP2), (1991) and further developed in The Management of Research Projects in the Historic Environment (MoRPHE) Project Planning Note 3: Archaeological Excavations (1997, revised 2008).

This report contains a summary of the recommendations made for publication. Section 2 summarises the palaeoenvironmental and archaeological background. The original research aims for the project are set out in Section 3. The methodologies involved on and off site are described in Section 4. This is followed by the quantification and assessment of the environmental assemblages from the site in Section 5. In Sections 6 the results of the assessment and Section 7 the synthesis of the data. In Section 8 and 9 the potential and significance of the findings are considered. Section 10 provides a discussion of the publication project. A preliminary publication synopsis is given and the task sequence necessary for this described.

Within the report the archaeological data is broken down into specific numbered units. For example [145] refers to the specific context number allocated to a feature during the excavation. Context numbers are distinguished in the text by square brackets [1] and environmental samples by the use of curly brackets {1}. Specialist subsamples such as pollen are prefixed with a P as in P3 with the exception of diatom subsamples which are prefixed with CR.

2 Palaeo-environmental and archaeological background

Introduction

In this section the landscape evolution and associated archaeology of the Crossrail Late East area is summarised. It forms the necessary background to place the assessment work within a wider landscape context. Dates in BP, refer to before present (ie before 1950), and are given as calibrated radiocarbon dates.

Timescales

Human activity in Britain has taken place during the period of geological time known as the Quaternary, which spans the last 2 million years and is characterised by the climatic oscillations known as ‘the Ice Ages’.

The Quaternary is subdivided into the:

Pleistocene:	2 million–10,000 BP (years before the present)
Holocene:	10,000 BP– present

Although hominins are known to have existed in other parts of the world from the beginning of the Quaternary, if not earlier, the earliest evidence for human activity yet found in Britain has been dated to the latter part of the Quaternary, about 650,000 years ago.

The archaeological timescale, charting the development of human activity in Britain through time, is as follows:

Prehistoric

Palaeolithic (ancestral humans: hominins):	1,000,000–10,000 BP
Mesolithic (hunter gatherer foragers):	10,000BP–4,000 BC
Neolithic (the earliest farmers):	4,000–2,000 BC
Bronze Age (first use of metal, more complex societies):	2,000–600 BC
Iron Age (agricultural intensification; political elites):	600 BC–AD 43

Historic

Roman:	AD 43–410
Saxon / early-medieval:	AD 410–1066
Medieval:	AD 1066–1485
Post-medieval:	AD 1485–present

The location of the Late East sites area, on the floodplain of the Thames, implies that only deposits dating from the very end of the Pleistocene will be present, as it was during this period (about 15,000–10,000 years ago) that the present floodplain was carved out. Consequently the background section focuses mainly on the Holocene and the Late Glacial/Late Upper Palaeolithic periods of the late Pleistocene.

Site location, topography and geology

The Late East area lies mainly on the northern bank of the River Thames with one site – XSW11 (Plumstead Portal) – located on the southern bank. According to the BGS mapping of the area (Solid and Drift Sheets 257 and 271) the Late East area lies over Holocene alluvium which covers the Shepperton floodplain gravels. The earlier Kempton Park gravel terrace and London Clay outcrops further to the north, with the more complex Woolwich and Reading Beds outcropping on the southern bank.

Pre-Quaternary geology

The outcrop pattern of the rocks in the Greater London area is closely related to the geological structure, which is dominated by the London Basin, a gentle synclinal fold, with its axis aligned west to east. The older rocks outcrop on the edge of the syncline: the Cretaceous Chalk of the Chilterns (in the north) and North Downs (forming the southern rim of the London Basin) in the south. Younger geological strata: Tertiary sands and clays, infill the centre of the syncline, which is followed for the most part by the Thames. As it flows through the Late East area the river has scoured the bedrock deposits, leading to London Clay outcropping to the north just beyond the Late East area, with slightly older Tertiary deposits (Woolwich and Reading Beds), outcropping to the south.

The bedrock pre-dates the evolution of hominin groups and has no archaeological potential in itself, although its characteristics often determined the nature of succeeding environments and the landscapes occupied and exploited by communities in the past. On the floodplain of the Thames, however, the impact of the bedrock is negligible, as it is overlain, and its characteristics and contours masked, by a considerable thickness of Quaternary deposits.

Quaternary deposits

River terraces (Palaeolithic)

The present course of the Thames was established about 0.5 million years ago, when the ice sheets of the Anglian Glaciation diverted it from its former course through the Vale of St Albans to its present more southerly route. Since that time successive cold and warm climatic oscillations have caused alternating downcutting and aggradational cycles to take place which, together with a background gradual tectonic uplift, has led to a sequence of progressively younger Quaternary deposits down the valley sides. These (mainly gravel) deposits form a series of terraces, which represent former floodplains of the river that subsequently became incised and left high and dry as the river down-cut to lower levels.

The present floodplain represents the most recent stage in this sequence. It was created as the river down-cut from a former, higher, floodplain (represented by the Kempton Park Gravels), as a result of the low sea-level and the large influx of meltwater which occurred after the Last Glacial Maximum of the Devensian Glacial period (c 18 000 BP). It subsequently deposited coarse grained sediments across the valley floor and these deposits (the Shepperton Gravel) underlie the alluvium in the present floodplain.

The gravel was probably deposited in a network of braided, ephemeral channels at a time when the river had similar characteristics to those flowing in arctic regions today. Within the river, sand and gravel bars accumulated, forming an irregular surface topography. This gravel aggradation is thought to have ceased by 15 000 BP (Wilkinson and Sidell 2000).

Palaeolithic material pre-dating the incision of the present Thames floodplain is occasionally found within or above the floodplain gravels, having been eroded from its place of discard on the higher, older terraces and deposited with the river gravels on the valley floor. Such artefacts are usually rolled and worn and their *ex-situ* context makes them of low interest archaeologically.

Deposits of the Late Pleistocene and Holocene (Late Upper Palaeolithic to the post-medieval period)

Previous work in the area has demonstrated that the floodplain gravel surface dips towards the river from around 98m ATD (-2m OD) at the floodplain edge to about 92m ATD (-8m OD) close to the river itself (Bates, 2000). Within this overall trend undulations occur, which represent the surface morphology of gravel bars accumulating in the late Pleistocene braided river channel. This has resulted in a mosaic of gravel 'highs' and 'lows' which have played an important part in how the landscape has evolved well into the prehistoric periods and even later.

Areas of higher gravel, sometimes overlain by sand, are likely to have remained as dry land during the prehistoric period (and occasionally even into the historic period) when the surrounding land was becoming waterlogged and buried beneath peat and minerogenic alluvium. In contrast, areas of low gravel are generally considered to have formed the thalwegs (main threads of water flow) of the Late

Pleistocene braided channels. Most appear to have become abandoned in the Late Pleistocene and Early Holocene and these abandoned channels have the potential to preserve fine-grained and organic sediments dating from the Late Glacial/Holocene interface. Such sediments are likely to contain biological remains suitable for reconstructing the evolving landscape and the rapid climatic change which was occurring at this time.

The gravel surface topography was modified by sand deposition, which probably took place as a result of changes in the river regime, as the climate warmed and river flow slackened at the Pleistocene/Holocene interface. The sand, which is typically found to be banked-up against areas of higher gravel, appears to be of Late Glacial to mid-Holocene date. It frequently 'fines-up' and passes laterally into clayey sand to sandy clay. Mesolithic flints have been found within and at the surface of bedded sands in the Erith Marsh area (Sidell *et al* 1997) suggesting that Mesolithic remains might be expected within or at the surface of the sand and the associated more clayey deposits.

Development of the Holocene floodplain (Mesolithic to post-medieval)

A general model for the landscape evolution for the Lower Thames floodplain area has been proposed by Bates and Whittaker (2004). The model suggests that, following the deposition of the floodplain (Shepperton) Gravel, and before the impact of rising relative sea level (RSL) was felt in this part of the Lower Thames Valley, a period of landscape stability existed in the early Mesolithic, when soils developed in the Shepperton Gravels and other pre-Holocene deposits. As estuarine conditions migrated upstream the silts and clays of salt marsh environments began to accumulate. Widespread peat subsequently developed during the Neolithic and earlier Bronze Age, with a switch to brackish conditions in the Iron Age and the deposition of minerogenic deposits continuing into the historic period.

The early Holocene floodplain (Mesolithic)

Clayey and sandy clay deposits, which probably represent increasingly slack water flow and overbank flooding, are typically found at the base of the Holocene sequence. Although the environment of deposition is not well understood, at least some of the sandy clay deposits are thought to be 'accretionary' soils, which are likely to have developed as a result of seasonal flooding of the valley floor. Extensive evidence for Mesolithic activity has been recovered from such deposits at Three Ways Wharf, Uxbridge (Lewis *et al* 1992), suggesting that the environments they represent were frequently utilised by Mesolithic hunter-gatherers.

Soils may also have developed above the gravel and sand adjacent to the river channels even in relatively low-lying parts of the floodplain during the Mesolithic. Pollen evidence from such early Holocene peaty soils indicates that the floodplain in the early to mid-Holocene between the river channels may have been forested, with a patchwork of lime-dominated woodland (Scaife 2000) which was rapidly becoming ousted by alder (Brown 1997).

In the Mesolithic period the topography of the floodplain landscape was more irregular than today, following the surface of the floodplain gravel. The evidence for soil formation suggests that much of the valley floor was relatively dry land, with freshwater streams and lakes or pools of standing water. Although the floodplain environment was probably attractive for exploitation by hunter-gatherer groups, Mesolithic remains are not frequently recovered from this stretch of the Thames floodplain, although they are frequently encountered in the tributary valleys of the Middle and Lower Thames, such as the Colne, Lee, Darent and Cray. The lack of finds may be a result of their great depth, buried below thick deposits of Holocene alluvium.

Relative sea level rise

During the cold glacial stages of the Pleistocene sea level was as much as 100m lower than it is today. Thus at the Pleistocene/Holocene interface sea level was still very low (estimated by Devoy (1982) to have been c -30m OD). Sea level rise appears to have been rapid until about 6,000 years ago, when sea level attained its present level. However, SE England is sinking as a result of isostatic rebound (the earth's crust compensating for the imbalance caused by the weight of ice over Northern England in the last cold stage) and so in relative terms, in SE England, the level of the sea has continued to rise with respect to that of the land.

The effect of rising relative sea level on any location within the floodplain of the Lower Thames Valley during the Holocene was for waterlogging of previously dry land surfaces to occur, as drainage became ponded-back. Subsequently the onset of increasingly brackish conditions (salt marsh and mudflats) took place in an upstream direction, as estuarine and marine environments migrated progressively upstream.

A model for the likely impact of rising relative sea level in the vicinity of the Lower Thames area has been proposed by Bates (2000). The model suggests that where the topography of the 'pre-Holocene surface' lay below 94m ATD (−6m OD) it was a wetland area by c 8000 BP (the Late Mesolithic) and by 6600 BP (the Early Neolithic) only land above 96m ATD (−4m OD) will have remained as dry land. Such wetland expansion caused islands of higher land to be created, as the surrounding lower-lying land turned to marsh and mudflats. These islands may have become targeted for exploitation and are often associated with evidence for prehistoric activity. The remains of timber structures, built to access and/or traverse the wetland are also frequently found in the surrounding peat deposits. Notable examples of which have been found just to the east of the Late East area at Beckton (Meddens, 1996).

The rate of isostatic rebound has not been constant and is often masked by the impact of other factors. As a result RSL rise has not been continuous and has at times appeared to fall, most conspicuously during the Late Neolithic/Early Bronze Age and Roman periods. In consequence the alluvial sequence is not generally a simple progression from dryland soils to peat to estuarine clays and silts but typically contains interbedded organic and minerogenic deposits (Devoy 1979; Sidell 2002).

Quaternary scientists and geographers are interested in the alluvial sequence for the information it provides on the pattern of local RSL rise and its implications for Holocene sea level fluctuations and climate change at a wider scale. Archaeologically, however, the significance of the interbedded peats and clays within the floodplain lies in the information they provide about past fluctuations in environment and thus the changing landscape available to be exploited and inhabited by people in the past. The waterlogged conditions of these deposits, also preserves evidence for prehistoric activity, which rarely survives on dry land sites (eg. timber structures, wooden artefacts, wattle and matting).

Neolithic to Bronze Age peat and floodplain forest

A thick peat bed, dating from the Neolithic to the Bronze Age period, is widespread in the Central and East London Thames area. On sites located at Dagenham Docks (Sankey and Spurr 2004) and Wennington Marsh, (Fairburn *et al* 1996; Sidell 2003) the base of the peat lay just above 97m ATD (−3m OD) and was dated to the Early Neolithic (c 5800-6000BP). At Wennington Marsh its surface, which was dated to c 3500BC, lay at 98.7m ATD (−1.3m OD) and at Dagenham Docks it was recorded at 99.2m ATD (c −0.8m OD) and dated to the Early Iron Age (2700–2480BP).

Detailed pollen and plant macrofossil analysis of the Wennington sequence (Fairburn *et al* 1996; Sidell 2003) showed that the peat represented a sequence of changing environments that at first became increasingly dry and later became increasingly wet and open. Initially, in the earliest stages of peat accumulation, aquatic and marshy species grew on the site, which were subsequently replaced by on-site tree growth, principally of yew, which though poorly recorded in the pollen sequence dominated the botanical macrofossil remains. Humified wood peat developed under the yew forest, which was overlain by wetter wood peat (alder carr) and subsequently by an organic mud, dominated by the pollen of grasses, sedges and goosefoots (a salt marsh plant).

In contrast to the characteristics of the Neolithic to Bronze Age peat at Wennington, its characteristics at Summerton Way at Thamesmead on the southern bank of the Thames, consisted of laminated peat and organic mud, thought to have accumulated in wet 'alder carr' woodland, with regular flooding or permanent standing water across much of the ground surface. The laminations may represent seasonal layers within floodplain pools. At Summerton Way the organic unit also lay between 97m ATD (−3m OD) and about 98.7m ATD (−1.3m OD), and here its surface was dated to 3220-2830 years BP (Lakin 1997).

In terms of archaeology a wooden doll, the 'Dagenham Idol', which has been dated to the Neolithic, was found within floodplain alluvium just to the east of the Late East area in 1922. It was recovered three metres below the 1922 ground level alongside the skeleton of a deer, which may suggest votive

deposition. It is one of the most famous pieces of anthropomorphic art from the prehistoric period known in Britain. It also provides evidence that Neolithic people were utilising the forest and watercourses of the floodplain in the area. There is also good evidence for exploitation of the wetland resources of the floodplain in the lower reaches of the Thames during the Bronze Age. The archaeological investigations along the route of Bronze Age Way in Erith revealed a timber trackway and a gravel causeway built to access the marsh from the higher dryer ground to the west. Radiocarbon dates suggest it was constructed in about 3500 BP. Another Bronze Age causeway, constructed of burnt flint and thought to have been used as a driveway for cattle, was found at the Hays Storage Depot, Dagenham (Divers 1994).

Upper silty clay (Iron Age to medieval)

It is likely that the silty clay, which forms the upper part of the alluvium, represents the gradual transition during the historic period (or possibly during the Iron Age) from mudflats to lower then upper saltmarsh and subsequently to reclaimed land, which may have been seasonally flooded. During the historic period many tidal creeks, natural channels and man-made drainage ditches were cut through the earlier alluvial deposits and are usually found to be infilled with silts and sands.

The area probably continued to be agricultural land, with marshland on the floodplain, although evidence for falling river levels in the later Roman period (Brigham 1990) suggests areas close to the river edge may have become available for occupation or cultivation at this time.

Most of the Late East area was probably grazing land in medieval times. Land reclamation from salt marsh may have begun before the Norman conquest and was probably carried out *ad hoc* in medieval times by various landowners.

Post-medieval deposits and archaeology

Post-medieval archaeology may exist within the upper part of the alluvium or within the lower part of the made ground deposits although the area probably remained as open undeveloped land into the latter half of the 19th century.

3 Original research aims

The potential for geo-archaeological and palaeoenvironmental deposits to be recovered will contribute to the following themes:

The development of models for understanding the significance of geomorphology, ecology, ecosystems and climate, hydrology, and vegetational and faunal development, on human lives;
 Characterising changing climatic conditions, and air and water quality and pollution, throughout the archaeological record, towards understanding its implications for how people behaved;
 The Mesolithic/Neolithic transition: understanding the significance of horticultural experimentation at this time, and the transition from hunter-gatherers into farmers; and
 Understanding what London's past environments meant to different groups and individuals.

The original aims and objectives were devised by MOLA to guide the fieldwork and listed in the WSI's for each site. Given the sites were in similar environments these guidelines were often repeated. As such, a summarised version of the research aims is listed here:

- What is the development of the local landscape, topography and environment of the Thames floodplain? What Palaeoenvironmental data is there to inform on this development?
- Is there any evidence for Palaeolithic activity at the interface between the Pleistocene gravels and early Holocene channel deposits? If so, what form does this take?
- If peat deposits can be securely dated, what activity is contained within them, and how does this help to refine knowledge of prehistoric activity, occupation and settlement in the marginal wetland habitats?
- Is there any evidence for prehistoric activity? If prehistoric remains are present, what is their character and what can be learned about the exploitation of the floodplain by prehistoric groups? In particular, is there any evidence for Mesolithic activity at the base of the alluvium/surface of the gravels?
- Is there any evidence for timber trackways or other structures of later prehistoric date?
- Is there any evidence for Roman activity, in particular for reclamation or flood defences, and marine transgression and regression?
- Is there any evidence for Saxon activity, in particular for water management, marginal wetland agriculture, flood defences and/or fishing?
- What can be learned about the process of land reclamation and management of the area from the medieval period until the construction of the docks?

4 Methodology of the assessment

Introduction

Several visits were made by a MOLA geoarchaeologist to examine, record and sample the natural sequences / archaeological features exposed during the evaluation work. Although window samples/boreholes were used in certain locations, samples taken from trench sections were preferred as trenches offer a wider understanding of the stratigraphic complexities and enable concomitant bulk sampling to be undertaken along with the monolith sampling. In general, therefore, sequences of monolith tins taken from sections exposed in the archaeological trenches (along with bulk samples taken adjacent to the monolith tins) provided the basis for off-site examination. The assessed sequences are summarised on a site by site basis as follows.

Summary of assessed sequences

XRW10 (Limmo Peninsula)

Two monolith samples ({33} and {34}) were taken from the Auxillary Shaft from section 5 were analysed in more detail in this report. Specialist pollen and diatom assessments were undertaken as part of this work.

XSX11 (Victoria Dock Portal)

Geoarchaeological assessment was undertaken on monolith tins {19},{20},{21},{22},{30},{31},{39},{40} and {46} from Trench 2 at XSX11. Specialist pollen, diatom, ostracod, plant macrofossil assessments and radiocarbon dating were undertaken as part of this work.

XTI13 (Custom House)

Given its proximity to XSX11 only radiocarbon dating of the organic deposits from Window Sample 1 (WS1) was undertaken for this site.

XSX11 (Connaught Tunnel)

Two trench sequences (Trench 1 and Trench 3) were sampled from Connaught Tunnel (XSX11). The sampled sedimentary sequence from Trench 1 consisted of monoliths {1}{2}{3}{4}{5}{6} and {7} and the sampled sedimentary sequence from Trench 3 consisted of monolith samples {45} {46} {48} {59} {49} {61} {60} {62} and {69}. Specialist pollen, diatom, ostracod, plant macrofossil assessments and radiocarbon dating were undertaken as part of this work.

XSV11 (North Woolwich Portal)

A monolith sequence {3}, {4}, {15} and {16} from Trench 3 coupled with a single monolith tin {31} from Trench 4 and {59} and {63} from Trench 2 were selected as representative for the site sequence as a whole at XSV11. Specialist pollen, diatom, ostracod, plant macrofossil and soil micromorphology assessments with radiocarbon dating were undertaken as part of this work. A lithic assessment report was also undertaken on the prehistoric flint horizons at XSV11.

XSW11 (Plumstead Portal and Depot)

The monolith sequence {37}, {35} and {34} from Trench 2 was selected as representative for the site sequence as a whole at XSW11. Specialist pollen, diatom, ostracod, plant macrofossil assessments and radiocarbon dating were undertaken as part of this work. To the northwest of the portal at Plumstead Depot (also XSW11), a series of three boreholes were undertaken to assess the nature of the underlying stratigraphy in the absence of trench work.

Geoarchaeological laboratory work and deposit assessment methodology

The following procedures were carried out on each monolith or window sample sequence as appropriate. The reports relevant to each site will be presented below with a synthesis of the data at the end.

Sediments

All the monolith samples were cleaned and described, using standard sedimentary criteria, as outlined in Jones et al (1999). This attempts to characterise the visible properties of each deposit, in particular relating to its colour, compaction, texture, structure, bedding, inclusions and clast-size. For each profile the depth and nature of the contacts between adjacent distinct units was noted.

Soil Micromorphology

Richard MacPhail

Soil micromorphology, chemical analysis and magnetic susceptibility were undertaken on two samples from XSV11 (North Woolwich Portal) monoliths {31} Trench 4 and {63} Trench 2, the first targeting the interface between sampled contexts [15] and [17] in Trench 4 to provide more detail on the land surface intermittently occupied throughout the Mesolithic and the second analysing the higher burnt flint deposit [36] sampled from Trench 2 (from monoliths <60> or <63>).

The monoliths were assessed, sawn into two thin section subsamples and then impregnated with a clear polyester resin-acetone mixture. Impregnated samples will then be topped up with resin, ahead of curing and slabbing for 75x50 mm-size thin section manufacture. The thin sections will be further polished with 1,000 grit papers and analysed using a petrological microscope under plane polarised light (PPL), crossed polarised light (XPL), oblique incident light (OIL) and using fluorescent microscopy (blue light – BL), at magnifications ranging from x1 to x200/400. The thin sections will be described, ascribed soil microfabric types (MFTs), microfacies types (MFTs) and counted according to established methods with a report written on the results Bullock et al, 1985; Courty, 2001; Courty et al, 1989; Macphail and Cruise, 2001; Stoops, 2003; Stoops et al, 2010).

Further to the soil micromorphology, chemical analysis was also undertaken on the fine earth (ie < 2 mm) fraction of the samples. Phosphate-Pi (inorganic phosphate) were determined using a two-stage adaptation of the procedure developed by Dick and Tabatabai (1977) in which the phosphate concentration of a sample is measured first without oxidation of organic matter (Pi), using 1N HCl as the extractant (after a slight excess of HCl has been added to remove any carbonate present); and then on the residue following alkaline oxidation with sodium hypobromite (Po), using 1N H₂SO₄ as the extractant. Phosphate-P (total phosphate) has been derived as the sum of phosphate-Pi and phosphate-Po, and the percentages of inorganic and organic phosphate calculated (ie phosphate-Pi:P and phosphate-Po:P, respectively). LOI (loss-on-ignition) was determined by ignition at 375°C for 16 hours (Ball, 1964) – previous experimental studies having shown that there is normally no significant breakdown of carbonate at this temperature.

In addition magnetic susceptibility was undertaken. χ (low frequency mass-specific magnetic susceptibility) determinations were made and determinations of χ max (maximum potential magnetic susceptibility) were made by subjecting a sample to optimum conditions for susceptibility enhancement in the laboratory. χ conv (fractional conversion), which is expressed as a percentage, is a measure of the extent to which the potential susceptibility has been achieved in the original sample, viz: $(\chi / \chi \text{ max}) \times 100$ (Scollar et al, 1990; Tite, 1972). In many respects this is a better indicator of magnetic susceptibility enhancement than raw χ data, particularly in cases where soils have widely differing χ max values (Crowther, 2003; Crowther and Barker, 1995). A Bartington MS2 meter was used for magnetic susceptibility measurements. χ max was achieved by heating samples at 650°C in reducing, followed by oxidising conditions. The method used broadly follows that of Tite and Mullins (1971), except that household flour was mixed with the soils and lids placed on the crucibles to create the reducing environment (after Graham and Scollar, 1976; Crowther and Barker, 1995).

Pollen

Rob Scaife

Pollen analysis has been carried out on samples taken from five Late East Crossrail sites (XRW10; XSX11; XSY11; XSV11 and XSW11). Forty four samples were examined (Appendix 1, Table 35). Standard techniques for extraction and concentration of the sub-fossil pollen and spores were used on sub-samples of 2ml. volume (Moore and Webb 1978; Moore *et al* 1992). Micromesh sieving (10 micron) was also used to assist removal of fine silica in these predominantly minerogenic samples. Counts of 200 total pollen were made for each sample.

Taxonomy in general follows that of Moore and Webb (1978) modified according to Bennett *et al* (1994) for pollen types and Stace (1991) for plant descriptions. These procedures were carried out in the Palaeoecology Laboratory of the School of Geography, University of Southampton.

Diatoms

Nigel Cameron

A total of thirty-four sediment sub-samples from five Late East Crossrail sites (XRW10; XSX11; XSY11; XSV11 and XSW11) have been prepared and assessed for diatoms (Appendix 1,

Table 36). The purpose of carrying out a diatom assessment is to test for the presence or absence of diatoms and the potential of the sediments for further diatom analysis. The diatom assessment of each sample takes into account the numbers of diatoms, the state of preservation of the diatom assemblages, species diversity and diatom species environmental preferences.

Diatom preparation followed standard techniques (Battarbee *et al* 2001). Two coverslips were made from each sample and fixed in Naphrax for diatom microscopy. A large area of the coverslips on each slide was scanned for diatoms at magnifications of x200 x400 and x1000 under phase contrast illumination.

Ostracods

John E. Whittaker

Ten samples were received from three sites being excavated as part of the C263 Late East project (Appendix 1, Table 37). Two samples came from XSW11, the Plumstead Portal, four were from XSX11, the Victoria Dock Portal and the final two came from XSY11, the Connaught Tunnel (two each from trenches 1 and 3). The purpose of the assessment was to examine the potential of the microfauna, especially the ostracods (if present), for the purpose of palaeoenvironmental reconstruction.

The sediment of each sample was first broken up into very small pieces by hand and put in ceramic bowls and thoroughly dried in an oven. Then a small amount of sodium carbonate was added to each (to help remove the clay fraction) and hot water poured over them. They were left to soak. Good breakdown was achieved by washing through a 75 micron sieve with hand-hot water. Each residue was then decanted back into a bowl and returned to the oven to dry. Samples were stored in labelled plastic bags and analysed by placing each sample into a nest of sieves and examining each of the fractions on a tray under a binocular microscope. The faunas were noted and representative microfossils, when they occurred, were picked out and put into 3"x1" slides for archive purposes.

Plant macrofossils

Anne Davis and Karen Stewart

During excavation on four Late East Crossrail sites (XSX11; XSY11; XSV11 and XSW11) environmental samples were taken for the retrieval of archaeobotanical and other organic remains in order to assess their potential to contribute to the interpretation of the site (Appendix 1, Table 39).

These samples were processed by flotation, using a Siraf flotation tank, with meshes of 0.25mm and 1.00mm to catch the flot and residue respectively. The flots were stored in water to maintain waterlogged conditions. The residue was dried and sorted by eye for artefacts and environmental material. The flot was scanned briefly, using a low-powered binocular microscope, and the abundance, diversity and general nature (method of preservation, unusual features) of plant macrofossils and any faunal or artefactual remains were recorded on the MOLA Oracle database.

Radiocarbon dating

Beta Analytic Inc.

Sub-samples of organic material were taken from the relevant organic contexts (outlined in

Table 38 below) for Accelerated Mass Spectrometry (AMS) dating, which was carried out by Beta Analytic, Florida.

After death, living organisms cease carbon exchange with the biosphere and the naturally occurring radioactive isotope of carbon in the organism (^{14}C) begins to decay to form the stable element ^{14}N . Measuring of the ratio of the amount of ^{12}C to the ^{14}C in a sample enables the amount of radioactive decay to be quantified and the age of the death of the organism to be determined.

The radiocarbon determination or conventional radiocarbon age, quoted with a plus or minus error, reflects the number of radiocarbon years before 1950 ('the present' [BP]) based on an assumed constant level of ^{14}C in the atmosphere. The radiocarbon determination is sometimes called the raw radiocarbon age to avoid confusion with a true calendar date.

5 Quantification and assessment

Post-excavation review

The following work has been completed for this post-excavation assessment.

- Trench sections from XRW10, XSX11, XSY11, XSV11 and XSW11 and window sample data from XTI13 has been entered into the Rockworks 15 digital database.
- Relevant Trench sections from XSY11, XSV11 and XSW11 have been subsampled and assessed for pollen, diatoms, ostracods, plant macro fossils and radiocarbon dating. The trench section from XRW10 has been subsampled and assessed for pollen and diatoms. The trench section from XSX11 has been subsampled and assessed for diatoms, ostracods, plant macro fossils and radiocarbon dating. The window sample from XTI13 has been subsampled and assessed for radiocarbon dating.
- Bulk samples taken from the archaeological trenches (XSX11, XSY11, XSV11 and XSW11) have been processed and assessed for plant macro fossils.
- Lithic and timber assemblages assessed recorded.

6 Results of the assessment

XRW10 (Limmo Peninsula)

Archaeological fieldwork summary

An archaeological targeted watching brief was carried out at the Limmo Peninsula, Main and Auxiliary Shafts. The results are summarised as follows.

All deposits observed between the London Clay and the base of the alluvium are likely late Devensian or Holocene in date, and are the result of several phases of erosion, deposition and silting by a number of channels cutting and reworking earlier floodplain deposits. These channels cut into the London Clay and have likely scoured away most, if not all, previous surfaces or deposits.

The alluvium in both shafts was likely to have been deposited within historic times. A medieval boat hull section in the Main Shaft dates the alluvium thus and while there were no currently available dates for finds from the Auxiliary Shaft it seems likely that the date range for the deposition of the silts is equivalent. It is significant that the bed of the river at this time was gravelly, the river perhaps not carrying as much fine silt sediment in the medieval period as it did later and continues to do to this day.

The thick layer of 19th-century industrial waste was presumably put down to raise the ground level higher to prevent flooding and at the same time consolidate the ground to create some kind of hard surface for the Thames Ironworks buildings to sit on. However, several very substantial 19th-century timber piles were seen below wall base in the Auxiliary shaft, so the layer of clinker may not have been deemed necessarily firm enough on its own over the soft alluvium.

Assessed Logs

Sediments sampled in the monolith tins {33} and {34} taken from section 5 in the Auxillary shaft at XRW10 were recorded in the laboratory and subsamples were taken for further analysis. The trench locations are illustrated in Fig 2 and the relevant section in Fig 3. All the monolith tin samples were described using standard sedimentary criteria (relating to colour, compaction, texture, structure, bedding, inclusions, and clast-size). The descriptions of the monolith tin sample is tabulated as follows (m BTM refers to metres below top of monolith sequence):

XRW10 (Limmo Peninsula) {33}									
Context	from (m BTM)	to (m BTM)	from (m ATD)	to (m ATD)	from (m OD)	to (m OD)	Description	Interpretation	Monolith No.
81	0	0.04	98.35	98.31	-1.65	-1.69	Small to medium subrounded clast supported gravel and grey silty sand	Late prehistoric/historic channel deposits	33
83	0.04	0.24	98.31	98.11	-1.69	-1.89	Mid grey silty sand		
	0.24	0.33	98.11	98.02	-1.89	-1.98	Mid grey fine to medium sandy silt		
	0.33	0.5	98.02	97.85	-1.98	-2.15	Mid grey bands of silt and medium sands		

Table 1: Sedimentary description of {33} from XRW10

XRW10 (Limmo Peninsula) {34}									
Context	from (m BTM)	to (m BTM)	from (m ATD)	to (m ATD)	from (mOD)	to (mOD)	Description	Interpretation	Monolith No.
82	0	0.11	98.37	98.26	-1.63	-1.74	Black peat with roots	Possible eroded clast	34
	0.11	0.25	98.26	98.12	-1.74	-1.88	Soft mid grey silty clay	Late prehistoric/ historic channel deposits	
	0.25	0.35	98.12	98.02	-1.88	-1.98	Clast supported small to medium subangular to subrounded gravel infilled with mid grey sandy silt		
	0.35	0.4	98.02	97.97	-1.98	-2.03	Soft mid grey clayey silt		
	0.4	0.5	97.97	97.87	-2.03	-2.13	Black peat with roots	Possible eroded clast	

Table 2: Sedimentary description of {34} from XRW10

The monolith samples {33} and {34} taken from section 5 in the Auxillary shaft at XRW10, represent contemporary late prehistoric or historic channel deposits on the whole, being the result of a number of erosional and depositional events reworking earlier floodplain deposits.

Pollen

Rob Scaife

Introduction

Samples from contexts [83] (P1 and P2) and [82] (P3 and P4) from monolith profiles {33} and {34} respectively have been examined. The results are illustrated in Fig 11.

Results

Monolith {33} Context [83]: Trees and shrubs comprise 40% and 49% of total pollen. These arboreal elements comprise largely *Quercus* (oak; 15-20%) *Corylus avellana* type (hazel; 7-10%) and *Alnus* (alder; 5-14%). There are also occasional pollen of *Tilia* (lime), *Fagus* (beech; at 97.9m ATD / -2.10m OD) and some *Pinus* (pine) in the upper sample P1 (at 98.04m ATD / -1.96m OD).

Herbs are important with a moderate diversity of taxa. Poaceae (non-cultivated grasses) are dominant in both samples (23%-35%). Other important taxa include Cereal type (12%; also with *Secale cereale* in P2), Chenopodiaceae (goosefoot, oraches, samphire; to 5%), Asteraceae types (dandelion and daisy family) and a range of other sporadically occurring taxa. Marsh herbs are of fen type and comprise Cyperaceae (sedges) which is most important in the upper sample (98.04m ATD / -1.96 mOD; P1; 20%), *Typha angustifolia/Sparganium* type (bur reed and/or reedmace) and *Typha latifolia* (reedmace). Aquatic macrophytes include *Potamogeton* type (pondweed) which may also include *Triglochin* (arrow grass). The Royal Fern, *Osmunda regalis* and cysts of freshwater algal *Pediastrum* are also present from the wetland habitat. Other fern spores include monolete, *Dryopteris* type (10-40%), some *Pteridium aquilinum* (bracken) and occasional *Polypodium* (polypody fern)

Herbs are important although there are numbers of trees and shrubs. The latter consist of oak (*Quercus*) and hazel (*Corylus*) possibly with some lime (*Tilia*) and it is probable that woodland was present. Lime (*Tilia*) is poorly represented in pollen assemblages and the small numbers here probably belie its real importance. This also applies to beech (*Fagus*) for which there is a single record in the lower profile (P4 at 97.95m ATD / -2.05mOD).

The on-site habitat was probably a grass sedge fen with other fen taxa. Small numbers of alder (*Alnus*) are not significant enough to suggest any local growth (of floodplain carr).

Cereal pollen in both samples shows use of cereals and with grasses and associated taxa of grassland/pasture suggests a mixed arable economy. It should also be considered that the cereal pollen may have derived from secondary sources such as dumped domestic waste or from crop processing activities which liberated pollen.

As with sample P3 in monolith {34} (98.17m ATD / -1.83 mOD), Chenopodiaceae (goosefoot, oraches and samphire) are present. These may indicate salt marsh and brackish water, tidal conditions.

Monolith {34} Context [82]: One of two samples (P4) (97.95m ATD / -2.05mOD) is suggested as being from reworked peat and as such is described separately. This sample differs significantly from P3 (98.17m ATD / -1.83 mOD) also from (higher up) this column. With only two samples from this column it is not possible, with certainty, to state that this sample is from a reworked peat ball. The pollen assemblages do, however, indicate that this may be the case. However, given the broad sample interval, it is also possible that there is a hiatus between the two levels examined.

Trees and shrubs are more important in this sample than P3. *Alnus* (alder) has values to 40% with *Quercus* (oak; 25%) and *Corylus avellana* type (hazel; 25%). There are correspondingly lower herb pollen numbers and taxonomic diversity. Marsh/fen herb taxa consist only of Cyperaceae (sedges) in small numbers. Fern spores are present with *Pteridium aquilinum*, (bracken) *Dryopteris* type (typical ferns) and *Polypodium* (polypody fern) in small numbers.

Tree and shrub pollen values in P3 are smaller than P4, lower in the profile. However, *Pinus* (pine) values are higher (15%), possibly an indication of fluvial, possibly brackish water conditions which aids the transport of these saccate pollen grains. A single *Abies* (fir; a non-native) is also present and may be of similar origin. Other trees include *Quercus* (17%), *Corylus* (5%) and *Alnus* (10%). Herbs comprise dominant Poaceae (grasses; 30%) with Chenopodiaceae (possibly halophytes), Asteraceae types (esp. Lactucoeae; dandelion types; 10%) and a range of other individual pollen occurrences (including *Ranunculus* (buttercups), *Plantago lanceolata* (ribwort plantain), *Sanguisorba minor* (salad burnet) and *Centaurea cyanus* (blue cornflower).

Marsh/fen taxa are dominated by Cyperaceae with some *Typha latifolia* and *Typha angustifolia*/Sparganium and *Nuphar luteum* (yellow water lily). Fern spores (*Dryopteris* type; typical ferns) have their highest values in this sample (40% sum + fern spores). Freshwater algal *Pediastrum*, *Sphagnum*, (bog) moss spores and reworked pre-Quaternary palynomorphs, are present.

The lower sample in [82] P4 differs from the upper sample P3 and it is realistic to think that this sample came from a reworked peat clast. However, the possibility of a hiatus should also be considered. The vegetation habitat shown by this sample was alder fen carr woodland surrounded by oak (*Quercus*) and hazel (*Corylus*) woodland, possibly with some elm (*Ulmus*) and lime (*Tilia*). This assemblage is typical of the later prehistoric period for the London region. Whilst a middle Holocene (Atlantic; FI II; Late Mesolithic) age is possible, the small values of elm and lime suggest a Neolithic-Bronze Age date. Radiocarbon dating would obviously clarify this. There is a general absence of herb pollen in this sample and in particular an absence of cereal type pollen and ribwort plantain (*Plantago lanceolata*) pollen, which is seen in all other levels/samples. This may also imply a middle Holocene or early prehistoric age.

The upper sample (P3) from [82] is in accord with samples (P1 and P2) examined from monolith {34}. Whilst trees and shrubs are important (to nearly 50%) of total pollen, there are also substantial numbers of herbs which include cereal type and a range of other taxa of grassland and arable/disturbed ground. Woodland consisted of oak (*Quercus*) with hazel (*Corylus*) with occasional lime (*Tilia*). Pine is present and is regarded as a long distant component which has been fluvially (marine?) transported or airborne. Alder (*Alnus*) is not present in sufficient pollen numbers to indicate any local growth and the on-site habitat was grass-sedge fen on the river floodplain. Small numbers of Chenopodiaceae may be from salt marsh halophytes (goosefoot, oraches, and samphire) if there was brackish water/tidal influence. Diatoms may be a better indication of this.

Conclusions

Samples from two monolith profiles have been examined for their sub-fossil pollen and spore content. Microfossils have been extracted from the four samples taken from contexts [82] and [83] and results have been obtained. The following principal points have been made in this study:

- With the exception of sample P4 from monolith {34} [82], there is a broad similarity between the pollen spectra.
- Sample P4 [82] at was suggested as coming from a reworked peat ball. Pollen evidence indicates that this is probably the case. The pollen assemblage shows a greater importance of woodland than the other samples which is in accord with pollen assemblages more typical of the middle Holocene and late prehistoric (Neolithic/Early Bronze Age). This woodland comprised oak, elm, lime and hazel.
- The upper sample (P3) of monolith {34} [82] is of the same character as those from monolith {33} (P1 and P2). Herbs are important but with some evidence of woodland. These samples also contain evidence of arable activities and possibly grassland/pasture.
- The woodland element in these samples consists largely of oak and hazel with small amounts of alder. This is probably from growth within the wider region.
- With the exception of sample P4 (the reworked peat), the sediment accrued under an open grass-sedge fen or floodplain community with grasses, sedges and other marginal aquatic taxa. There are occasional aquatic taxa including yellow water lily, possibly common pondweed, the Royal Fern and also freshwater algal *Pediastrum*.
- Peat/sediment of sample P4 accumulated under an alder carr floodplain community.
- Chenopodiaceae in sample P3 {34} and P1 and P2 {33} may indicate saline, tidal conditions although there are no obvious halophytes. Chenopodiaceae (goosefoot, oraches and samphire) may also come from other habitats.

Diatoms

Nigel Cameron

Introduction

Diatoms are present in all four samples assessed from the XRW10 site. The numbers of diatoms in CR samples 1, 1B and 2 are moderate or moderate to low; the quality of diatom preservation is poor or moderate to poor and diatom species diversity is moderate or low. There is moderately high potential to carry out percentage diatom counting and diatom analysis of these three samples. In sample CR 3 there are extremely low number of diatoms and the quality of diatom preservation is extremely poor; diatom species diversity is very low and there is no potential for further diatom analysis of this sample.

Results

The diatom results from XRW10 are tabulated below:

Diatom Sample No.	Height (m ATD)	Height (mOD)	Diatom Numbers	Quality of Preservation	Diversity	Assemblage type	Potential for % count
CR1	98.04	-1.96	mod/low	poor	mod	est bk mar (fw)	mod
CR1B	97.9	-2.10	Mod	mod to poor	mod/low	est bk mar (fw)	mod
CR2	98.17	-1.83	mod/low	poor	mod	est bk mar (fw)	mod
CR3	97.95	-2.05	ex low	ex poor	v low	mar est bk	none

(fw – freshwater, bk – brackish, mar – marine, halophil – halophilous, aero – aerophilous)

Table 3: Diatom results from the Auxillary shaft at XRW10

The diatoms present in CR samples 1, 1B, 2 and 3 are mainly estuarine brackish and marine taxa. A few oligohalobous indifferent diatoms are present in CR samples 1, 1B and 2. These freshwater

diatoms include *Cocconeis disculus*, *Cocconeis pediculus*; and *Fragilaria* taxa with growth optima in freshwater but also having wide salinity tolerances (eg *Fragilaria pinnata*, *Fragilaria construens* var. *venter* and *Fragilaria brevistriata*).

The polyhalobous and mesohalobous taxa are characteristic of tidal habitats. Coastal marine diatoms present include *Cymatosira belgica*, *Paralia sulcata*, *Podosira stelligera*, *Rhaphoneis* spp., *Actinoptychus undulatus* and *Pseudopodosira westii*. The planktonic estuarine species *Cyclotella striata* is relatively abundant in CR samples 1, 1B and 2. Benthic mesohalobous diatoms include *Campylodiscus echeneis*, *Catenula adhaerans*, *Diploneis didyma*, *Nitzschia hungarica*, *Nitzschia navicularis* and the mesohalobous to halophilous planktonic species *Actinocyclus normanii*.

Conclusions

Diatoms are present in all four samples from the XRW10 sequence. All four samples have marine, and brackish water estuarine diatom taxa that are indicative of tidal habitats. In three samples there are small components of freshwater diatoms; some of these have wide salinity tolerances.

XSX11 (Victoria Dock Portal)

Archaeological fieldwork summary

There were no archaeological remains recorded on the site. The site has a simple alluvial sequence between 100.60m ATD and 97m ATD, which consisted of Pleistocene Thames gravels overlain by evidence for an early Holocene river meander or tidal creek. Woody peats, probably formed during the Neolithic and Early Bronze Age periods, before rising sea level in the Late Bronze Age and later periods inundated the area to form the estuarine floodplain that existed until the development of the site in the 19th century. There was no evidence of human activity. Modern ground level lay at 100.90m ATD.

Assessed Logs

Sediments sampled in the monolith tins {19},{20},{21},{22},{30},{31},{39},{40} and {46} from Trench 2 at XSX11 were recorded in the laboratory and subsamples were taken for further analysis. The trench locations are illustrated in Fig 2 and the relevant section in Fig 4. All the monolith tin samples were described using standard sedimentary criteria (relating to colour, compaction, texture, structure, bedding, inclusions, and clast-size). The descriptions of the monolith tin samples are tabulated as follows:

XSX11 (Victoria Dock Portal)_ {19}, {20}, {21}, {22}, {30}, {31}, {39}, {40} and {46} Trench 2								
Context	from (m BMT)	to (m BMT)	from (m ATD)	to (m ATD)	from (mOD)	to (mOD)	Description	Interpretation
x	0.00	0.30	100.33	100.03	0.33	0.03	Firm mid yellowish brown silty clay with crushed modern building material	Made ground
9	0.30	0.4	100.03	99.93	0.03	-0.07	Firm dark blueish grey silty clay mottled mid orangey brown with some shell fragments and rare fine gravel. Rare degraded plant fragments.	Weathered alluvium
	0.40	0.5	99.93	99.83	-0.07	-0.17	Firm dark blue grey silty clay	Alluvium
	0.00	0.20	99.85	99.65	-0.15	-0.35	Firm dark blueish grey silty clay mottled mid orangey brown with rare degraded plant fragments.	
	0.20	0.30	99.65	99.55	-0.35	-0.45	Firm light yellowish grey silty clay.	
	0.30	0.50	99.55	99.35	-0.45	-0.65	Firm mid greyish brown silty clay	

XSX11 (Victoria Dock Portal)_ {19}, {20}, {21}, {22}, {30}, {31}, {39}, {40} and {46} Trench 2									
	0.00	0.15	99.47	99.32	-0.53	-0.68	Firm dark blue grey silty clay		Monolith 21
10	0.15	0.20	99.32	99.27	-0.68	-0.73	Soft dry mid reddish brown peat	Ephemeral marsh or eroded peat deposit	
	0.20	0.32	99.27	99.15	-0.73	-0.85	Soft dark blue grey silty clay with flecks and laminations of organic material throughout	Alluvium	
11	0.32	0.50	99.15	98.97	-0.85	-1.03	Firm dark reddish brown clayey peat.	Marsh and overbank flood deposits	Monolith 22
	0.00	0.50	99.30	98.80	-0.70	-1.20			
		0.00	0.40	98.85	98.45	-1.15	-1.55	Firm very dark reddish brown slightly silty clayey peat with frequent decayed plant fragments increasing with depth.	Forested marsh and overbank flood deposits
12	0.40	0.50	98.45	98.35	-1.55	-1.65	Soft very dark brown to black clayey peat with abundant large wood fragments.		
	0.00	0.50	98.27	97.77	-1.73	-2.23		Monolith 31	
	0.00	0.30	97.95	97.65	-2.05	-2.35		Monolith 39	
13	0.30	0.50	97.65	97.45	-2.35	-2.55	Soft, black highly organic silty clay with rare fine plant fragments throughout.	Early Holocene alluvium	Monolith 40
	0.00	0.35	97.50	97.15	-2.50	-2.85	Firm, black desiccated highly organic silty clay		
	0.35	0.42	97.15	97.08	-2.85	-2.92	Firm, black desiccated highly organic silty clay with pockets of light grey fine sandy silt and rare granular gravel.		
14	0.42	0.50	97.08	97.00	-2.92	-3.00	Light yellowish grey silty sand	Early Holocene/ late Pleistocene channel deposit	Monolith 46
	0.00	0.45	97.07	96.62	-2.93	-3.38	Light yellowish grey silty sand and frequent chalk flecks.		
	0.45	0.50	96.62	96.57	-3.38	-3.43	Light yellowish grey fine sand with rare granular gravel.		

Table 4: Sedimentary description of Monolith samples from XSX11

The monolith sequence {19} through to {46} from XSX11 covers the full sequence of deposits in Trench 2 from the early Holocene environment through to recent made ground deposits. In this sequence the late Pleistocene / early Holocene sands are overlain by alluvium which in turn is overlain by thick peat deposits representing a marsh environment, probably dating to the mid Holocene during the prehistoric. The marsh was in turn covered by later alluvial deposits which probably accumulated through the historic period until stabilised with modern made ground deposits.

Pollen

Rob Scaife

Introduction

Pollen samples from the Crossrail site XSX11 at Victoria Dock Portal have been examined to ascertain the preservation of sub-fossil pollen and spores from which past vegetation and environment might be inferred. Of the eight samples examined, five contained satisfactory numbers of pollen and spores. The pollen assemblages obtained show change from woodland to an open herbaceous habitat.

Results

Pollen was absent in samples below 97.47m ATD (P6-P8) (contexts [13] to [15]). The five pollen samples which contain sub-fossil pollen and spores span 1.7m from 97.57m to 99.32m ATD (P1 to P5; contexts [9] to upper [13]). Within this sedimentary span, there is an apparent change in the pollen assemblages and the inferred vegetation environment. As such, two local pollen assemblage zones (l.p.a.z.) have been recognised in the pollen profile. These zones are characterised in Fig 12 and Table 5 below.

<i>l.p.a.z.</i>	Palynological characteristics
<i>l.p.a.z. 2</i> [9] & [10] Poaceae- Cyperaceae	Herb pollen becomes important with increased diversity and pollen numbers. Poaceae are dominant (to 30%) with Lactucoideae (to 23%) and cereal type (4%). Other herbs include Brassicaceae, <i>Dianthus</i> type, Chenopodiaceae, <i>Rumex</i> , <i>Plantago lanceolata</i> and Asteraceae types. Arboreal and shrub pollen decline from l.p.a.z.1. <i>Alnus</i> remains most important (declining to 15%). <i>Quercus</i> and <i>Corylus avellana</i> type decline. <i>Tilia</i> occurs sporadically after higher values in l.p.a.z. 1. Marsh taxa become important with dominant Cyperaceae (increasing to 45%) with <i>Typha angustifolia</i> type (6%) and occasional <i>Typha latifolia</i> . Fern spores become important with <i>Dryopteris</i> type (to 50%) <i>Pteridium aquilinum</i> (10%) and occasional <i>Polypodium</i> . Pre-Quaternary palynomorphs become important (25%).
<i>l.p.a.z. 1</i> Quercus-Alnus	<i>Alnus</i> is dominant throughout (to 46%) with <i>Quercus</i> (peak to 38%). <i>Tilia</i> is also more important in this zone (6-7% degraded and non-degraded) with some <i>Betula</i> (peak to 4%) and occasional records of <i>Pinus</i> , <i>Fraxinus</i> , and <i>Ulmus</i> . There are few herbs with only Poaceae (5%) and occasional Brassicaceae, Apiaceae. Marsh taxa comprise Cyperaceae (10%) and incoming <i>Potamogeton</i> type. Ferns comprise monolete <i>Dryopteris</i> type (12%) and <i>Polypodium</i> (to 11%) and a basal peak of <i>Pteridium aquilinum</i> (20%).

Table 5: Pollen zonation of XSX11 pollen data.

Discussion

These pollen data can be interpreted in terms of the pollen coming from the on-site vegetation and other wetland plant taxa which have been fluvially transported to the site and that pollen derived from the surrounding dry-land/terrestrial zone (largely airborne derived pollen).

The on-site habitat: l.p.a.z. 1 (contexts [11] to upper [13]) appears to have been a wetland with strong representation of alder (*Alnus glutinosa*) with sedges (Cyperaceae). This matches the stratigraphy with the presence wood peat. It is probable that this was a floodplain carr with a sedge ground flora. Subsequently, conditions became wetter as suggested by the increasing importance of sedges and the progressive reduction in alder pollen. The latter declined as the habitat became wetter and standing ground water exceeded three months during the winter. A grass-sedge fen community (l.p.a.z. 2) became dominant with other fen taxa including bur reed (*Sparganium*) and reed mace/bulrush (*Typha angustifolia*, *T. latifolia*), water plantain (*Alisma plantago-aquatica*). Standing or slow flowing water may be indicated by the presence of *Pediastrum* (freshwater alga). Although no dating is available for this event, it is probable that this change to alluvial, probably floodplain sedimentation, was late-prehistoric or early historic and occurred in response to rising regional sea level (eustatic) change. Positive

eustatic change resulted in ponding back of the freshwater systems and alluviation (Sidell et al 2000). The presence of walnut pollen (see below) provides evidence of a Romano-British or later age for this phase of alluviation.

The dry-land flora: l.p.a.z. 1 shows a local and near regional environment which was largely woodland. This woodland was dominated by oak (*Quercus*) and hazel (*Corylus*), probably on the heavier soils and lime (*Tilia*) on well-drained soils. The latter is under represented in pollen spectra (Andersen 1970, 1973) due to entomophily and the fact that it flowers in summer when other trees are in leaf, which inhibits pollen dispersion. The values here suggest local importance. This is diagnostic of the middle Holocene (Flandrian II; the Atlantic period) and the late Prehistoric, Neolithic and Early-Middle Bronze Age as seen at various sites in London (Scaife 2000).

With l.p.a.z. 2, there is an apparent decline of the oak, lime and hazel woodland. Although there was undoubtedly human clearance of woodland at some stage, the changes in arboreal pollen frequencies here are probably a taphonomic phenomenon. With the closed alder carr floodplain woodland pollen from exterior sources would have been inhibited into this community and still microclimate (Tauber 1967). As the environment became more open as alder died out and grass-sedge fen became dominant, the pollen catchment became wider. As a result, there is a more diverse range of herbs present which may have been fluviially transported from some distance. These taxa include strong evidence of agriculture with probable grassland indicated by grass pollen and associated pastoral taxa such as ribwort plantain (*Plantago lanceolata*) and arable cultivation with cereal pollen present.

Pollen of walnut (*Juglans regia*) is present in l.p.a.z.2. This is a diagnostic occurrence indicating a Roman or post-Roman age for the sediment of l.p.a.z. 2. Walnut was a Roman introduction to Europe as a whole and thus, provides a useful datum point which has been noted in a number of other London sites (Scaife 2000, 2003) of Roman and post-Roman age.

Conclusions

The following principal points have been made in this examination of sediment from the Victoria Dock Portal.

- Five of eight samples examined contained sufficient pollen to enable identification, counting and construction of a preliminary pollen diagram.
- Pollen was absent in the lower contexts below 97.60m ATD (−2.40m OD).
- Pollen is moderately well preserved in sediment above 97.60m ATD (−2.40m OD).
- There is a significant change in the pollen flora between 99.22m and 98.70m ATD (−0.78mOD and −1.30mOD). Two local pollen assemblage zones have been defined.
- The lower zone (l.p.a.z. 1) is dominated by tree and shrub pollen. On site, alder was dominant and formed floodplain carr woodland with an under storey vegetation including sedges. This formed the wood peat.
- The terrestrial zone adjacent to the site comprised oak (*Quercus*), lime (*Tilia*) and hazel (*Corylus*) woodland.
- The alder carr woodland was destroyed, as conditions became wetter. A negative hydrosere occurred which culminated in an open, wet, grass-sedge fen habitat.
- The wetter conditions were probably a result of regionally rising sea level (relative to land) which ponded back the freshwater systems causing higher ground water tables which impacted the floodplain vegetation.
- There was a decline in the terrestrial/dry-land woodland. This is indicated by reductions in pollen of the oak, hazel and lime. This was also accompanied by a marked expansion of herbs which include evidence of grassland (? pasture) and arable cultivation.

Diatoms

Nigel Cameron

Introduction

Four samples were assessed from the XSX11 site. Diatoms are absent from three samples (Samples CR 23-25). An extremely low number of extremely poorly preserved diatoms are present in sample CR 22. There is no further potential for diatom analysis of any of the samples assessed from the XSX11 site. Possible fragments of the marine planktonic diatom *Paralia sulcata* and the aerophilous freshwater diatom *Pinnularia major* are present in sample CR 22.

Results

The results from XSX11 are tabulated below:

Diatom Sample No.	Height (m ATD)	Height (m OD)	Diatom Numbers	Quality of Preservation	Diversity	Assemblage type	Potential for % count
CR22	99.22	-0.78	ex low	ex poor	2 frags	mar aero fw	none
CR23	98.7	-1.3	-	-	-	-	none
CR24	98.07	-1.93	-	-	-	-	none
CR25	97.6	-2.4	-	-	-	-	none

(fw – freshwater, bk – brackish, mar – marine, halophil – halophilous, aero – aerophilous)

Table 6: Diatom results from XSX11

Conclusions

Diatoms are absent from three samples in XSX11. Very low numbers of very poorly preserved diatoms are present in one sample. Possible fragments of marine planktonic and aerophilous freshwater diatoms are present in sample CR 22.

Ostracods

Dr. John E. Whittaker

Introduction

Four samples were examined cover a 3.18m thick section from XSX11. They appear to represent freshwater conditions throughout however their nature clearly changes through time.

Results

The results are tabulated below:

ORGANIC REMAINS

Height	99.75m ATD	97.27m ATD	96.82m ATD	96.60m ATD
CONTEXT	9	13	14	15
MONOLITH/BULK SAMPLE NUMBER	20	40	46	
SAMPLE	O1	O2	O3	O4
plant debris + seeds + spores	X	x	x	x
charcoal	X			
earthworm granules	X		x	
rhizoliths			x	
freshwater ostracods			x	

Table 7: Organic remains from Ostracod assessment XSX11

FRESHWATER OSTRACODS

Height	99.75m ATD	97.27m ATD	96.82m ATD	96.60m ATD
CONTEXT	9	13	14	15
MONOLITH/BULK SAMPLE NUMBER	20	40	46	
SAMPLE	O1	O2	O3	O4
<i>Cyclocypris</i> sp.			x	
Organic remains are listed on a presence (x)/absence basis	Ostracods are listed: o - one specimen; x - several specimens; xx – common; xxx – abundant			

Table 8: Ostracod results XSX11

Conclusions

The lowest sample (O4) contains only plant debris, the sediment - a pebbly, silty-sand - probably indicating alluvium, but with a rather high-energy regime at this time. The next sample (O3) contains, significantly rhizoliths and earthworm granules. Rhizoliths are calcareous tubes (externally with sand/silt grains, internally with impressions of stems and rootlets). Candy (*in Ashton et al*, 2005: 16) maintains they reflect (when associated with a freshwater environment)...“the drying out of the environment and the formation of fully terrestrial conditions either as a result of the initiation of a drier climate....or because of sediment infilling/lateral migrations of the channel system.” The associated earthworm granules seem to suggest we have a semiterrestrial environment, with the channel drying out either through migration of a meander and/or seasonal climatic change. The few freshwater ostracods (their only occurrence in this site) might indicate a wetter period. Sample O2 [13], a very organic silty-sand, seems to indicate further channel migration, the large amount of plant debris (plus spores and the like) meaning that it has now become a “dead” backwater of the meander. The uppermost sample (O1) contains plant debris, earthworm granules, and for the first time, charcoal - a semiterrestrial environment is suggested, but still subject to seasonal flooding. The charcoal could be indicative of human activity.

Plant macrofossils

Anne Davis and Karen Stewart

Introduction

Fifteen bulk samples were taken alongside geoarchaeological monolith tins from Trench 2 during excavations at the site. Sub-samples of each residue were scanned briefly, using a low-powered binocular microscope, and the abundance, diversity and general nature of plant macrofossils and any faunal remains were recorded on the MOLA Oracle database.

Results

The botanical information is summarised in Table 9.

Context	Sample	ID	Abundance	Diversity	Comments
9	23	chd grain	1	1	DRY. C.5 CHD GRAINS
		chd wood	1	1	
		wlg seed	1	1	
		wlg misc	1	1	
	25	-	-	-	NO FLOT/WS RES
	26	-	-	-	NO FLOT/WS RES
10	27	wlg seed	2	1	WET. PEATY. RUB SEEDS. SOME ?ID'ABLE WOOD
		wlg misc	3	2	
	28	chd wood	1	1	WET. BETTER PRES THAN {27}
		wlg seed	1	1	
		wlg misc	3	1	
11	29	wlg seed	3	2	WET. MUCH WOOD. SPARSE SEEDS.
		wlg misc	3	3	
	32	wlg seed	2	1	WET. MUCH WOOD. MOD ALDER SEEDS
		wlg misc	3	2	
	34	wlg seed	1	1	WET. MANY ROOT/LETS. FEW ALN SEEDS
		wlg misc	3	1	
12	35	wlg seed	1	1	WET. PEATY LUMPS and ROOTS

Context	Sample	ID	Abundance	Diversity	Comments
	38	wlg misc	3	2	WET. SPARSE SEEDS. SOME LGE WOOD FRAGS
		wlg seed	2	2	
		wlg misc	3	2	
	43	wlg seed	2	2	WET. SEEDS SPARSE
		wlg misc	3	2	
	44	wlg seed	2	2	WET. SEEDS SPARSE
		wlg misc	3	2	
13	45	chd wood	1	1	WET. SPARSE SEEDS.
		wlg seed	2	2	
		wlg misc	3	2	
14	47	wlg seed	1	1	WET. V FEW SEEDS SEEN
		wlg misc	3	2	
	48	wlg seed	1	1	WET. MOSTLY ROOT/LETS
		wlg misc	3	1	

A: abundance, D: diversity (1 = occasional, 2 = moderate, 3 = abundant)

Table 9: Organic remains from the plant macrofossil samples from XSX11

Discussion

Charred remains: A small amount of highly fragmented wood charcoal was present in the residue from sample [9]{23}, which also contained about five charred cereal grains, the majority of them rye (*Secale cereale*). Very occasional charcoal fragments were also seen in sample [10]{28}, and a number of rather larger fragments in [13]{45}.

Waterlogged and mineralised remains: Most of the samples contained very large amounts of wood and/or roots/rootlets, and often occasional moss, buds and thorns, but seeds were very rare in most samples, with fewer than five seeds being seen in most of the assessed samples from [9], [10], [11] and [14]. Only sample [11]{29} produced a reasonably large assemblage, with moderate numbers of seeds, very sparsely distributed, in samples [12]{38}, {43} and {44}, and [13]{45}.

Predictably, the majority of identified taxa were of wetland plants, with seeds of sedges (*Carex* spp) in several samples, crowfoots (*Ranunculus* subgen. *Batrachium*) and dropwort (*Oenanthe* sp.) common in samples from context [12], and water pepper (*Persicaria hydropiper*) and narrow-leaved water-parsnip (*Berula erecta*) each seen in two samples. None of these is fully aquatic, but live in and by water in ditches, marshes, ponds and rivers. The most commonly represented plant however was alder (*Alnus glutinosa*), whose seeds and often catkins, were absent from contexts [9] and [10], but found in all samples from context [11] and most from [12], [13] and [14]. Seeds of other woodland plants were limited to a few seeds of hawthorn (*Crataegus* sp.) in sample [12]{38}, several hazel (*Corylus avellana*) nut fragments in [13]{45} and the ubiquitous blackberry/raspberry (*Rubus fruticosus/idaeus*) seeds in eight samples from all contexts.

Seeds of dry-ground plants were very limited and showed no particular pattern between the samples, with those of buttercup (*Ranunculus acris/repens/bulbosus*) seen in four samples but other remains, generally from plants of disturbed ground habitats, each occurring in only one sample.

Conclusions

While is very difficult to draw any conclusions from these very limited assemblages, it does seem as if the land here was quite uniformly wet during the deposition of contexts [14] to [11], supporting alder carr and with areas of standing or slow-flowing water as well, perhaps, as areas of higher and dryer land. Sample from [10] may suggest some drying out and [9] gives a mixed picture, although the presence of charred cereal grains in the latter obviously indicates occupation nearby.

Radiocarbon dating

The results of the radiocarbon dating for XSX11 are presented in the Table 10 below.

CONTEXT /SAMPLE	BETA No.	MOLA ref	MATERIAL PRE-TREATMENT	13C/12C	CONVENTIONAL AGE	2 SIGMA CALIBRATION
[11] / {29}	407275	XSX/2/29/11	(bulk): acid/alkali/acid	NA	3150 +/- 30 BP	Cal BC 1495 to 1320 (Cal BP 3445 to 3270)
[12] / {44}	407277	XSX/2/44/12	(seeds): acid/alkali/acid	NA	4540 +/- 30 BP	Cal BC 3365 to 3105 (Cal BP 5315 to 5055)
[13] / {40}	407276	XSX/2/40/13	(seeds): acid/alkali/acid	-28.4	5020 +/- 30 BP	Cal BC 3940 to 3710 (Cal BP 5890 to 5660)

Table 10: Radiocarbon dating results XSX11

The date range from the XSX11 samples indicates the lowest context [13] accumulated in the early Neolithic period (BETA 407276) with the overlying context [12] in the early to mid Neolithic period (BETA 407277) and [11] in the mid Bronze Age.

XTI13 (Custom House)

Archaeological fieldwork summary

There were no archaeological remains recorded on the site. The site has a simple alluvial sequence (over Shepperton Gravels) of potentially prehistoric wood peat of a former backswamp area of the Thames floodplain, eroded at the surface by creek formation as a result of tidal action and increased energy environments. This was overlain by potentially medieval alluvial clays.

Pleistocene Thames Terrace Gravel was observed varying between 98.32m ATD (Trench 1) and 97.6m ATD (Trench 3). The gravels were typically then overlain by Holocene silt followed by wood peat from the backswamp area of the Thames Floodplain 99.82m ATD (Trench 1) and 99.42m ATD (Trench 2 and 3). Above this was alluvial clay in all trenches indicative of estuarine influence

In contrast, in Trench 4, because of the degree of water ingress and large limbs or trunks of trees pulled in the sides of the excavation by the excavator causing the weakening of the sides of the evaluation trench hence sampling stopped at 98.84m ATD (excavation with observations from the surface continued to approximately 98.1m ATD). The investigation of this area continued with Window Samples 1 and 2.

Window Sample 1 sampled the full sequence of the surviving alluvial deposits immediately to the east of Trench 4. Pleistocene Thames Terrace Gravel was observed at 96.7m ATD. This graded up into a wood peat from the backswamp area of the Thames Floodplain, to 99.3m ATD. Above this was alluvial clay with a degree of estuarine influence. The interface between the alluvial clay and overlying >1m of dumped clayey soil was hard to accurately locate whilst recording the sediments within the window samples. It is possible that the dumped silts are upcast from the excavation of the Royal Victoria Dock.

Window Sample 2 sampled the full sequence of the surviving alluvial deposits immediately to the west of Trench 4. This sample was retained unopened to enhance preservation and provided better sample integrity. The deposit depth observations are assumed from WS1 and confirmed by observation of the open top and bottom of the core. Pleistocene Thames Terrace Gravel was observed at c. 96.7m ATD. This graded up into a wood peat from the backswamp area of the Thames Floodplain, to c. 99.3m ATD. Above this was alluvial clay with a degree of estuarine influence.

Assessed Logs

Sediments sampled from cores taken as part of Window Sample 1 (WS1) from XTI13 were recorded in the laboratory and subsamples were taken for further analysis. The window sample and relevant trench locations are illustrated in Fig 2. All the cores were described using standard sedimentary criteria (relating to colour, compaction, texture, structure, bedding, inclusions, and clast-size). The descriptions of the cores from WS1 are tabulated as follows:

XTI13 (Custom House) WS1									
Equivalent context (Trench 4)	from (m BGL)	to (m BGL)	from (m ATD)	to (m ATD)	from (mOD)	to (mOD)	Description	Interpretation	Core no.
-	0.00	0.65	101.50	100.85	1.50	0.85	Loose concrete and ceramic building material crush.	Made ground	Core 1
14	0.65	1.00	100.85	100.50	0.85	0.50	Firm mid-brownish grey silty clay.	Weathered alluvium	
	1.00	2.00	100.50	99.50	0.50	-0.50	Firm mid-brownish grey silty clay with rare rootlets and occasional iron staining mid unit.	Alluvium	Core 2
	2.00	2.45	99.50	99.05	-0.50	-0.95	Soft mid greyish brown silty clay with rare iron staining		Core 3
	2.45	2.83	99.05	98.67	-0.95	-1.33	Firm mid-brownish grey silty clay with flecks of organics throughout, increasing with depth.		
	2.83	3.00	98.67	98.50	-1.33	-1.50	Black highly organic silty clay with frequent small plant fragments.		
	3.00	3.50	98.50	98.00	-1.50	-2.00	Soft light brownish grey mottled orange (iron staining) silty clay with small organic flecks increasing with depth		Core 4
11	3.50	3.95	98.00	97.55	-2.00	-2.45	Black soft wet woody peat	Forested marsh	Core 5
	3.95	4.00	97.55	97.50	-2.45	-2.50	Black soft peat		
	4.00	4.15	97.50	97.35	-2.50	-2.65	Dark reddish brown slightly silty peat		
	4.15	4.23	97.35	97.27	-2.65	-2.73	Black soft peat		

12	4.23	4.36	97.27	97.14	-2.73	-2.86	Soft black highly organic silt with rare plant fragments	Alluvium
	4.36	4.75	97.14	96.75	-2.86	-3.25	Light grey fine slightly sandy silt with dark brown organic bands mid unit.	
13	4.75	4.85	96.75	96.65	-3.25	-3.35	Compact mid to dark blue grey fine to coarse sand with frequent subrounded to angular fine gravel	Early Holocene sands
	4.85	5.00	96.65	96.50	-3.35	-3.50	Loose coarse granular golden sands with frequent fine to medium gravel clasts	River gravels

Table 11: Sedimentary description of WS1 from XTI13

The cores taken from WS1 (adjacent to Trench 4) at XTI13 represent the full sequence of deposits from the early Holocene environment through to recent made ground deposits. In this sequence the late Pleistocene gravels are overlain by early Holocene sands and alluvium which, in turn, is overlain by thick peat deposits representing a riparian marsh, probably dating to the mid Holocene (during the prehistoric). The marsh was in turn covered by later alluvial deposits which probably accumulated through the historic period until stabilised with modern made ground deposits.

Radiocarbon dating

The results of the radiocarbon dating for XTI13 are presented in the Table 12 below.

CONTEXT	BETA No.	MOLA ref	MATERIAL PRE-TREATMENT	13C/12C	CONVENTIONAL AGE	2 SIGMA CALIBRATION
[11]	396252	XTI13WS1-202	(bulk): acid/alkali/acid	-27.5%	3950 +/- 30 BP	Cal BC 2565 to 2535 (Cal BP 4515 to 4300)
[11]	396253	XTI13WS1-240	(bulk): acid/alkali/acid	-28.8%	4340 +/- 30 BP	Cal BC 3020 to 2895 (Cal BP 4970 to 4845)
[11]	396254	XTI13WS1-265	(bulk): acid/alkali/acid	-26.8%	4630 +/- 30 BP	Cal BC 3505 to 3425 (Cal BP 5455 to 5305)

Table 12: Radiocarbon dating results XTI13

The date range from the XTI13 samples through the peat deposit indicates the basal sample (BETA 396254) at approximately 97.30m ATD accumulated in the early to mid-Neolithic; the middle sample (BETA 396253) at approximately 97.53m ATD accumulated in the mid Neolithic; and the uppermost sample from equivalent context [15] (BETA 396252) at approximately 97.75m ATD accumulated during the Late Neolithic.

XS11 (Connaught Tunnel)

Archaeological fieldwork summary

No direct evidence for human activity was recorded within the trenches however the elevation of the sands lying over the gravel terraces in Trenches 1 and 4 (98.73m ATD and 97.6m ATD respectively) suggest that these are situated on low floodplain islands or on the margins of higher larger islands.

In contrast, Trenches 2 and 3 appear to be located within lower lying channel areas around 96.95 and 96.92m ATD.

It is likely that the woody peats overlying the sands formed during the Late Mesolithic. Clayey peats and organic clays recorded in the upper portion of the sequence appear to indicate that estuarine expansion associated with Devoy's (1979) Thames IV event may have led to localized channel activity that intermittently flooded the Middle Bronze Age woodland. A small channel was partially visible from 98.34m ATD in Trench 3. It was filled with a grey silty clay containing wood chips and occasional pockets of peat. This deposit is also seen in Trench 2 as a horizontal band of overbank flooding. It seems likely that the organic inclusions within this deposit represent erosion of the underlying peat surface as this small channel weaved its way through the dense vegetation.

Organic but increasingly minerogenic deposits are also recorded in Trenches 1 and 4, situated on the island areas. These deposits are more organic than probable contemporary deposits in Trenches 2 and 3 and the change is more gradual. It is likely that the nearby channel's effect lessened in these slightly higher drier areas.

On the whole, the organic and waterlogged nature of these deposits will provide good preservation for palaeoenvironmental remains and radiocarbon dating.

Overlying and truncating all sediments on both the west and east sections of the site was a series of dumps and make-up layers associated with the railway development. These layers of modern made-ground are generally heterogeneous in nature and in most areas are for the purposes of making up and levelling an area prior to the laying of rail track. The deposits are 0.5 to 1.5m in thickness.

Assessed Logs

Two trench sequences (Trench 1 and Trench 3) were sampled from Connaught Tunnel (XSY11). Trench 1 and Trench 3 lie some 1.5km distant from one another at the tunnel portals (to the northwest and southeast of Connaught Bridge crossing Victoria and Royal Albert Docks, respectively) and hence these two separate areas needed investigation. The trench locations are illustrated in Fig 2 and the relevant section in Fig 5 and Fig 6. Monolith tin sequences from both trenches from XSY11 were consequently recorded in the laboratory and subsamples were taken for further analysis. All the monolith tin samples were described using standard sedimentary criteria (relating to colour, compaction, texture, structure, bedding, inclusions, and clast-size). The descriptions of the monolith tin samples from Trench 1 and Trench 3 are tabulated as follows:

XSY11 (Connaught Tunnel) {1}{2}{3}{4}{5}{6}{7} Trench 1								
Context	from (m BTM)	to (m BTM)	from (m ATD)	to (m ATD)	from (mOD)	to (mOD)	Description	Interpretation
1	0.00	0.22	101.56	101.34	1.56	1.34	Firm dark blue grey mottled yellow grey silty clay	Alluvium
2	0.00	0.11	101.34	101.19	1.30	1.19	Firm blue grey silty clay mottled red (iron staining) and black (manganese staining)	
4	0.11	0.30	101.19	101.00	1.19	1.00	Firm mid yellow grey silty clay with some iron staining and pockets of dark black silt	
6	0.30	0.50	101.00	100.80	1.00	0.80	Friable mid brownish grey clay with rare iron staining	
	0.00	0.12	100.69	100.57	0.69	0.57	Friable mid brownish grey clay with root channels	Monolith 3

7	0.12	0.30	100.57	100.39	0.57	0.39	Firm mid yellowish grey silty clay with rare iron stained root channels		Monolith 4
8	0.30	0.5	100.39	100.19	0.39	0.19	Firm dark yellowish grey silty clay with moderate iron stained root channels		
	0.00	0.18	100.25	100.07	0.25	0.07	Firm mid to dark yellowish grey silty clay with rare iron stained flecks		
9	0.18	0.32	100.07	99.93	0.07	-0.07	Firm mid yellowish grey silty clay with occasional iron stained root channels		
10	0.32	0.50	99.93	99.75	-0.07	-0.25	Firm brownish grey silty clay	Overbank flood deposits (Alluvium)	Monolith 5
	0.00	0.20	99.67	99.47	-0.33	-0.53	Soft mid greyish brown silty clay		
	0.20	0.25	99.47	99.42	-0.53	-0.58	Soft dark bluish grey organic silty clay with organic flecks and wood fragments		
	0.25	0.33	99.42	99.34	-0.58	-0.66	Soft mid greyish brown silty clay mottled with rare iron staining		
	0.33	0.40	99.34	99.27	-0.66	-0.73	Firm dark blue grey silty clay with frequent small wood and plant fragments		
11	0.16	0.32	99.27	99.13	-0.71	-0.87	Wood fragment in dark brown clayey peat	Forested marsh	
	0.32	0.40	99.13	99.05	-0.87	-0.95	Firm mid brown clayey peat with frequent fine to medium plant fragments		
12	0.40	0.50	99.05	98.95	-0.95	-1.05	Firm black woody peat		
	0.00	0.30	99.05	98.75	-0.95	-1.25			
13	0.30	0.50	98.75	98.55	-1.25	-1.45	Firm mid yellowish grey fine sandy silt with root channels.	Early Holocene deposit	

Table 13: Sedimentary description of Monolith samples from XSY11 (Trench 1)

XSY11 (Connaught Tunnel) {45}{46}{48}{59}{49}{61}{60}{62}{69} Trench 3									
Context	from (m BTM)	to (m BTM)	from (m ATD)	to (m ATD)	from (mOD)	to (mOD)	Description	Interpretation	
25	0.00	0.40	100.54	100.14	0.54	0.14	Firm yellowish grey brown mottled silty clay	Alluvium	Monolith 45

XSY11 (Connaught Tunnel) {45}{46}{48}{59}{49}{61}{60}{62}{69} Trench 3									
26	0.40	0.50	100.14	100.04	0.14	0.04	Firm dark grey brown silty clay with moderate CaCO3 flecks, iron staining and root channels.	Monolith 46	
	0.00	0.5	100.04	99.54	0.04	-0.46	Firm dark grey brown silty clay with moderate CaCO3 flecks, iron staining and root channels.		
	0.00	0.40	99.45	99.05	-0.55	-0.95	Firm mid, becoming dark grey brown silty clay with moderate CaCO3 flecks and iron staining. Becoming more organic toward base.		
27	0.40	0.50	99.05	98.81	-0.95	-1.19	Firm very dark reddish brown peat with moderate wood and plant fragments.	Marsh	Monolith 48 and 59
28	0.25	0.33	98.81	98.73	-1.19	-1.27	Firm mid greyish brown mottled yellow highly organic silt with rare fine plant fragments.	Overbank flood deposits (Alluvium)	
	0.33	0.5	98.73	98.56	-1.27	-1.44	Firm dark grey brown woody clayey peat.	Forested marsh	
	0.00	0.04	98.41	98.37	-1.59	-1.63	Firm dark blue grey highly organic silty clay.	Overbank flood deposits or meandering channel (Alluvium)	
	0.04	0.20	98.37	98.21	-1.63	-1.79	Firm dark reddish brown very woody clayey peat.	Forested marsh	
29	0.20	0.50	98.21	97.91	-1.79	-2.09	Firm dark reddish brown woody clayey peat or peaty clay.	Forested marsh flooded	Monolith 60
	0.00	0.33	98.16	97.83	-1.84	-2.17	Firm dark bluish grey highly organic silty clay with frequent degrade plant fragments.	Overbank flood deposits (Alluvium)	
30	0.15	0.40	97.91	97.66	-2.09	-2.34	Firm dark brownish grey highly organic silty clay with frequent large plant fragments.		Forested marsh
	0.40	0.50	97.66	97.56	-2.34	-2.44	Firm dark reddish brown woody clayey peat.		
	0.00	0.50	97.56	97.06	-2.44	-2.94	Firm dark reddish black woody clayey peat.	Monolith 69	

Table 14: Sedimentary description of Monolith samples from XSY11 (Trench 3)

The monolith sequences {1} to {7} from Trench 1 and {45} to {69} from Trench 3 at XSY11, capture the whole Holocene sedimentary sequence (Trench 1) and the bulk of the Holocene sedimentary sequence in Trench 3 so that these two ends of the site can be contrasted and compared not only to themselves but to the sequences recovered in the Late East areas as a whole. Importantly both sequences include

the palaeo-environmentally rich peat deposits dating to the prehistoric and subsequent overlying deposits through to the modern day.

Pollen

Rob Scaife

Introduction

Two pollen profiles have been examined and preliminary pollen diagrams (Fig 13 and Fig 14) have been constructed for the Connaught Tunnel site.

Results Trench 1:

Pollen and spore preservation is good in contexts [11]; [10]; [9]; [8]; [6] but is poor in the upper context [4] (101.05mATD) and absent in basal sediment of context [13] (at 98.6mATD). The suggested age for the sequence spans the possible basal Mesolithic sediments to the Late Iron Age and Historic period (Fig 13).

Two local pollen assemblage zones have been recognised in this profile. These are characterised in Table 15. Overall, tree and shrub pollen are more important in lower, l.p.a.z. 1. Herbs become progressively more important and reaching dominance at the top of the profile in l.p.a.z. 2.

<i>l.p.a.z.</i>	<i>Palynological characteristics</i>
<p><i>l.p.a.z. 2</i></p> <p><i>Poaceae-Lactucoeidae</i></p>	<p>Arboreal values decline with reductions in <i>Quercus</i>, <i>Alnus</i> and <i>Corylus avellana</i> type to low levels. Herb pollen totals increase from l.p.a.z. 1 to become dominant. Poaceae (peak to 70%) with Lactucoeidae; to 40% at the top of the profile) are most important. Cereal type is present (6%). Brassicaceae (peak to 30%) with <i>Sinapis</i> type (15%) and Cereal type (6%) are also important. Chenopodiaceae decline from l.p.a.z. 1. Marsh taxa remain with Cyperaceae with a peak to 30% sum + marsh) in the upper level. Ferns expand with <i>Dryopteris</i> type (49%). Pre-Quaternary palynomorphs are at their highest level in the uppermost sample (30%).</p>
<p><i>l.p.a.z. 1</i></p> <p>Quercus-Alnus</p>	<p><i>Alnus</i> is dominant (to 78%) with <i>Quercus</i> (38% at base of profile). Both taxa decline in value through the lower part of the zone. Also present are <i>Tilia</i> (5%), <i>Corylus avellana</i> type (to 16%) and <i>Pinus</i>. The latter becoming more important at the top of the zone (to 16%). Small numbers of <i>Ulmus</i> are incoming., Herb numbers are low but steadily increase whilst diversity is low and comprise largely Chenopodiaceae (6%), with Asteraceae types (esp. increasing Lactucoeidae) and Poaceae increasing from mid zone. Marsh taxa comprise Cyperaceae (to 11%) with occasional <i>Typha latifolia</i> and <i>Typha angustifolia/Sparganium</i> type. Spores of ferns include <i>Pteridium aquilinum</i> (peak to 20%), Monolete <i>Dryopteris</i> type and occasional <i>Polypodium</i>., Pre-Quaternary palynomorphs expand upwards with the change to mineral sediment</p>

Table 15: Pollen zonation of XSY11

Discussion Trench 1

The pollen data can be considered in relation to the on-site and off-site past vegetation and communities.

The on-site vegetation: There was a distinct change in the on-site (autochthonous) vegetation communities. These changes are also seen at other Thames floodplain and river tributary sites where floodplain alder carr woodland was replaced by a wetter and more open grass-sedge fen. This negative hydrosere was probably a response to rising relative sea level in the London basin/Thames estuary. This was asynchronous depending upon local topography/height OD and is seen at other Thames floodplain sites (Devoy 1977, 1979; 1980, 1982, 2000; Haggart 1995; Sidell *et al* 2000, Wilkinson *et al* 2000).

l.p.a.z. 1 Shows the clear dominance of alder carr woodland on the site. Alder pollen attains high values in [11] and [10] and which declines [9] from c. -0.46mOD upwards. This community was ubiquitous for the Thames floodplain sites of the middle Holocene and late prehistoric periods and has been discussed for many sites (Devoy 1979; Scaife 2000a, 2000b; Thomas and Rackham 1996). Yew (*Taxus*) was a component of this carr in drier areas of this floodplain woodland. This is an interesting occurrence of a floodplain woodland community which no longer exists but which has been recorded from the East Anglian Fens (Godwin 1975) and also from the Thames floodplain at Beckton (Scaife 1997) Sidell (2003) and Seel (2000) where substantial root boles and trunks have been found. The ground flora of this site comprised grasses, sedges such as tussock sedge and other taxa which are rarely found in pollen spectra. This community was largely stable and was responsible for the alder wood peat of context [11] and overlying humic silt where winter flooding and overbank mineral sediment deposition mixed with humic/peat [10] and [9].

This alder community was then subject to change, which, as noted, may have been due to eustatic (sea-level) change or other causes of alluviation which resulted in the site to become wetter with demise of on-site alder. Although not well represented palynologically, the site developed into an open grass-sedge fen (*l.p.a.z. 2*) with alder progressively pushed to the drier fringes of the site. Increasing numbers of pre-Quaternary palynomorphs in *l.p.a.z. 2* also attest to the onset of alluviation with erosion and deposition of older sediment which contained geological microfossils.

The dry-land flora: For the purposes of this assessment, alder has been included in the main pollen sum at this and other sites. Alder produces copious quantities of pollen and as a result is over represented in pollen spectra where it was growing on site (Andersen 1970, 1973; Janssen 1969). As such, the other tree taxa are underrepresented because of the high percentage values of its pollen within the sum. Furthermore, the density of the carr woodland on site will also have been inhibited pollen input to the site. These taphonomic factors have been considered.

Because of the above factors, the dry-land flora is under represented in Fig 13; and other sites discussed here. In *l.p.a.z. 1*, oak (*Quercus*) and hazel (*Corylus*) with lime/linden (*Tilia cordata*) were the principal woodland components. This is typical of the late prehistoric period and is commensurate with the suggested age for this part of the profile. Lime is poorly represented in pollen spectra (Andersen 1970, 1973) and as such, the apparently small percentage values denote its importance in the local landscape especially given the over representation of alder within the pollen sum.

Change to *l.p.a.z. 2* and the predominantly more mineral sediment also shows a reduction in the tree and shrub pollen noted from *l.p.a.z. 1*. This is also associated with evidence of cereal cultivation with cereal type pollen and weeds present. It is not clear without a more detailed analysis, whether the reduced woodland was a direct consequence of increased agricultural activity or due to dominant fluvial transport with pollen from farther afield. The increase in pine pollen along with the increased numbers of reworked earlier pollen and fern spores of *Dryopteris* type is, however, a typical occurrence in alluvial sediment.

Saline influence: as noted, the change to mineral sediment may have been a response to rising regional and local Thames Estuary / sea level. This is not clearly shown in this profile. However, it is possible that the record of Chenopodiaceae (goosefoot, orache and samphire) may derive from salt marsh nearby and/or fluvially transported from down river.

Dating: pollen analysis is not a dating technique. However, comparison of this profile with other known and dated London sequences supports the suggested ages of probably Late Mesolithic or late-prehistoric (Neolithic) for the peat and, early historic Iron Age to Romano-British for the overlying sediment.

Results: Trench 3

All of the (eight) pollen samples examined from contexts [30] to [25] contained sub-fossil pollen and spores but with variable preservation. Three local pollen assemblage zones have been recognised. These are characterised and described in Table 16 below and data plotted as a pollen diagram in Fig 14. Tree and shrub pollen are important throughout with some decline occurring in the upper levels

where herb taxa become dominant with Lactucoeae (dandelion types), Brassicaceae (charlocks) and Chenopodiaceae (goosefoot, orache and samphire).

<i>I.p.a.z.</i>	<i>Palynological characteristics</i>
<i>I.p.a.z. 3</i>	In this upper zone, tree and shrub values are at low levels except for an increase of <i>Pinus</i> (to 18%) and <i>Quercus</i> in the uppermost level (15%). Herbs are dominant with Brassicaceae (20%), Chenopodiaceae (12%), Lactucoeae (25%) and Poaceae (increasing to 30%). Small numbers of cereal pollen are present in this zone. Marsh/fen taxa become more important with <i>Typha angustifolia</i> type (to 30% at top of profile), Cyperaceae (27%) and <i>Typha latifolia</i> . Fern spores become important with <i>Dryopteris</i> type (c.40%) and <i>Pteridium aquilinum</i> (12%). Derived pre-Quaternary palynomorphs (20 sum + Misc.) incl. Dinoflagellates (12%) are more important in this zone.
<i>I.p.a.z.2</i> Poaceae	This zone (2 levels) has been tentatively recognised by a peak of Poaceae (to 40%) with Chenopodiaceae (15%) Cyperaceae type (15%) and spores of <i>Pteridium</i> and <i>Dryopteris</i> type. <i>Quercus</i> declines during this zone and <i>Alnus</i> attains its highest values (90%). This zone requires confirmation with additional samples especially above -0.99mOD.
<i>I.p.a.z. 1</i> Quercus-Alnus	Trees and shrub pollen dominate, with <i>Quercus</i> (35% at base) and <i>Alnus</i> (av. 50% with peak to 70% at 99.01mATD). Other trees include <i>Tilia</i> (to 4%) but under represented, and occasional <i>Fraxinus</i> and <i>Corylus avellana</i> type (20%). These pollen are at their lowest values for the sequence. There are occasional Chenopodiaceae, Asteraceae types and Poaceae. Spores include <i>Dryopteris</i> type and small numbers of <i>Pteridium aquilinum</i> and <i>Polypodium</i> .

Table 16 :Pollen zonation of XSY11 Trench 3 pollen data.

Discussion Trench 3

The pollen data can be considered in relation to the on-site and off-site past vegetation and communities.

The onsite vegetation: Alder carr (Alnetum) was dominant on-site as a floodplain carr woodland also observed in Trench 1 at this site. As such, similar arguments apply. The wood peat accumulated in this relatively stable habitat. There was a ground flora of grasses, sedges and bur reed (*Sparganium*) and/or reedmace (*Typha angustifolia*). This habitat would have been flooded (overbank) for up to three months in winter but was a relatively dry and biologically active (and inhospitable) environment during summer months. It is probable that this habitat prompted the creation of trackways as seen at Silvertown (Wilkinson *et al* 2000).

Conditions became wetter, probably due to rising sea levels which resulted in an initial decline in the extent of the alder carr [26] also with increased deposition of minerogenic sediment (overbank). However, a constricted and detrital peat horizon [27] (I.p.a.z. 2) shows highest values of alder in the profile. This suggests clear dominance of alder and may represent a wave of alder transgressing the site ahead of the increasingly wetter conditions. It is also possible that this pollen may be eroded earlier sediment, which was subsequently re-deposited.

L.p.a.z. 3 falls within the more minerogenic levels of contexts [26] and [25] and displays a more open and developing grass-sedge fen. This was a negative hydrosere, floodplain habitat culminating at the top of the profile with bur reed and/or reedmace (*Typha/Sparganium*) grass and sedge swamp/fen. The presence of freshwater algal *Pediastrum* cysts also suggest a final freshwater environment [25].

The dry-land flora: In common with the other sequences examined, alder has been included in the sum for this evaluation with the consequence that the values of other within some taxa are underrepresented in the pollen diagrams. Initially, during the late prehistoric period, oak (*Quercus*), elm (*Ulmus*) and hazel (*Corylus*) were important. Lime (*Tilia*) has lower values than seen in Trench 1 but was, nevertheless probably a constituent of the nearby woodland. Ash (*Fraxinus*) is also very poorly represented in pollen

spectra unless growth is immediately over the site. The small numbers here suggest some local growth of ash if not importance. Overall, this woodland assemblage is diagnostic for the middle Holocene (Atlantic FI.II) and the Neolithic to Middle Bronze Age (Sub-Boreal FI.III). However, it is not possible to ascertain from the pollen data which part of this long time-span is represented. This is especially the case as no cereal; pollen or associated range of indicative weed taxa have been found. Values of lime and elm, however, are such that a Neolithic to Bronze Age date seems likely. That is, the values here are lower than often seen in other middle Holocene assemblages from London.

Conclusions Trench 3

With the change to more alluvial mineral sediments of contexts [25] and [26], the taphonomy of the pollen will have changed with a greater fluvial component. This will have extended the area of the pollen catchment. Pollen preservation is also poorer in these upper contexts and there is evidence of reworking and differential preservation of more robust pollen types such as the Lactucoideae (dandelion types) and of fern spores (*Dryopteris* type) which attain high values here. The expansion of reworked geological palynomorphs (pollen, spores and dinoflagellates) attest to a higher energy fluvial environment.

Dating: As noted above, pollen analysis is not a dating technique. However, comparison of this profile with other known and dated London sequences suggests that the suggested ages of probably Late Mesolithic (middle Holocene; Atlantic) or more probably a late-Prehistoric (Neolithic) for the lower contexts [30]-[28] and, early Historic, Iron-Age to Romano-British for the overlying sediment [25] and [26], is likely.

Agriculture and human activity: Cereal pollen and other agricultural indicators are present and although there is a reduction in tree and shrub pollen which may imply woodland clearance for agriculture, it is probable that the increases, fluvial catchment has transported such evidence of agriculture from farther afield.

Saline influence: As noted for Trench 1 (above), the change to mineral sediment may have been a response to rising regional and local sea level. Similarly, it is possible that the record of Chenopodiaceae (goosefoot, orache and samphire) in l.p.a.z. 3 may derive from salt marsh nearby and/or fluvially transported from down river.

As with the analysis of Trench 1, this profile shows the development of the late-Prehistoric and early historic vegetation and habitat development of the Thames floodplain.

Diatoms

Nigel Cameron

Introduction

Diatoms were assessed from twelve samples from the XSY11 site. Diatoms are absent from six samples (CR samples 28, 37, 30, 31, 33, 36). Diatoms are present in very low numbers and are very poorly preserved in the remaining six samples.

Results

The diatom fragments present in CR samples 27, 34 and 35 are of indeterminate taxa or undifferentiated Naviculaceae. In sample CR26 a possible fragment of the marine planktonic diatom *Paralia sulcata* is present. In sample CR29 a possible fragment of the benthic mesohalobous diatom *Campylodiscus echeneis* is present. In sample CR32 a very low number of poorly preserved freshwater, benthic and aerophilous diatoms are present. These diatoms include *Hantzschia amphioxys*, *Pinnularia intermedia*, *Pinnularia viridis* and *Pinnularia* sp. These diatoms suggest a shallow freshwater habitat that was prone to drying out or possibly the inwash of soil.

Sample / Context	Height (m ATD)	Height (m AOD)	Diatom Numbers	Quality of Preservation	Diversity	Assemblage type	Potential for % count
CR26	99.01	-0.99	ex low	ex poor	-	indet mar?	none
CR27	97.71	-2.29	ex low	ex poor	-	indet	none
CR28	100.3	0.3	-	-	-	-	none
CR29	98.76	-1.24	ex low	ex poor	-	indet bk?	none
CR37	98.01	-1.99	-	-	-	-	none
CR30	97.08	-2.92	-	-	-	-	none
CR31	101.05	1.05	-	-	-	-	none
CR32	100.85	0.85	v low	poor	v low	fw aero benthic	none
CR33	100	0.00	-	-	-	-	none
CR34	99.54	-0.46	ex low	ex poor	-	indet	none
CR35	99.1	-0.9	ex low	ex poor	-	indet	none
CR36	98.9	-1.1	-	-	-	-	none

(fw – freshwater, bk – brackish, mar – marine, halophil – halophilous, aero – aerophilous)

Table 17: Diatom results from XSY11

Discussion and conclusions

Diatoms are absent from six samples from the XSY11 site and are present in very low numbers and are very poorly preserved in the remaining six samples. The diatom fragments present in three samples are of indeterminate taxa or undifferentiated Naviculaceae. In sample CR26 a possible fragment of a marine planktonic diatom is present and in sample CR 29 a possible fragment of a benthic mesohalobous diatom is present. In sample CR 32 a very low number of poorly preserved freshwater, benthic and aerophilous diatoms are present. These diatoms suggest a shallow freshwater habitat that was prone to drying out or possibly the inwash of soil into the sedimentary environment.

Ostracods

Dr. John E Whittaker

Introduction

Two trench sequences (Trench 1 and Trench 3) were sampled from Connaught Tunnel (XSY11).

Results

The results from the two samples examined from each of the trenches (1 and 3) are shown in Table 18 below.

ORGANIC REMAINS (Trench 1)

Height	100.60m ATD	98.58m ATD
CONTEXT	8	13
MONOLITH/BULK SAMPLE NUMBER	3	7
SAMPLE	O1	O2
plant debris + seeds	X	x
earthworm granules	X	
iron mineral	X	
freshwater ostracods	X	
brackish ostracods	X	
charcoal		x

ORGANIC REMAINS (Trench 3)

Height	100.60m ATD	98.58m ATD
CONTEXT	26	28
MONOLITH/BULK SAMPLE NUMBER	46	59
SAMPLE	O3	O4
plant debris + seeds + spores	X	x
earthworm granules	X	
iron mineral	X	
charcoal	X	
insect remains		x

Table 18: Organic remains from Ostracod assessment XSY11 Trench 1 and 3

Discussion and conclusions Trench 1

Taking Trench 1 first, the lower of the two samples (O2), a silty-sand, contained only plant debris and some charcoal. In the absence of any other finds, it must be presumed to be freshwater alluvium. The charcoal may benefit from further investigation. The upper sample (O1), in comparison, is not short of evidence. It contains earthworm granules, seeds, and both freshwater and brackish ostracods. The occurrence of very large numbers of the exclusively brackish species, *Cytherura gibba*, most of them preserved as carapaces, indicates a total lack of transport and thus an *in situ* population. The co-occurrence of 5 species of freshwater ostracods is less of a conflict as most of them, in particular *Sarscypridopsis aculeata* and *Heterocypris salina*, actually prefer low salinity situations. Iron mineral would indicate the brackish mudflat which this sample represents, was subject to some degree of subaerial weathering (but perhaps nothing more than at periods of low tide).

FRESHWATER OSTRACODS

Height	100.60m ATD	98.58m ATD
CONTEXT	8	13
MONOLITH/BULK SAMPLE NUMBER	3	7
SAMPLE	O1	O2
<i>Candona neglecta</i>	Xx	
<i>Sarscypridopsis aculeata</i>	X	
<i>Limnocythere inopinata</i>	X	
<i>Heterocypris salina</i>	X	
<i>Ilyocypris</i> sp.	O	

BRACKISH OSTRACODS

Height	100.60m ATD	98.58m ATD
CONTEXT	8	13
MONOLITH/BULK SAMPLE NUMBER	3	7
SAMPLE	O1	O2
<i>Cytherura gibba</i>	Xxx	
<i>Cyprideis torosa</i>	O	
<i>Leptocythere lacertosa</i>	O	
Organic remains are listed on a presence (x)/absence basis	Ostracods are listed: o - one specimen; x - several specimens; xx - common; xxx - abundant	

Table 19: Ostracod results XSY11(Trench 1)

Discussion and conclusions Trench 3

Trench 3, on the other hand, contains no positive indications of tidal access at all. The uppermost sample (O3) contains plant debris, earthworm granules and some charcoal. The presence of iron mineral would again suggest weathering, but this time, perhaps rather more of an intense nature than in Trench 1, to the extent that all calcareous material might have been destroyed. It is tentatively assumed to be semiterrestrial alluvial flat, subject to seasonal (?freshwater) flooding. The lower sample in Trench 3 (O4) is a peat (or a very organic clay). A thorough search was made for agglutinating foraminifera (which are indicative of saltmarsh and whose organic templates are preserved in the most reducing of environments) but none was found.

Plant macrofossils

Anne Davis and Karen Stewart

Introduction

Fifteen bulk samples were taken from a sequence of alluvial sediments in Trench 3, alongside geoarchaeological monolith tins. These were taken to retrieve plant macrofossils and invertebrates as well as suitable organic remains for radiocarbon dating. Sub-samples of 10 to 20 litres were processed by wet-sieving over a 0.25mm mesh, and the wet-sieved residues stored in water. No residue was obtained from samples {50} to {53}, or sample {55}.

Results and discussion

The botanical information is summarised in Table 20.

Context	Sample	ID	Abundance	Diversity	Comments
26	54	wlg seeds	2	2	MOSTLY WOOD. SEEDS VERY SPARSE
		wlg misc	3	1	
27	56	chd wood	1	1	MOSTLY WOOD, FEW SEEDS
		wlg seeds	1	1	
		wlg misc	3	1	
	57	wlg seeds	1	1	WOOD, ROOT/LETS, FEW SEEDS
		wlg misc	3	2	
28	58	wlg seeds	1	1	MUCH WOOD (SEP SAMPLE), FEW SEEDS
		wlg misc	3	2	
29	63	wlg seeds	1	1	MOSTLY ROOTS
		wlg misc	3	1	
	64	wlg seeds	1	1	ROOTS, LUMPS OF CLAY
		wlg misc	3	1	
	65	wlg seeds	1	1	WOOD/ROOT. NO SEEDS SEEN
		wlg misc	3	1	
30	66	wlg seeds	1	1	WOOD and ROOT/LETS. FEW ALDER SEEDS
		wlg misc	3	1	
	67	wlg seeds	1	1	WOOD, ROOTS, FEW SEEDS
		wlg misc	3	1	
	68	wlg seeds	2	1	SILTY, LITTLE WOOD. SOME SEEDS, ALDER CK
		wlg misc	2	2	

A: abundance, D: diversity (1 = occasional, 2 = moderate, 3 = abundant)

Table 20: Organic remains from plant macrofossil samples XSY11

Discussion

Charred remains: Very occasional charcoal fragments were present in the residue from sample [27]{56}, but no charred remains were seen in any other samples.

Waterlogged and mineralised remains: All the samples contained wood and roots/rootlets, usually in very large quantities, and small amounts of moss were seen in samples from [28] and [27], and also [26]{54}. Seeds were very scarce in most samples, with fewer than five taxa being noted in most of the assessed samples and none in sample [29]{65}. Only in samples [28]{58} and [26]{54} were between five and ten taxa seen.

Samples [30]{66}, {67}, and {68} (woody peat):

These samples were rather siltier than others, with a smaller proportion of wood and root material. Seeds of alder (*Alnus glutinosa*) were seen in two of the samples, and also occasional alder catkins in {68}. Blackberry (*Rubus* cf. *fruticosus*) and sedge *Carex* sp.) seeds were seen in {67} and {68}, and also water-dropwort (*Oenanthe* sp.) in {68}.

Samples [29]{63}, {64}, {65} (silty clay)

The wet sieved residues contained large amounts of roots and woody material but very few seeds. Very occasional blackberry seeds were seen in {63} and {64} and also alder in {64}. No seeds were seen in {65}.

Sample [28]{58} (clayey peat)

A slightly larger, though still very sparse, assemblage of seeds was seen in this sample, and included a few seeds of gipsy wort (*Lycopus europeus*) and a possible fragment of a hazel (*Corylus avellana*) nut as well as alder, blackberry and sedge. Large quantities of wood fragments made up the bulk of the residue, along with roots and a little moss.

Samples [27]{56}, {57} (peat)

These samples were similar to {58}, though fewer plant taxa were noted. Both samples produced alder seeds, with a few from sedge and buttercup (*Ranunculus acris*.*bulbosus/repens*) in {56}, and occasional blackberry, elder (*Sambucus nigra*) and possible hazelnut in {57}.

Samples [26] {50} to {55}

No residue was obtained after wet sieving samples {50} to {53} and {55}, but sample {54} produced the largest assemblage from this site, though still small. The majority of taxa came from plants of wetland habitats, though no remains of alder were seen here. A single sloe (*Prunus spinosa*) stone was also seen.

Conclusions

Preservation of plant remains, other than wood and roots, was reasonable in the wet-sieved sample residues, but these remains were extremely sparsely distributed and very few were seen in the sub-samples assessed.

Radiocarbon dating

The results of the radiocarbon dating for XSY11 (Trench 1 and 3) are presented in the Table 21 and Table 22 below.

CONTEXT /SAMPLE	BETA No.	MOLA ref	MATERIAL PRE-TREATMENT	13C/12C	CONVENTIONAL AGE	2 SIGMA CALIBRATION
[11] / {6}	407278	XSY/1/6/11	(bulk): acid/alkali/acid	-25.7%	3580 +/- 30 BP	Cal BC 2020 to 1880 (Cal BP 3970 to 3830)
[12] / {6}	407279	XSY/1/6/12	(bulk): acid/alkali/acid	-30.1%	3250 +/- 30 BP	Cal BC 1610 to 1450 (Cal BP 3560 to 3400)
[12] / {7}	407280	XSY/1/7/12	(bulk): acid/alkali/acid	-27.4%	4360 +/- 30 BP	Cal BC 3085 to 2905 (Cal BP 5035 to 4855)

Table 21: Radiocarbon dating results XSY11 (Trench 1)

The date range from the XSY11 (Trench 1) samples indicates those samples taken from the lower peat deposits of context [12] (BETA 407280 and 407279) accumulated in sequence (both in stratigraphy and period) between the Mid Neolithic and Early Bronze Age with the overlying uppermost peat deposit [11] dating to Late Neolithic or Early Bronze Age (BETA 407278). Again the anomaly with the date from [11] is probably due to erosion of the upper peat or indeed bioturbation although the dates returned for peat deposits as a whole for Trench 1 indicates the peat accumulated during the Neolithic and Bronze Age.

CONTEXT /SAMPLE	BETA No.	MOLA ref	MATERIAL PRE-TREATMENT	13C/12C	CONVENTIONAL AGE	2 SIGMA CALIBRATION
[27] / {57}	407281	XSY/3/57/27	(seeds): acid/alkali/acid	-27.4%	2900 +/- 30 BP	Cal BC 1205 to 1005 (Cal BP 3155 to 2955)
[28] / {61}	408194	XSY/3/61/28	(bulk): acid/alkali/acid	-26.4%	3770 +/- 30 BP	Cal BC 2285 to 2060 (Cal BP 4235 to 4010)
[30] / {68}	407283	XSY/3/68/30	(seeds): acid/alkali/acid	-28.2%	5340 +/- 30 BP	Cal BC 4315 to 4050 (Cal BP 6265 to 6000)

Table 22: Radiocarbon dating results XSY11 (Trench 3)

The date range from the XSY11 (Trench 3) samples form a good sequence of dates that correlate well with the stratigraphic architecture. The dates returned indicate that [30], at the base of the sequence (at the initiation of the first peat deposit at approximately 97.1m ATD) accumulated during the Late Mesolithic (BETA 407283); [28] at the top of the first peat sequence (approximately 98.25m ATD) accumulated in the Late Neolithic period (BETA 407283); and context [27] at the last phase of marsh (peat) accumulated in the mid Bronze Age period (BETA 407281).

XSV11 (North Woolwich Portal)

Archaeological fieldwork summary

The watching brief revealed a profile of river deposits on the fringes of the meandering river channel. The sandy floodplain was overlain by a woody peat and subsequently by silty clay deposits that were probably deposited in the bed of a river meander. Fluctuations in the depths of the deposits were noted and they became more obvious as ground reduction continued in a westerly direction towards the end of the portal.

Trenches 2, 3 and 4 and the watching brief revealed the existence of a sandy island in the proximity of the western side of the portal, gently sloping down to the east. Flint scatters within the sands demonstrate occupation of the exposed sand and gravel areas during the Mesolithic period. The provisional appraisal of the flints has not only suggested the presence of humans during the Mesolithic period, but has gone so far as to begin to describe the way in which the shoreline environment was used by those people and also suggests the spatial complexity of their industry. The partially prepared flint would presumably have been removed to further locations in the chain of supply as required. Also, ground reduction revealed a deep sequence of naturally deposited silts and peats which, though for the most part archaeologically sterile, demonstrated a progression of landforms resulting from changing environmental conditions and from which extensive geoarchaeological and palaeoenvironmental samples were taken.

Assessed Logs

Sediments sampled in the monolith tin sequence {3}, {4}, {15} and {16} from Trench 3 and monolith tin {31} from Trench 4 and {59} and {63} from Trench 2 at XSV11 were recorded in the laboratory and subsamples were taken for further analysis. The trench locations are illustrated in Fig 2 and the relevant sections in Fig 7, Fig 8 and Fig 9. These samples link the base of the peats ([9] in Trench 3, [19] in Trench 4 and [32] in Trench 2) with the Mesolithic flint rich sand deposit [15] in Trench 4 and [36] in Trench 2. All the monolith tin samples were described using standard sedimentary criteria (relating to colour, compaction, texture, structure, bedding, inclusions, and clast-size). The descriptions of the monolith tin samples are tabulated as follows:

XSV11 (North Woolwich Portal) {3}{4}{15}{16} Trench 3 and {31} and Trench 4									
Context	from (m BTM)	to (m BTM)	from (m ATD)	to (m ATD)	from (m OD)	to (m OD)	Description	Interpretation	
3	0.00	0.37	99.52	99.15	-0.48	-0.85	Firm very dark brown / black highly organic clay silt with frequent small plant fragments and occasional large plant fragments.	Overbank flood deposits (Alluvium)	Monolith 3 and 4
8	0.00	0.30	98.27	98.50	-1.73	-1.5	Soft dark blue grey and brown highly organic silty clay with rare degraded plant fragments		Monolith 3, 4 and 15
9 and 19	0.30	0.50	98.50	98.30	-1.5	-1.7	Black spongy peat with frequent wood fragments	Forested marsh	Monolith 15
	0.00	0.20	98.45	98.25	-1.55	-1.75	Dry crumbly black peat with frequent large wood fragments.		Monolith 16
	0.20	0.33	98.25	98.12	-1.75	-1.88	Dark reddish brown well-formed peat.	Marsh	
	0.33	0.36	98.12	98.09	-1.88	-1.91	Firm dark blue grey silty clay.	Overbank flood deposits (Alluvium)	
	0.36	0.5	98.09	97.95	-1.91	-2.05	Dark reddish brown well-formed	Marsh	

XSV11 (North Woolwich Portal) {3}{4}{15}{16} Trench 3 and {31} and Trench 4								
							peat.	
19	0.00	0.12	97.67	97.55	-2.33	-2.45	Firm dark reddish brown black peat with frequent small plant fragments.	
18	0.12	0.24	97.55	97.43	-2.45	-2.57	Soft black highly organic silty clay	Overbank flood deposits (Alluvium)
17	0.24	0.39	97.43	97.28	-2.57	-2.72	Black soft coarse sandy peat with medium, subrounded gravel at base.	Early Holocene marsh
15	0.39	0.50	97.28	97.17	-2.72	-2.83	Loose grey coarse sand with granular gravels	River Gravels

Monolith 31

Table 23: Sedimentary description of Monolith samples from Trench 3 and 4 (XSV11)

XSV11 (North Woolwich Portal) {59} and {63} Trench 2.									
Context	from (m BTM)	to (m BTM)	from (m ATD)	to (m ATD)	from (mOD)	to (mOD)	Description	Interpretation	
31	0.00	0.19	0.00	-0.19	-100.00	-100.19	Soft light orange brown organic silty clay becoming dark brown black with depth	Late historic / historic alluvium	
32	0.19	0.3	-0.19	-0.30	-100.19	-100.30	Firm black peaty silty clay	prehistoric Marsh	Monolith 59
	0.30	0.4	-0.30	-0.40	-100.30	-100.40	Black well formed peat		
	0.40	0.50	-0.40	-0.50	-100.40	-100.50	Black well formed peat with coarse golden sand throughout		
35	0.00	0.25	0.00	-0.25	-100.00	-100.25	Soft light golden yellow sand mottled with dark organic staining; rare granular flint.	Early Holocene sands	Monolith 63
36	0.25	0.35	-0.25	-0.35	-100.25	-100.35	Soft light golden yellow sand mottled with pockets of black organic silt.		
34	0.35	0.50	-0.35	-0.50	-100.35	-100.50	Soft yellow grey sand		

Table 24: Sedimentary description of Monolith samples from Trench 2 (XSV11)

The monolith tin sequences {3}, {4}, {15} and {16} from Trench 3 and monolith tin {31} from Trench 4 at XSV11 can be taken as one continuous sequence which captures the whole Holocene sedimentary sequence at North Woolwich from the Pleistocene river gravels through the Mesolithic flint debitage deposits, the prehistoric alluvium and marsh to the overlying historic alluvium. The monolith tin sequence {59} and {63} also captures the sedimentary sequence over the Mesolithic flint rich sands in Trench 2. For assessment of the worked flint deposits see Appendix 2.

Pollen

Rob Scaife

Introduction

Pollen preservation is good above the basal sample P8 [15] which was, however, barren. Although there are some distinct changes in the upper sample P1; this is a single level and does not warrant pollen zonation without additional analysis of closer spaced samples. As such, the characteristics of the pollen profile are described as follows.

Results

Trees and shrubs: *Alnus* is dominant (92% at base) and with consistently high values throughout. *Quercus* (to 30%), *Tilia* (c.15%) and *Corylus avellana* type are the principal taxa. There are small numbers of *Taxus*, *Betula*, *Pinus* and *Ulmus*. *Tilia* and *Ulmus* have slightly higher values in the lower half of the profile. Occasional shrubs include *Rhamnus catharticus* and *Salix*.

Herbs: Except for the upper level, there is little herb pollen and species diversity is very low. There are sporadic occurrences of Brassicaceae, Chenopodiaceae, and Poaceae (cereal type is noted). Poaceae has high values in the upper level at P1 (45%).

Marsh/wetland: *Alnus* (noted above) with *Rhamnus* and *Salix* were the principal wetland components. The upper sample (P1) has higher values of Cyperaceae (20%) with occasional *Typha latifolia* and *Typha angustifolia*/Sparganium types.

Ferns: Fern spores include high values of *Pteridium aquilinum* in the upper sample (43% Sum + Fern spores) and monolet Pteropsida in the lower half of the sequence (to 20%).

Discussion

The pollen data can be considered in relation to the on-site and off-site past vegetation and communities.

The onsite vegetation: It is clear that alder (*Alnus glutinosa*) was dominant on-site as floodplain alder carr woodland with some decline in the upper level where there is a stratigraphical change [3]. The latter is also manifested by an increase in fen herbs with higher values of sedges (Cyperaceae) and bulrush and/or bur reed. (*Typha latifolia* and *Typha angustifolia* type). This suggests that the alder carr community was becoming wetter at this point and was being replaced by a wetter grass-sedge fen. This was likely in response to late prehistoric rise in sea level which instigated as at the other sites, a negative hydrosere at this locality.

Other constituents of the carr prior to onset of wetter conditions included alder buckhorn (*Rhamnus catharticus*), willow (*Salix*) and probably yew (*Taxus*). The latter is an interesting occurrence of drier floodplain woodland which no longer exists. A ground flora of sedges and grasses would also have been present.

The dry land vegetation: Throughout this profile, oak (*Quercus*) with hazel (*Corylus*) appear as the principal and continuous woodland elements. In the lower levels of the profile [15][17] and [18], lime (*Tilia cordata*) and elm (*Ulmus*) are also present. The former is particularly important at this site. It is usually underrepresented in pollen spectra (Andersen 1970, 1973) and was clearly a very important constituent of the nearby woodland growing on well-drained soils. Lime woodland was characteristic of the middle Holocene (Atlantic Flandrian Chronozone II) and the late prehistoric Neolithic and early to Middle Bronze Age periods in southern and eastern England (Moore 1977; Scaife 1980; Greig 1982) and was especially evident for the same period in the London region (Greig 1992; Scaife 2000a, 2000b). Clearance of lime woodland for agriculture took place for agriculture during the Late Neolithic and especially middle Bronze periods in London (Scaife 2000a) and may also be seen at the Plumstead Portal Site (XSW11). The decline of lime here ([6]) may be anthropogenic or may be due to changing sediment regime and differing taphonomy as the site became wetter.

Agriculture and human activity: Cereal pollen and weeds of grassland (ribwort plantain (*Plantago lanceolata*) and grass are present in the upper contexts above [16].

Saline influence: It is possible that the upper sediments of contexts [9]; [4]; [3] are of very late prehistoric or more probably historic age. This period corresponds with rising sea level and brackish water incursion in the middle Thames. Chenopodiaceae (goosefoot, orache and samphire) in the upper contexts (98.03m ATD upwards) may be from salt marsh vegetation community with pollen fluvially transported.

Dating: Pollen is not a dating technique but this pollen sequence, when compared with existing data from London suggests, that the base of the profile is probably of Neolithic or Early Bronze Age date and subsequently, the sediment of [9]; [4] and [3] are alluvial deposits of historic age.

Diatoms

Nigel Cameron

Introduction

Eight samples were assessed for diatoms from XSV11.

Results

Diatoms are present in two (samples CR9 and CR11) of the eight samples assessed from XSV11 however there are extremely low numbers of diatoms in these samples and the quality of diatom preservation is extremely poor. Further, diatoms are absent from the remaining six samples from site XSV11 (samples CR 8, CR 10, CR 12-15)

Diatom Sample No.	Height (m ATD)	Height (m OD)	Diatom Numbers	Quality of Preservation	Diversity	Assemblage type	Potential for % count
CR8	99.32	-0.68	-	-	-	-	none
CR9	98.87	-1.13	ex low	ex poor (dis)	v low	mar bk aero	none
CR10	98.43	-1.57	-	-	-	-	none
CR11	98.11	-1.89	ex low	ex poor	-	indet	none
CR12	97.57	-2.43	-	-	-	-	none
CR13	97.47	-2.53	-	-	-	-	none
CR14	97.35	-2.65	-	-	-	-	none
CR15	97.19	-2.81	-	-	-	-	none

(fw – freshwater, bk – brackish, mar – marine, halophil – halophilous, aero – aerophilous)

Table 25: Diatom results from XSP10

Discussion

The absence or poor preservation of diatom remains in this sequence, and in some other samples assessed from the Crossrail sites, can be attributed to taphonomic processes (Flower 1993, Ryves *et al* 2001). This may be the result of diatom silica dissolution and breakage caused by factors such as extremes of sediment alkalinity or acidity, the under-saturation of sediment pore water with dissolved silica, cycles of prolonged drying and rehydration, or physical damage to diatom valves from abrasion or wave action.

In sample CR 11 the diatom remains are from indeterminate taxa. In sample CR 9 marine, brackish and aerophilous diatoms are present. The planktonic marine diatom *Paralia sulcata* is relatively common. The benthic mesohalobous diatom *Nitzschia navicularis* is present, and the freshwater aerophile *Ellerbeckia arenaria*.

Conclusions

Diatoms are poorly preserved in two samples from site XSV11 and are absent from six samples from this site. Marine, brackish and freshwater aerophilous diatoms are present in sample CR 9. The diatom fragments present in sample CR 11 could not be determined to species level.

Plant macrofossils

Anne Davis and Karen Stewart

Introduction

During excavation environmental samples were taken for the retrieval of archaeobotanical and other organic remains in order to assess their potential to contribute to the interpretation of the site.

Results

The botanical information is summarised in Table 26.

Context	Sample	ID	Abundance	Diversity	Comments
3	5	WLG ROOTS	1	1	
		WLG SEEDS	3	2	SAMNI RUB CAR ALN LAM
		WLG WOOD	3	1	
8	7	WLG MISC	3	2	MOSS ROOTS CK
		WLG SEEDS	2	1	CORAV CAR
		WLG WOOD	1	1	
	17	INV BEETLES	2	1	
		WLG MISC	3	2	CORAV ROOTS CK EPI MOSS
		WLG SEEDS	3	2	ALNGL TILPA CALPA IRIPS
		WLG WOOD	3	1	
9	19	WLG MISC	2	1	ROOTS, CK
		WLG SEEDS	2	1	ALNGL, MORE
		WLG WOOD	3	1	
	22	WLG SEEDS	2	1	ALNGL RAN
		WLG WOOD	3	1	
15	44	BONE FISH	1	1	
		MOLSC FW	1	1	
		WLG SEEDS	1	1	
		WLG SHELL	1	1	
16	28	CHD WOOD	1	1	V SMLL
		INV BEETLES	1	1	
		WLG MISC	3	1	ROOTS, BUDS
		WLG SEEDS	1	1	RUB OEN
		WLG WOOD	1	1	
17	45	WLG MISC	2	1	ROOTS
		WLG SEEDS	1	1	ALNGL RUB
		WLG WOOD	2	1	
32	66	INV BEETLES	1	1	
		WLG MISC	2	1	LF ROOTS
		WLG SEEDS	2	2	CAR ALNGL
		WLG WOOD	3	1	
	68	WLG MISC	2	1	ROOTS, CORAV
		WLG SEEDS	1	1	ALNGL
		WLG WOOD	3	1	
	69	WLG SEEDS	2	2	ALNGL RAN CORAV
		WLG WOOD	3	1	

A: abundance, D: diversity (1 = occasional, 2 = moderate, 3 = abundant)

Table 26: Organic remains from plant macrofossil samples XSV11

Charred remains: Very low amounts of charcoal were noted in sample {28} from [16].

Waterlogged remains: Waterlogged wood was the most common organic remain identified in the samples. Plant parts related to woody taxa were also recorded frequently, particularly catkins (generally of alder (*Alnus glutinosa*)) and buds. Root and leaf fragments were also common and in most samples at least low levels of waterlogged seeds were noted. Of the waterlogged seed assemblages, samples {5} from [3] and {17} from [8] were the most abundant seeds assemblages. In sample {17} [8], alder and lime seeds/fruits were very common, as were marsh marigold (*Caltha palustris*) and yellow flag (*Iris pseudacorus*), taxa of damp to wet ground.

Conclusions

The botanical material preserved in the samples indicate a marsh environment dominated by Alder.

Soil Micromorphology

Introduction

Soil micromorphology, chemical analysis and magnetic susceptibility were undertaken on two samples from XSV11 (North Woolwich Portal) monoliths {63} from Trench 2 and {31} from Trench 4.

Results and Discussion

The results are illustrated in Photos 1-9. Fourteen characteristics were recorded from the 3-6 layers identified in the 2 thin sections studied.

Monolith Sample {63} :The thin section found a very heterogeneous soil-sediment, which was broadly separated into three layers, because there are only diffuse boundaries between Contexts [34] and [36] (very poorly humic sands; 0.449% LOI; Photo 1). There is also a broad, approximately horizontally oriented, woody root channel fill and diffusely mixed very dark brown silty sands (Photos 1 - 3).

The following were noted: a trace of very fine charcoal below root channel, with rare fine roots; broad root channel includes very abundant woody remains, including bark residues, and examples of a fungal sclerotium (300 µm) and a trace of burned/calcined flint (max 3mm); above ([36]) rare charcoal (max 600 µm), occasional fine roots and many calcined and rubefied sharply angular flint fragments (max 18mm)(Photos 1-5). There is a rare trace ([34]) to rare ([36]) very dark and poorly oriented dusty clay grain and void coatings, which rarely are microlaminated, and many preserved silty clay channel infills, many bleached grains including burned flint, occasional ferruginised fine fabric (relict organic matter?), many thin burrows, and occasional thin organic and organo-mineral excrements. Soil-Sediment layers are minerogenic 0.449-0.519% LOI;), and show neither phosphate concentrations nor magnetic susceptibility evidence of burning (the latter also reflects the leached/iron-depleted nature of the mineral material).

The contexts are probably poorly humic alluvial gleysols formed in typical fine to medium Thames River sands, which were elutriated of fine material when they and the sandy midden containing many fine to coarse rubefied and calcined flints were inundated by rising Thames levels. Flooding also seems to have deposited small amounts of alluvial clay, or clay from dispersed topsoils. Evidence of later flooding and alluviation characterised by typically Mid-Holocene silty clay is also present, especially within a broad woody root channel, that also infers the later presence of a fen carr vegetation.

Monolith Sample {31}: [15] was heterogeneous with minerogenic structurless gravelly sands and weakly peaty gravelly sands, and with common gravel (max 15mm, flint and chert) with patchy coarse silts (Photo 6; Photo 7). There is a trace of fine charcoal (max <0.5mm), rare weakly calcined and rubefied flint fragments and sand grains, many woody(?) and monocotyledonous humified root remains. A trace of iron staining of organic remains, abundant thin burrows, and many very thin and abundant thin organic excrements, were found.

There is a diffuse, root-disturbed boundary between [15] and [17], with gravels present in both units. The weakly humic alluvial gley gravelly soils are also influenced by both humic/peaty soils in [17] above, and by the inwash of humic coarse silts.

Context [17] was essentially a homogeneous very dark brown peaty sands and gravels but with very few silty peat, with common gravel (max 12mm, flint)(Photo 6; Photo 8 and Photo 9). Occasional fine charcoal, and including possible subhorizontally oriented fragmented monocotyledonous charcoal (4 mm in length overall; Fig 8), occasional weakly calcined flint fragments, occasional woody(?) and monocotyledonous humified root remains, and rare wood fragments – some weakly iron stained, are present. A trace of iron staining of organic remains, very abundant thin burrows, and abundant very thin and very abundant thin organic excrements, were noted. There is an irregular, mixed boundary to [15].

These peaty sands also include gravels here. There are a few charred organic traces alongside possibly weakly burned flint material, suggesting perhaps burning of the monocotyledonous(?) vegetation at one time – lower water tables ‘ripening’ a peat into a peaty soil. This probably preceded a second onset of peat formation. Fluctuating water tables have induced small amounts of iron staining that have affected organic matter.

The chemical and magnetic susceptibility results are as follows:

- LOI: despite being described as ‘humic’, both samples contain relatively little organic matter – could be attributable to active post-burial organic decomposition processes in what seem likely to be well-drained contexts
- Phosphate: exceptionally low concentrations of phosphate-P – presumably due to leaching of sandy soil; most of phosphate present in inorganic fraction of soil (which is typical of archaeological contexts)
- Magnetic susceptibility: exceptionally low χ and χ_{conv} value is much less than 5% – no evidence of heating/burning (despite presence of burned flint in xM63/36); very low χ_{max} – indicating a low Fe content

Conclusion

Both monolith locations have had complicated site formation histories. Possibly, once-humic alluvial gley topsoils (cf Avery, 1990, 310-311) became elutriated as base levels rose; soils also became very strongly iron-depleted and overall currently measured magnetic susceptibility, LOI and P are very low (inundated relict hearths at Goldcliff still showed MS enhancement, however; see Crowther, 2000). Soils have also lost structure and ‘heavy’ inclusions such as burned flint have fortunately not floated away as happens with coarse charcoal and hence such inundated middens may include little relict charcoal (Macphail et al, 2010). Alluvium at these Woolwich Thames sites appears to be moderately well sorted fine and medium sands, with gravels at monolith {31} which is typical of Late Glacial-Early Holocene Thames river sites as mid-Holocene rises in water table led to the formation of fen carr peats and finer alluvial sedimentation (Sidell, 2003; Sidell et al, 2000). Such sandy alluvial sediments have been studied by the author from Southwark (Courages Brewery) and Bermondsey (Phoenix Wharf; Macphail 2003). At Phoenix Wharf, the palaeosol was affected by overlying peat and peaty silt sedimentation (unpublished but there is a brief mention in Macphail et al, 1990). Peaty alluvial soil formation and inwash of silts affected both sites. At both these peat ‘ripening’ (Jongnerius, 1962) took place, with at monolith {31}, evidence of further amorphous peat accumulation taking place.

Two thin sections and two bulk samples (LOI, P and MS) were studied in order to characterise early Holocene soils and overlying alluvial sediment accumulations. The soils were probably once-humic sandy gley soils, but have been strongly leached and elutriated because of ensuing mid-Holocene inundation. One midden sampled in monolith {63} includes strongly burned (calcined and weakly rubefied) flint, and traces of charcoal. The soils were also influenced by a trace of inwashed clay – typical of soil dispersion and/or alluviation – with trees from fen carr development rooting into the old soil. Humic silts also became inwashed at this time. At both sites alluvial silts were washed in and peats formed. It is possible that fluctuating base levels led to short-lived peat ‘ripening’. In monolith {31} this may have occurred at a time when the local monocotyledonous vegetation was affected by fire/managed by fire, before another phase of peat formation took place.

Radiocarbon dating

The results of the radiocarbon dating for XSV11 are presented in Table 27 below.

CONTEXT /SAMPLE	BETA No.	MOLA ref	MATERIAL PRE-TREATMENT	13C/12C	CONVENTIONAL AGE	2 SIGMA CALIBRATION
[32] / {59}	407268	XSV/2/59/32	(bulk): acid/alkali/acid	-25.6%	3470 +/- 30 BP	Cal BC 1885 to 1690 (Cal BP 3835 to 3640)
[3] / {5}	407269	XSV/3/5/3	(seeds): acid/alkali/acid	-28.7%	3040 +/- 30 BP	Cal BC 1395 to 1215 (Cal BP 3345 to 3165)
[9] / {15}	407270	XSV/3/15/9	(bulk): acid/alkali/acid	-28.6%	3830 +/- 30 BP	Cal BC 2435 to 2150 (Cal BP 4385 to 4100)
[8] / {17}	407271	XSV/3/17/8	(seeds): acid/alkali/acid	-27.1%	3750 +/- 30 BP	Cal BC 2275 to 2040 (Cal BP 4225 to 3990)

Table 27: Radiocarbon dating results XSV11

The dates from XSV11 samples come from both Trench 3 and Trench 2. The date range for Trench 3 begins with the peat deposit [9] (the marsh deposit at approximately 98.45m ATD which significantly overlies the prehistoric flint deposit [11]) returned a date relating to the Late Neolithic (BETA 407270), whereas the overlying context [8] - which dates the initiation of the alluvium over the marsh - returned a slightly later but still Late Neolithic date (BETA 407271). Finally the uppermost context dated from Trench 3, [3], the highest level dated in this sequence at approximately 99.4m ATD, returned a mid-Bronze Age date (BETA 407269). In contrast to [9], context [32] from Trench 2 dates the peat directly overlying the prehistoric flint rich sequences here to the Early Bronze Age (BETA 407268) although lying at approximately 99.4m ATD, similar to [3], Trench 3.

XSW11 (Plumstead Portal and Depot)

Archaeological fieldwork summary

Five trenches were excavated during a field evaluation at Plumstead Portal and three geoarchaeological boreholes were drilled at the Plumstead Depot site.

The geoarchaeological boreholes at the Plumstead Depot site suffered through poor recovery of the sediments although the boreholes (coupled with the geotechnical data), did indicate a channel feature in this area which, through previous deposit modelling, has been conjectured to be an arm, or indeed route, of the Great Breach Dyke (Crossrail 2011). The poor recovery of the deposits - particularly in BH9 to the east of the Depot site - meant that the presence of the channel arm could not be conclusively proved in this location however.

As a consequence as well as the wider perspective archaeological trenches provide, the trench samples from Plumstead Portal were preferred. The results of field evaluation are summarised as follows.

Trench 1a,b and c had no archaeological finds recorded although in general they revealed a sequence of natural fluvial sand from 98.08m ATD in the base of the trench overlain by a woody peat. Three timbers [10], [11] and [38] were recorded within the fluvial deposits and peat deposit are indicative of fallen and water sorted round wood and timber in Trench 1b and three postholes with peat fills [13], [15], and [25] were recorded in Trench 1c in the southwest corner cutting the natural gravel and are likely to be anthropogenic in origin. Two shallow cut features, [17] and [19], were recorded in the same area, and are probably evidence for natural rooting.

In 1d a number of timbers [31], [32], [33], [34] and [35] were recorded across the area are likely to be indicative of fallen and water sorted round wood and timber. However, timber [36] was not naturally broken but had one neatly bevelled end left from either cross cutting or felling with a metal axe. Similarly timber [37] was also found to have traces of working.

Similarly, Trench 2 revealed a sequence of natural fluvial sand between 98.96 and 99.2mm ATD in the base of the trench overlain by a wetland peat. Within the peat deposits a series of naturally deposited timbers, [48], [49], [50], [51], and [52], and one [53] initially thought to have anthropogenic origins, were recorded. The overlying alluvial deposits were 1.30m thick. The sequence probably represents the

seasonal flood deposits of the Thames with evidence for human interaction within the area during the prehistoric to early historic period. A series of late 19th or early 20th-century dumps sealed the sequence. Contained within these were glass and metal fragments, including two ex-situ railway rails.

Assessed Logs

Sediments sampled in the monolith tins {37}, {35} and {34} from Trench 2 at XSW11 were recorded in the laboratory and subsamples were taken for further analysis. The trench locations are illustrated in Fig 2 and the relevant section in Fig 10. All the monolith tin samples were described using standard sedimentary criteria (relating to colour, compaction, texture, structure, bedding, inclusions, and clast-size). The descriptions of the monolith tin samples are tabulated as follows:

XSW11 (Plumstead Portal) {37}{36}{35}{34} Trench 2									
Context	from (m BTM)	to (m BTM)	from (m ATD)	to (m ATD)	from (mOD)	to (mOD)	Description	Interpretation	Monolith No.
46	0.00	0.10	100.88	100.78	0.88	0.78	Loose dry light brown grey clayey sandy medium to coarse gravel	Made ground	Monolith 37
45	0.10	0.20	100.78	100.68	0.78	0.68	Dark brownish grey clay with iron stained root channels	Historic soil	Monolith 37
44	0.20	0.5	100.68	99.53	0.68	-0.47	Firm orangey brown silty clay with rootlets and rare abraided shell fragments	Alluvium	Monolith 37 and 36
43	0.35	0.50	99.53	99.22	-0.47	-0.78	Firm very dark brown to black peat grading into peaty clay with occasional wood fragment	Marsh	Monolith 35 and 34
42	0.46	0.50	99.22	99.18	-0.78	-0.82	Firm light yellowish grey fine sandy silt with rare fine angular gravel	Early Holocene channel deposit	Monolith 34

Table 28: Sedimentary description of Monolith samples from XSW11, Trench 2.

The monolith sequence {37}, {35} and {34} from XSW11 has sampled the sedimentary sequence at Plumstead Portal which encompasses the whole Holocene sequence from early Holocene sands through to modern made ground deposits. These deposits include prehistoric marsh deposits, historic alluvium and possible medieval/post-medieval soils.

Pollen

Introduction

Eight pollen samples were examined from contexts [42] to [45] at XSW11 (Plumstead Portal).

Results

All of the pollen samples examined from XSW11 contained sub-fossil pollen and spores but with variable preservation. Absolute numbers of pollen were extremely low in the sediment of contexts [44] and [45], the upper half of the profile. As such, these data should be treated with caution. Preservation is, however, satisfactory in the lower peat contexts of [42] and [43] and adequate pollen assessment counts were obtained. Two local pollen assemblage zones have been recognised. These are characterised in Table 29 below and data plotted as a pollen diagram in Fig 16.

<i>I.p.a.z.</i>	<i>Palynological characteristics</i>
I.p.a.z. 2	Pollen preservation is very variable and overall poor from c 100.0mATD upwards. Pollen totals in some levels are low and data obtained for this

<i>I.p.a.z.</i>	<i>Palynological characteristics</i>
<i>Quercus</i>	zone should be treated with caution. Trees and shrubs become more important, largely through increase in <i>Pinus</i> to 55% at the top of the profile. There are peaks of <i>Quercus</i> (to 40% at 70cm) and <i>Alnus</i> (25% at 50cm). Herbs include Brassicaceae (4%), Lactucoideae (c.20%) and Poaceae (20%). There is a reduction in Cyperaceae and <i>Typha angustifolia</i> type to low levels. Ferns spores (<i>Dryopteris</i> type) are abundant (differential preservation). <i>Pediastrum</i> is present in this zone (3-4%). Pre-Quaternary palynomorphs remain important after a peak of 45% (Sum + Misc.) at 70cm.
<i>I.p.a.z. 1</i> <i>Alnus</i>	Pollen preservation is satisfactory in this zone. <i>Alnus</i> is dominant with high values (67% at base of profile) declining upwards. <i>Quercus</i> (to 24%), with <i>Tilia</i> (20% total) and <i>Corylus avellana</i> type (peak to 20% at top of zone) are also important. <i>Pinus</i> increases through the zone (to 20%). A single grain of <i>Picea</i> was recovered at 110cm. Herbs are more important at the top of the zone with Poaceae (20%) and Lactucoideae (25%), other Asteraceae types and Cereal type pollen (2-3%). Marsh/fen taxa are dominated by Cyperaceae (peak to 20%), <i>Typha angustifolia</i> type (20%) and <i>Osmunda regalis</i> . Fern spores become increasingly important, except for a basal peak of <i>Polypodium</i> , of <i>Dryopteris</i> type (to 80%) with some Pteridium (3-4%). Pre-Quaternary palynomorphs start to increase in importance.

Table 29: Pollen zonation of XSW11 pollen data.

Discussion

The pollen data can be considered in relation to the on-site and off-site past vegetation and communities.

The on-site habitat underwent a number of significant changes. Initially, alder floodplain carr was dominant (I.p.a.z. 1) in contexts [42] and [43] as indicated by the high pollen values. This declined from the base to low values with mineral sedimentation in context [35] and subsequently only attains high values in a single anomalous level (100.20mATD). There are indications that this may be a contaminated level. Alder carr was replaced by wetter conditions with expansion of grasses (a proportion of), sedges (Cyperaceae) and notably bur reed and/or reed mace (*Typha/Sparganium* type) to five an open reed swamp/fen. This was at the cost of the alder carr which was unable to survive, on site, the increased wetness. As suggested for other sites in this study, the negative hydrosere was triggered by progressively rising sea-level impacting on the freshwater fluvial systems through ponding back creating fen habitats has been observed at other sites in London (Scaife 2000a). This habitat probably remained but pollen preservation is poor and many of the taxa are not robust and may have been destroyed in this alluvial environment.

The dry-land flora: because of the poor pollen preservation in the upper half of the pollen sequence, levels within contexts [35] and [37] are treated with caution.

I.p.a.z. 1 may be divided into a lower [42] [43] (a possible assemblage zone or sub-zone with additional analysis) level in which lime (*Tilia*) is present. With oak and hazel present, the assemblage is similar to that seen in the Connaught Tunnel and North Woolwich profiles. Again, with the dominance of alder and inclusion here within the pollen sum, the values represented in the pollen diagram are not representative of the importance of lime growing nearby on drier/well drained soils. Lime dies out and there is some expansion of hazel. This decline in lime and expansion of hazel is associated with an increase in cereal pollen and some other herbs. It is possible that this is the 'Lime Decline' a phenomenon largely dated to the Late Neolithic and Middle Bronze Age in London (Scaife 2000a, 2000b). The decline in lime pollen is seen in many late Holocene profiles from southern and southeast England. Originally attributed to climatic change (Godwin 1956. 1975) at the transition between the sub Boreal (Zone VIIb) and Sub-Atlantic (Zone VIII), it was shown by J. Turner to have been of

anthropogenic causation (Turner 1962). This appears to be the case here with its strong association with agriculture shortly after its decline.

After the lime decline, oak and hazel woodland became the principal woodland remaining in the region. These also decline in value upward in the profile but, as noted, pollen preservation is poor and as a consequence the data is not wholly reliable. A single sample with lime is present at 100.20m ATD. This is also associated with higher alder and elm values and it is possible that this sample is a contaminant of reworked earlier material.

Pine values are notably high, increasing to the top of the profile. This is probably due to over representation in this poor pollen-preserving environment and also through the fluvial conditions in which its pollen floats. It is, however, also possible that this upper sediment may post-date c.AD1650-1700 with the introduction of the exotic/planted pine in parks and gardens. Spruce (*Picea*) is also noted in the lower sediment and may also be an indication that the sediments are of late historic date.

Saline influence: There is no pollen evidence of saline conditions in this profile.

Conclusions

Pollen preservation is extremely poor in the upper contexts although the lower contexts illustrate the late prehistoric lime decline and subsequent agricultural activity.

Diatoms

Nigel Cameron

Introduction

Six samples were assessed for diatoms from site XSW11.

Results

Diatom assemblages are absent from all six samples. In the four samples (CR samples 16, 17, 19, 20) where diatom fragments are present these are in extremely low numbers and the quality of preservation is extremely poor. A single fragment, comparable with the marine planktonic diatom *Paralia sulcata*, was identified in sample CR 19.

Diatom Sample No.	Height (m ATD)	Height (m OD)	Diatom Numbers	Quality of Preservation	Diversity	Assemblage type	Potential for % count
CR16	100.7	0.7	ex low	ex poor	-	indet	none
CR17	100.6	0.6	ex low	ex poor	-	indet	none
CR18	100.04	0.04	-	-	-	-	none
CR19	99.96	-0.04	ex low	ex poor	-	indet	none
CR20	99.62	-0.38	ex low	ex poor	-	indet	none
CR21	99.26	-0.74	-	-	-	-	none

(fw – freshwater, bk – brackish, mar – marine, halophil – halophilous, aero – aerophilous)

Table 30: Diatom results from XSW11

Discussion and conclusions

The preservational environment at XSW11 was extremely poor regarding diatom survival.

Ostracods

John E. Whittaker

Introduction

Two samples were assessed for Ostracods from XSW11.

Results

The results are listed in Table 32 below:

ORGANIC REMAINS

Height	100.00m ATD	99.20m ATD
CONTEXT	44	42
MONOLITH/BULK SAMPLE NUMBER	35	34
SAMPLE	O1	O2
plant debris	X	x
charcoal	X	x
earthworm granules	X	
molluscs	F	
<i>Bithynia opercula</i>	X	
brackish ostracods	X	

Table 31: Organic remains from Ostracod assessment XSW11

BRACKISH OSTRACODS

Height	100.00m ATD	99.20m ATD
CONTEXT	44	42
MONOLITH/BULK SAMPLE NUMBER	35	34
SAMPLE	O1	O2
<i>Cyprideis torosa</i>	X	
Organic remains are listed on a presence (x)/absence basis	Ostracods are listed: o - one specimen; x - several specimens; xx - common; xxx - abundant	

Table 32: Ostracod results XSW11

Discussion and conclusions

The two samples produced rather different results (Table 32). The upper one (O1) – a silty clay - contained plant debris, earthworm granules, *Bithynia opercula*, fragmentary molluscs and a few brackish ostracods. The ostracods were *Cyprideis torosa* which were weakly noded – this is an ostracod of brackish tidal flats which develops nodes when the salinity is low (below c. 5‰). The locality at this time would therefore have been brackish, a mudflat perhaps near the limit of tidal access with also freshwater and semi-terrestrial influences (the latter evidenced by the co-occurrence of freshwater molluscs and earthworm granules). Sample O2 – a silty sand - on the other hand, situated only 0.80m below O1 in the sedimentary sequence, appeared to be freshwater alluvium. The charcoal present in both these samples could have been the result of human activity or natural fire.

Plant macrofossils

Anne Davis and Karen Stewart

Introduction

During excavation at XSW11, environmental samples were taken for the retrieval of archaeobotanical and other organic remains in order to assess their potential to contribute to the interpretation of the site.

Results and Discussion

The botanical information is summarised in Table 33

Context	Sample	ID	Abundance	Diversity	Comments
2	3	INV BEETLES	1	1	
		WLG MISC	3	1	WOOD CK
		WLG SEEDS	2	2	APIA FOEVU CAR THA ALNGL
	4	WLG MISC	3	1	WOOD, CK
		WLG SEEDS	1	1	RUBFRID
4	9	CHD WOOD	1	1	
		WLG MISC	1	1	WOOD
		WLG SEEDS	1	1	ALNGL
5	10	WLG MISC	1	1	WOOD

Context	Sample	ID	Abundance	Diversity	Comments
	11	WLG SEEDS	1	1	ALNGL SAM
		CHD WOOD	1	1	
		WLG MISC	3	1	CK WOOD
		WLG SEEDS	2	1	APIA RUB ALNGL
	12	WLG MISC	3	1	WOOD CK
		WLG SEEDS	2	1	ALNGL RUB
7	16	CHD SEEDS	1	1	INDET FRAG
		INV PUPARIA	1	1	CADDIS
		WLG MISC	3	2	WOOD CK CORAV BDS BRYO
		WLG SEEDS	2	2	APIA ALNGL ILEAQ RANBA
8	15	CHD WOOD	1	1	
		WLG MISC	2	1	WOOD BD RT
		WLG SEEDS	2	2	ILEAQ APIA RUB

A: abundance, D: diversity (1 = occasional, 2 = moderate, 3 = abundant)

Table 33: Organic remains from samples

Plant material was preserved by charring and waterlogging.

Charred remains: Small wood charcoal fragments were noted in samples {9} from [4], {11} from [5] and {15} from [8]. Charred seeds of indeterminate type were also noted in sample {16} from [7].

Waterlogged remains: Waterlogged wood was the most common organic remain identified in the samples. In samples {3} and {4} from [2], {11} from [5], {12} [5] and {16} from [7], catkins of alder (*Alnus glutinosa*) were also frequently noted. These samples also generally contained well preserved seed assemblages, with alder seeds perhaps unsurprisingly common. Seeds of carrot family taxa (Apiaceae) were also occasionally noted. Sample {16} from [7] produced the largest waterlogged plant assemblage, with hazelnut (*Corylus avellana*), mosses (Bryophyta) and a large seed assemblage including holly (*Ilex aquifolium*) and crowfoot (*Ranunculus* subgen. *Batrachium*). Holly seeds were also recorded in {15} from [8], but as a large assemblage of roots was also recorded here, it is certainly plausible that these are intrusive from [7] above.

Conclusions

The assemblages from the peat deposits [2], [5] and [7] contained moderately well preserved plant assemblages, dominated by wood fragments and woodland taxa, with some wetland type taxa also present.

The environmental assemblage from the clay deposit [4] and the sand layer [8] were less productive, and in the case of [8], the material was possibly intrusive.

The data recorded from the samples are of significance to the site and its local environment.

Radiocarbon dating

The results of the radiocarbon dating for XSW11 are presented in the Table 34 below.

CONTEXT / SAMPLE	BETA No.	MOLA ref	MATERIAL PRE-TREATMENT	13C/12C	CONVENTIONAL AGE	2 SIGMA CALIBRATION
[2] / {4}	407273	XSW/1A/4/2	(seeds): acid/alkali/acid	-24.0%	3480 +/- 30 BP	Cal BC 1885 to 1695 (Cal BP 3835 to 3645)
[2] / {3}	407272	XSW/1A/3/2	(seeds): acid/alkali/acid	-27.8%	3560 +/- 30 BP	Cal BC 2005 to 1780 (Cal BP 3955 to 3730)
[7] / {16}	407274	XSW/1B/16/7	(seeds): acid/alkali/acid	-25.7%	3500 +/- 30 BP	Cal BC 1900 to 1745 (Cal BP 3850 to 3695)

Table 34: Radiocarbon dating results XSW11

The date range from the XSW11 samples come from Trench 1A and 1B, contexts [2] and [7] respectively. Contexts [2] and [7] ally with [43] in the sampled Trench 2 as all are contexts for the peat deposit across the site. The dates indicates the peat formed in the Early Bronze Age (BETA 407272 , 407273 and 407274).

7 Synthesis of the data

Introduction

The results of the different types of sedimentary, macrofossil, microfossil and radiocarbon analyses outlined above have been drawn together in this geoarchaeological summary with regards to monolith and window sample sequences from the Late East sites.

XRW10 (Limmo Peninsula)

The Limmo Peninsula site consisted of monitoring and sampling the Main and Auxiliary Shafts being put down as part of the Crossrail works on the site. The site lies within the alluvial floodplain of the River Lea and within the wider alluvial floodplain of the River Thames. The drift geology of the general area consists of Holocene Floodplain/Shepperton gravels, which have been located in boreholes at c 96.0m to 97.0m ATD above which lay alluvial deposits, most or all of which are thought to represent fills of channels of the River Lea (Fig 2, Fig 3 and Fig 18).

Indeed, the archaeological monitoring revealed alluvium in both shafts (contexts [62], [63] and [64]) is likely to have been deposited within historic times as the medieval boat hull section in the Main Shaft dates the alluvium here and, while there were no currently available dates for finds from the Auxiliary Shaft, it seems likely that the date range for the deposition of the silts is equivalent.

Two monolith samples ({33} and {34}) were taken from the Auxiliary Shaft from section 5 (Fig 3) were analysed in more detail in this report. They represented two height-equivalent sedimentary sequences (approximately 98.35 to 97.85m ATD) but two different sequences of channel deposits which were capped by the homogeneous historic alluvium [64].

Monolith {33} sampled contexts [81] and [83], generally banded silty sands or sandy silts (Fig 3). The pollen revealed Oak and hazel dominating the higher, drier ground and interfluvies with Alder along the water's edge. Along with these, pollen representing disturbed ground taxa and cereals was also noted. In general the pollen describes a late prehistoric to historic, partially cultivated environment as cereal production indicates anthropogenic activity in the area. The diatom results concur largely with the pollen in terms of describing a tidal or brackish water environment small components of freshwater diatoms indicating freshwater input, presumably from the Lea.

Monolith {34} sampled context [82] which again was generally banded silty sands or sandy silts but with the important inclusion of eroded peat clasts (Table 2). Although both the pollen and diatom results for [82] mirror that of the contexts sampled in {33} the peat clasts in the sediment are indicative of a phenomenon seen elsewhere across the Late East sites which is (older) peat bed erosion and redeposition within alluvial contexts. Again, context [64] seals the sampled sediments. Overall both monolith samples {33} and {34} describe a late prehistoric to historic depositional environment in which the tidal head of the Thames, as a consequence of sea level rise, ponds back the Lea but, in doing so, incurs periods of river scour and adjustment prior to the quiescence represented by the later, overlying alluvium (contexts [62], [63] and [64]) in which the medieval boat was recovered.

XSX11 (Victoria Dock Portal)

The Victoria Dock Portal site was situated on the Holocene alluvial floodplain of the Thames, approximately 700m north of its modern day course where modern ground level was approximately 101.5m ATD. Here three trial trenches (Trenches 1, 2 and 3) and a targeted watching brief afforded the opportunity to record and sample the sequence above the Pleistocene Thames gravels (from 96.70m ATD). The sequence across the site (and in each trench) consisted of evidence for a meandering river and tidal creeks with woody peats and alluvial deposits developing across the floodplain.

From the three trenches, the sampled sedimentary sequence from Trench 2 (monoliths {19}, {20}, {21}, {22}, {30}, {31}, {39}, {40} and {46}) was selected for assessment (Table 4) as it was considered representative of the site as a whole. In general, the Trench 2 sequence consisted of floodplain gravels [15] overlain by grey silty sands [14] which, in turn, were overlain by grey clay alluvium [13] over which

peat deposits developed [12] and [11] representing a marsh. The marsh deposit subsequently becomes inundated under two distinct phases of clay alluvium (contexts [10] and [9]) which were finally capped with modern made ground material (Fig 4).

The lowest contexts, [15] and [14], which represented late Pleistocene or early Holocene (Mesolithic) deposits were unfortunately barren of any pollen although, in the ostracod assessment, earthworm granules and rhizoliths representative of a dry stable land surface were recorded in [14]. This early Mesolithic land surface lying at approximately 97m ATD (or -3m OD) allies with the general model for the landscape evolution for the Lower Thames floodplain area (Bates and Whittaker 2004) which suggests that, following the deposition of the floodplain (Shepperton) Gravel, and before the impact of rising relative sea level was felt in this part of the Lower Thames Valley, a period of landscape stability existed in the early Mesolithic, when soils developed in the Shepperton Gravels and other pre-Holocene deposits. No soil development was detected here as it is quite likely – given the amount of rootlets noted in the plant macrofossil assessment of [14] – that this context suffered a degree of bioturbation (and soil obliteration) from the vegetation that developed in the contexts above as well as weathering.

The overlying context [13], black, increasingly organic silty clay, built up over the silty sands. The ostracod assessment evidence indicated a redundant channel or dead backwater area developing infilling with overbank flood deposits and pools of standing/stagnating water. This was echoed with the plant macrofossil and pollen assessments as, particularly toward the top of the context, Oak and hazel with some Lime taxa was noted (representing a mixed deciduous woodland habitat) with Alder once more along the water's edge. This again fits in with the general model of the lower Thames environment at this time as pollen evidence from such early Holocene peaty soils indicates that the floodplain in the early to mid-Holocene between the river channels may have been forested, with a patchwork of lime-dominated woodland (Scaife 2000) which was rapidly becoming ousted by alder (Brown 1997). Notably, the radiocarbon dating places the initiation of [13] in the Early Neolithic (BETA 407267) which fits in well with this model.

Indeed, the development of the forested marsh represented by the peat of [12] sees Alder dominating the increasingly wet environment (Alder can tolerate up to three months of low level flooding) although Oak and Hazel still dominate the deciduous taxa on the higher drier ground. The initiation of the marsh has been dated to the early Mid Neolithic toward the end of the 3rd millennium BC which again fits in well with other work in the area both attitudinally (c. 97.7m ATD (-2.3m OD) (Sankey *et al* 2004, Fairburn *et al* 1996; Sidell 2003). As groundwater levels continued to rise through the Neolithic because of the knock on effect of RSL the site vegetation began to change with pollen and plant macrofossil evidence from [11] showing a decline in Alder and the rise of marsh species. Radiocarbon dating puts the top of the [11] at 99.10m ATD, prior to the cessation of the peat, in the mid Bronze Age.

The wetter conditions persist through the overlying alluvium and ephemeral peat deposit of [10] as a negative hydrosere develops across the lowland areas of the site. Diatom evidence, although poor, indicates marine planktonic species appearing in the water column as the tidal head encroaches and the mudflats become salt marsh. In contrast, on the higher, drier ground, indications of anthropogenic activity through pollen representative of cereal production appears alongside a rise in grasses, indicative of a more open, treeless environment.

This environment continues throughout the uppermost sampled context [9], a blue grey silty clay alluvium, which probably accumulated from the late prehistoric onward. Both plant macrofossil and pollen assessments for [9] indicate peaks in cereal production along with evidence of fire (charcoal), perhaps indicative of clearance activity. Interestingly, the ostracod assessment of [9] indicates earthworm granules and plant debris indicative of a semiterrestrial environment, or an environment only seasonally flooded. This interpretation agrees with both the accepted model of the lower Thames development (Bates and Whittaker, 2004; Sidell 2003) and with the stratigraphy as toward the top of [9] the alluvium is logged as mottled as it weathered through exposure to air as water levels fluctuated and flood deposits built up the sediment through accretion.

In sum, the Victoria Dock Portal site has provided a very comprehensive sedimentary sequence for the development of the lower Thames as a whole from the Mesolithic to the Medieval / post-medieval periods. From the dry silty sand land surface of the Mesolithic through to a backwater area where peat deposits dating to the Neolithic and Bronze Age periods developed to the tidal environments of the late

prehistoric / historic, evidence of a changing vegetational environment and indications prehistoric agricultural activity have tied in well with the stratigraphy recorded and sampled across the site.

XTI13 (Custom House)

A palaeo-environmental assessment was undertaken on a window sample (borehole) sequence WS1 sited just to the east of Trench 4 at Custom House (NGR: 540886.15, 180948.09) (XTI13). WS1 sampled the full sequence of the surviving alluvial deposits initially revealed in the trench sections. Pleistocene gravel and sands [13] was observed at 96.7m ATD overlain by grey silt alluvium [12] which graded up into a woody peat [11] to 99.3m ATD. Above this was alluvial clay [14] with a degree of estuarine influence. Given its proximity to XSX11 (Connaught Tunnel, see below) these deposits were thought only to need three radiocarbon dates from the highest and lowest organic material sampled (and the top of the woody peat) to put the sedimentary sequence into a chronological framework as well as to compare time transgressive differences between the accumulations of the peats across the Late East area.

Modern ground level adjacent to the site lies at c 101.5–102m ATD (1.5m to 2m OD).

The radiocarbon dates returned for XTI13 provide a good, sequential chronostratigraphy for the peat deposit [11]. The lowest date, from approximately 97.30m ATD (-2.7m OD) at the initiation of the peats, returned an early mid Neolithic date (BETA 396254). The middle of the peat (c. 97.50m ATD / -2.50m OD) returned a date relating to the mid Neolithic and the uppermost sample (c. 97.9m ATD / -2.10m OD), dating the cessation of the peat at XTI13, returned a date relating to the Late Neolithic. The dating of the peat also gives a *terminus ante quem* for the underlying alluvium [12] as it must have accumulated before the early mid Neolithic. Similarly, the date from the top of the peat provides a *terminus post quem* for the initiation of the overlying alluvium [14] as it could only have begun to accumulate after the Late Neolithic although it is probable [14] accumulated as part of an historic channel which is identifiable in WS2 and probably eroded the top of the peat [11] at XTI13 (Fig 17 and Fig 18).

The radiocarbon dating assays from XTI13 place the development of the peats securely within the Neolithic period which ties in well with the other dates returned for similar contexts across the Late East area.

XSX11 (Connaught Tunnel)

Two trench sequences (Trench 1 and Trench 3) were sampled from Connaught Tunnel (XSX11). Trench 1 and Trench 3 lie some 1.5km distant from one another at the tunnel portals (to the northwest and southeast of Connaught Bridge crossing Victoria and Royal Albert Docks, respectively) and hence these two separate areas needed investigation.

Trench 1

Trench 1 was located approximately 600m west of the north side of Connaught Bridge, just south of the Victoria Dock road (NGR: 541095, 180944); modern ground level was 102.57m ATD (2.57m OD).

The sampled sedimentary sequence from Trench 1 consisted of monoliths {1}{2}{3}{4}{5}{6} and {7} (Table 13). In general, the Trench 1 sequence consisted of early Holocene sandy silts [13] overlain peat deposits [12] and [11] representing prehistoric marsh, which in turn was submerged beneath overbank flood deposits [10] which developed into continued phases of alluvial deposition through contexts [9] [8] [7] [6] [4] [2] and [1] (Fig 5).

The pollen assessment of the lowest context [13] returned no results because of the poor preservational environment the ancient silty sands present however the ostracod assessment of the same context indicated plant debris and, importantly, charcoal, which possibly indicates anthropogenic activity such as clearance, locally. Lying at 98.75m (-1.25mOD) this area probably remained a relatively high area across the Mesolithic floodplain remaining dry until changes in relative sea level increased ground water levels and the peat [12] and [11] developed.

The lower level of [12], and therefore the initiation of the peat, was dated to the mid Neolithic (BETA 407280) and the upper part of [12] was dated to the early Middle Bronze Age (BETA 407279). The peat is described as a firm black woody peat indicating compaction and age which could concur with the particularly long period of time (nearly 2500 years) for the peat to have built up through [12]. Interestingly, the pollen assessment noted the ubiquitous Alder dominating the pollen count with a background not only of Oak and hazel as seen previously but Yew as well – forests of which have been found in similar peat deposits to the east (Fairburn *et al* 1996; Sidell 2003). Notably, the upper part of [11] was dated to the Late Neolithic / Early Bronze Age (BETA 407278). This anomalous date can be probably explained by the fact that a piece of wood was dated lying in a clayey peat and therefore was probably an eroded fragment from an earlier deposit. This is supported by the fact that the overlying context [10], in close proximity to the dated wood in [11], is clearly an alluvial flood deposit and possibly affected the upper part of [11]. Nevertheless, the peat of [11] and [12] clearly relates to the later prehistoric (Neolithic and Bronze Age) periods aligning with other peats across the Late East area.

Through the overlying contexts [10] to [4] the pollen assessment clearly shows a decline in the tree taxa and rise of grass and marsh taxa as RSL brings higher water levels and brackish conditions to the site area (also confirmed through the ostracod data returned for the upper part of [8]). Notably, in context [6], cereal pollen also features indicative of agricultural activity locally during this time. Again these alluvial deposits probably date from the late prehistoric and continue to accumulate through the historic period. Interestingly, both the ostracod and diatom data from these upper levels ([8] and [6], respectively) point toward dry periods in the accumulation of the alluvium possibly indicative of seasonal flooding rather than permanent inundation. This is supported by the stratigraphic evidence as the alluvium is mottled (oxidised) throughout, which, coupled with evidence of fine roots, indicates fluctuating water levels.

Trench 3

Trench 3 was located approximately 500m east of the southern side of Connaught Bridge, just north of Factory road ((NGR: 542150, 180093); modern ground level was 101.35m ATD (1.35m OD)).

The sampled sedimentary sequence from Trench 3 consisted of monolith samples {45} {46} {48} {59} {49} {61} {60} {62} and {69} (Table 14). In general, the sequence recorded in Trench 3 begins with a pale grey to mid grey silty fine sand [31] at 96.92m ATD (-3.08m OD) overlain by peat deposits [30] and ephemeral peat and alluvial deposits in [29], [28] and [27] representing an intermittently flooded prehistoric marsh, which in turn was submerged beneath phases of alluvial deposition seen in [26] and [25] (Fig 6).

At 96.92m ATD the top of the gravels lie approximately 2m below those at Trench 1 and, where Trench 1 represents a gravel 'high', the Trench 3 levels represent a gravel 'low' across an undulating gravel surface topography. Areas of higher gravel probably remained as dry land during the bulk of the prehistoric period (as in Trench 1) whereas the surrounding low areas, such as in Trench 3, rapidly became waterlogged and buried beneath peat thereby preserving biological remains dating from the Mesolithic onward.

It was of no surprise therefore that the base of the peat sequence in context [30] at approximately 97m ATD (-3m OD) was radiocarbon dated to the Late Mesolithic (BETA 407283) which was the earliest date returned across the whole of the Late East area. The peat continued to accumulate in this hollow in the landscape through to the Late Neolithic as dated at the base of [28] (BETA 407294), which interestingly equates approximately in both height (98.3m ATD) and date with the initiation of the peats in Trench 1. The pollen and plant macrofossil evidence both describe a stable woodland throughout this period (contexts [30] and [29]) dominated by Alder at the river bank and Oak and Hazel on the higher drier ground.

Increasingly however, as in other areas across the Late East area, the knock on effects of RSL create a progressively wet environment, too wet for Alder to sustain, which although Alder peaks in [27] (radiocarbon dated to the mid Bronze Age; BETA 407281) it begins to decline rapidly throughout [26]. Indeed, already by the upper part of [27] low counts of marine diatoms were present indicative of the encroaching tidal head and through [26] and [25] the pollen and plant macrofossil evidence clearly shows an opening up of the woodland and the dominance of grasses, reeds and ferns of a much wetter mudflat / salt marsh environment. These thick alluvial deposits of [26] and [25] also contain indicators of

anthropogenic activity in the form of charcoal and cereal production (similar, indeed, to equivalent contexts in Trench 1).

All in all, Trench 1 and Trench 3 at the Connaught tunnel site represent two different environments typical of the undulating topography of the Thames floodplain, namely a gravel high area and a gravel low area, respectively. As a consequence, the low area of Trench 3, was first to accumulate sediments and peats probably as a redundant channel during the Mesolithic. In contrast, the Trench 1 area remained high and dry until the mid-Neolithic. The pollen and plant macro fossil evidence point to an Alder dominated stable woodland environment initially at both sites which, particularly in Trench 1, becomes eroded and eventually submerged beneath increasingly brackish water with the rise in relative sea level. Finally, in the open environments of grass dominated mudflats / saltmarsh during the late prehistoric / historic period, accretionary alluvial deposits flood both trench areas where clearance and agricultural activity is occurring in the locality.

XSV11 (North Woolwich Portal)

A monolith sequence {3}, {4}, {15} and {16} from Trench 3 coupled with a single monolith tin {31} from Trench 4 (which links the base of the peats and the Mesolithic flint rich sands of Trench 4) were selected as representative for the site sequence as a whole at XSV11 (Table 23). Furthermore, given that this area recovered rich deposits of Mesolithic flint debitage across the sands at the base of the sequences in Trenches 3 and 4 soil micromorphology (and associated tests) were undertaken on the interface between sampled contexts [15] and [17] of Trench 4 (monolith {31}) to provide more detail on the land surface intermittently occupied throughout the Mesolithic as well as examination of the higher burnt flint deposit [36] sampled from Trench 2 (monolith {63}; Fig 7, Fig 8 and Fig 9).

In Trench 4, natural gravel [16] was recorded at 97.07m ATD in the west of the trench and at 97.21m ATD in the east, indicating a slight rise in the gravel bank from west to east. Above it, a layer of light yellowish/grey medium sand [15] was seen which was approximately 0.20m in depth and extended for 8m from the western side of the trench. A large quantity of worked flints was recovered from [15]. The flints were concentrated in one area of the trench, suggesting they may be fairly close to being *in situ*. The deposit was also bulk sampled in a grid pattern to enable the deposit to be processed for further information such as potential micro-debitage or any microliths which may have been present with the added potential for spatial analysis (see Appendix 2 Flint assessment).

A layer of very organic slightly peaty sand [17] overlay [15] which, in turn was overlain by [18], a grey alluvial clay suggesting an inundation of the land surface prior to stabilisation of vegetation giving rise to the peaty deposits interspersed with flood deposits [19] which equated with context [9] in Trench 3. Overlying the peat deposits, late prehistoric / historic overbank flood deposits (alluvium) [8] and [3] were sampled from Trench 3. Sealing all of the above features and deposits was a layer of crushed concrete of c 0.2m thick, recorded from a starting height of 99.80m ATD to approximately 101.5 m ATD.

Similar to Trench 4, the earliest deposit exposed in Trench 2 (sampled by {63}, Table 24) was layer of natural yellow-beige sand [34] at 99.10m ATD. Layer [34] was overlain by a finer and whiter sandy horizon [33] provisionally interpreted as a bioturbated prehistoric land surface with the top of the layer at c 99.20m ATD. A number of burnt flints were found distributed within the layer, concentrated in the vicinity of a pit [37]. This was c 0.45m deep, filled with darker grey sand [35] containing horizontal lenses of burnt flint. At the base of the pit was a large concentration of broken burnt flint [36], which had lightly baked the surrounding deposit [34] a pink colour. Sandy horizon [33] was overlain by an approximately 0.6m thick layer of peat [32]. This was laid down over time during conditions becoming increasingly wet prior to the inundation represented by the overlying alluvium [31]. The assessment of Trench 2 consisted of Soil micromorphology of [34] [36] [36] and radiocarbon dating of the lower part of [32].

The soil micromorphology assessment of the lower (early Holocene) sandy contexts [34], [36] and [35] underlying the peats in Trench 2 (sampled in monolith {33}) and [15] and [17] in Trench 4 (sampled in monolith {31}) indicated remnant ancient soils with evidence of burning (burnt flint and charcoal) indicative of midden deposits. This context therefore represents the prehistoric land surface (as predicted) that existed prior to the development of the peats as ground water levels rose. As in other sites across the Late East area, these once humic sandy deposits became heavily leached (due to their

antiquity and sandy nature) so that barely any evidence of soil formation remains. They were however, once high and dry areas of the floodplain which provided areas of temporary occupation for hunter gatherer groups in particular. Interestingly evidence of fen carr rooting (from the peat deposits) have bioturbated the sands and the resultant voids infilled with clays as water levels rose.

The flint assessment also indicates these flint accumulations represent ephemeral events. The fresh condition and the tight distribution of the flint assemblages, particularly that lying within context [15], suggests that it could represent a single, short-lived and more or less *in situ* knapping episode sealed beneath Late Neolithic peats. The presence of unworked burnt flint and traces of charcoal may also indicate the presence of other anthropogenic activity connected with the use of hearths and/or the firing of the local vegetation. Fascinatingly, the plant macrofossil evidence for [15] included evidence of food waste such as fish bone and shell, indicative more of a hearth.

The wider palaeo-environmental assessment of context [17] through to [9]/ [19] - based on the pollen data - portrays an Alder/Oak/Hazel dominated vegetational environment albeit with peaks in [17] of the deciduous forest genera Lime and Elm. Both these species suffered through hydrological changes and/or disease and largely disappeared from the pollen record by the Neolithic in London (Scaife 2000a, 2000b) which could provide a relative date for these contexts. In any case, radiocarbon dating of contexts [9] and [8] at the top of the peat / alluvium interface places the cessation of the peats to the Late Neolithic (BETA -407270 and 407271). The overlying alluvium sees the opening up of the environment again with woodland decline and grasses becoming dominant. Coupled with evidence of brackish water diatoms in [8] it is likely that hydrological change through sea level rise has once more led to the demise of the woodland as mudflats/saltmarsh developed across the site by the mid Bronze Age (BETA-407268, [3]).

The assessment at North Woolwich therefore ties the environmental data tightly with the other sites across the Late East area with the peats developing through the Neolithic period. Of greater interest is the Mesolithic flint assemblage and associated middens. Analysis of these rare and ephemeral finds have confirmed that the high areas of sands throughout the site area were once dry land surfaces, open long enough for soils to develop and across which prehistoric hunter/ gatherer groups roamed.

XSW11 (Plumstead Portal and Depot)

The Plumstead Portal and Depot site is the only one from the Late East area which is situated on the southern fringes of the Holocene alluvial floodplain of the Thames. Just to the south of the site, outcrops of the Tertiary Woolwich and Reading beds form an area of higher ground with lower ground associated with a channel feature toward the east. In contrast to all the other sites in this report, the site lies between the high and dry ground towards the south, and the wetland landscape towards the north and east.

The boreholes (coupled with associated geotechnical works) indicated the existence of a channel feature to the east of Plumstead Depot site which previously had been conjectured as an arm of the Great Breach Dyke. Results were inconclusive however given the poor recovery in the boreholes. Further deposit modelling might help resolve this issue however.

For assessment, the trench sections from Plumstead Portal were preferred to the boreholes from Plumstead Depot. The locations of the two trenches at Plumstead Portal were sited to form an adequate sample of the site where archaeology might survive, following the results from a geoarchaeological evaluation where peat and alluvial deposits were identified. The location of Trenches 1 and 2 are illustrated in Fig 2. Both trenches were excavated to the surface of the floodplain gravels which marked the baseline for deposits of palaeological/palaeoenvironmental interest with Trench 1 bulk samples being examined for plant macrofossils and radiocarbon dating and Trench 2 for pollen, diatoms and ostracod assessments.

Trench 2 revealed a sequence of natural fluvial sand [42] between 98.96 and 99.2mm ATD in the base of the trench overlain by a 0.30–0.60m depth of woodland peat [43]. The overlying alluvial deposits [44] and [45] were 1.30m thick. The sequence probably represents the seasonal flood deposits of the Thames with evidence for human interaction within the area during the prehistoric to early historic period. In particular, worked timber recovered from the site dating from the Bronze Age shows direct

evidence of the utilisation of this landscape on this site. A series of late 19th or early 20th-century dumps sealed the sequence.

The pollen assessment of the early Holocene sandy silt [42] indicate Alder occupying the lower riparian environment and Oak / hazel deciduous woodland on the higher drier areas. This pollen is probably intrusive as typically these species are mid Holocene in date which would concur with the plant macrofossil data for [42] which recorded a lot of intrusive roots from the fen carr above.

The thin peat deposit [43] representing the prehistoric marsh included wider pollen spectra including Lime and cereals amid the ubiquitous Alder and Oak/Hazel woodland. The ostracod data proved this to be a freshwater environment as the equivalent peat deposit in Trench 1a ([2]) and Trench 1b ([7]) was dated to the Early Bronze Age (BETA-407272, 407273, 407274). Interestingly, the plant macrofossil evidence supports the indirect anthropogenic activity (cereal production) seen in the pollen with charred seeds (and wood) throughout this and the overlying contexts.

With the occurrence of the alluvial deposits [44] and [45] the pollen portrays the familiar opening up of the woodland with grasses and cereals predominating along with high Pre-Quaternary palynomorphs (Pre-Quaternary pollen) indicating eroded Tertiary material entering the floodplain. With brackish ostracods and marine diatoms evident in [44] it is clear tidal conditions are reaching the site by this time. Again the ostracod assessment indicates intermittent inundation of the alluvium with earthworm granules being indicative of albeit temporarily dry land surfaces. Indeed the final historic context [45] being a dark brownish grey clay with numerous root channels was considered to be an historic soil horizon over which the made ground was lain. [45] was probably akin to a water meadow environment still subject to occasional inundation seasonally.

Plumstead Portal and Depot, although the only site on the Late East project to be located on the southern bank of the Thames, has shown marked similarities to the preceding northern bank sites. Dry early Holocene sand deposits have been overlain with Bronze Age peats which in turn have been submerged beneath late prehistoric/historic alluvium. The riparian vegetation likewise was dominated by Alder with Oak and hazel on the higher ground. Cereal and other more direct indications of anthropogenic activity were found in the overlying alluvial contexts.

Geoarchaeological summary

To summarise the sequences across the late East area this section discusses the deposits in terms of identified facies (or deposits with similar characteristics), from the oldest to the most recent. The facies and lithology recorded within the boreholes and trench sections are illustrated in the transect drawn across the site (Fig 19). A key to the facies units and the individual lithology is provided with the transect. The major landscape features recorded are illustrated on the annotated plots of the early Holocene surface (Fig 17 and Fig 18).

Facies 1: Late Pleistocene/Early Holocene gravels and sands (Upper Palaeolithic)

The basal deposits observed in nearly all interventions across the Late East area consisted of moderately well sorted, clast supported sandy gravels (facies 1, Fig 19). The gravel clasts were predominately fine to medium rounded, sub-rounded and sub-angular clasts. These gravels are characteristic of the Shepperton gravel formation and represent the last phase of down cutting and gravel aggradation before the temperate Holocene epoch. The gravel deposition occurred after the Last Glacial Maximum of the Dimlington Stadial (c 18 000 BP) although reworking of these sediments probably occurred into the Late Glacial and Early Holocene periods.

The gravels were found to undulate across the floodplain as these are bedforms and sedimentary structures associated with the braided channel regime of the Thames during the late Pleistocene. As a result, a mosaic of gravel highs and lows occur across the floodplain, the former being areas of high ground (often covered with sand) overlooking the latter which are frequently channel (or redundant channel) threads. The Late East early Holocene surface (Fig 17 and Fig 18) picks out the nature of these former channel areas well (the darker blue areas in the Figs) as, in general, they parallel the route of the Thames across the wider floodplain area.

As has been seen across a number of sites in the Late East area, the undulating gravel topography influenced the environments and depositional processes of the Holocene (Mesolithic onwards) of which, in particular, the two trenches at the Connaught Tunnel site were good examples where Trench 3 was first to accumulate sediments and peats during the Mesolithic (probably as a redundant channel) whereas Trench 1, in contrast, remained high and dry until the mid-Neolithic. These high areas provided access to the resources of the channels and backwaters throughout the Mesolithic and, as a consequence, still have the potential (though rarely) retain evidence of Stoneage cultures such as at North Woolwich.

Facies 2: Early to Mid-Holocene organic silty clay and peat deposits (Mesolithic to Bronze Age)

Across the majority of the Late East area the Pleistocene sands and gravels are overlain by organic silty clays and/or by dark reddish brown to black humified peats and peaty clays (facies 2, Fig 19). These deposits, as seen in the pollen and plant macrofossil data, represent the slow decline of the channel areas and the development of alder carr (wooded marsh) environments represented by the peats, with Oak and Hazel occupying the higher, drier ground and interfluvies. The landscape characteristics and relationship between the different facies indicates that the peat did not develop at the same time across the whole site, and either formed within abandoned channel threads or across previously dry land surfaces as a result of increased river levels through upstream migration of the tidal head.

As discussed above, the lower lying peats infilling the deeper channels formed in response to channel abandonment within the former channel threads and can be of Mesolithic date although, in general, were found to date from the early to mid-Neolithic through to the Bronze Age. Indeed, worked timber at Plumstead Portal considered to be Bronze Age shows direct evidence of the utilisation of this wooded marsh landscape. The nature and date of the organic silty clays and peats fit in well with other sites across the lower Thames floodplain (Fairburn *et al* 1996; Sidell 2003) importantly adding to the emerging picture of the prehistoric environment here.

Facies 3: Mid to late Holocene alluvial deposits (Late prehistoric to post-medieval).

The upper floodplain deposits across the Late east area consisted of massive silty clays often displaying weathered, oxidised orangey brown colouration (facies 3, Fig 19). These deposits were found to be characteristic of semi terrestrial accretionary soils deposited through seasonal overbank flooding. Diatom, pollen and ostracod assessment indicated theses largely occurred as a result of tidal inundation during the later prehistoric / historic period which, over time as the land surface built up, became less frequent, and the salt marsh, mudflat environments gradually developed into grass watermeadow environments. In some areas these deposits were found to have eroded the peats of facies 2 both truncating them and making radiocarbon dating of the facies 2 and 3 interface problematic. Dating evidence indicates these deposits began to accumulate during the Bronze Age (eg Plumstead Portal) and continued through to at least the medieval period (dated by the boat at Limmo Peninsula).

Facies 4: Modern made ground deposits

Across the Late East area modern made ground was recorded (facies 4, Fig 19) overlying and often truncating the silty clays of Facies 3. Only at Plumstead Portal was a buried topsoil horizon recorded below dumped made ground. The made ground deposits are of little palaeo-environmental or archaeological significance and, as such, were not investigated in this report.

8 Potential of the data

Realisation of the original research aims

- *What is the development of the local landscape, topography and environment of the Thames floodplain? What palaeo-environmental data is there to inform on this development?*

The palaeoenvironmental data returned for the Late East area indicated that the local landscape across the Thames floodplain was characterised by an undulating gravel topography at the start of the Mesolithic. Areas of low gravels probably representing redundant freshwater channels silted up gradually during the Mesolithic developing into Alder dominated marsh deposits by the Neolithic. This environment persisted into the Bronze Age when rising river levels as a result of changes in relative sea level submerged the peats below alluvial sediments representative of brackish tidal environments. The alluvium continued to accrete (slowing over time) up until the medieval / post-medieval periods.

- *Is there any evidence for Palaeolithic activity at the interface between the Pleistocene gravels and early Holocene channel deposits? If so, what form does this take?*

No evidence for Palaeolithic activity at the interface between the Pleistocene gravels and early Holocene channel deposits was recorded.

- *If peat deposits can be securely dated, what activity is contained within them, and how does this help to refine knowledge of prehistoric activity, occupation and settlement in the marginal wetland habitats?*

The peat deposits across the Late East area ranged in date from the Late Mesolithic through to the Bronze Age periods. Indirect data from the pollen evidence indicated that cereal production during the Late Neolithic and Bronze Age periods took place in the vicinity of the Late East area throughout this time.

- *Is there any evidence for prehistoric activity? If prehistoric remains are present, what is their character and what can be learned about the exploitation of the floodplain by prehistoric groups? In particular, is there any evidence for Mesolithic activity at the base of the alluvium/surface of the gravels?*

A Mesolithic or Neolithic flint debitage was recorded in the sands at the base of the alluvium/surface of the gravels at the North Woolwich Portal site. Lithic and plant macrofossil evidence points to a midden with evidence of fish and seed waste recorded. Ostracod and soil micromorphology assessments (and radiocarbon dating of the overlying peat deposits) also indicated that these sands had remained an open land surface for the bulk of the Mesolithic period. Worked Bronze Age timber from the Plumstead site shows direct human occupation of the landscape and hints at the exploitation of the marshland and woodland resource by past peoples. Furthermore, indirect data from the pollen and plant macrofossil assessments of the overlying peats and alluvium indicated that cereal production and possibly clearance activity was occurring locally during the Late Neolithic and Bronze Age periods.

- *Is there any evidence for timber trackways or other structures of later prehistoric date?*

There was no evidence for timber trackways or other structures of later prehistoric date.

- *Is there any evidence for Roman activity, in particular for reclamation or flood defences, and marine transgression and regression?*

There was no evidence for Roman activity, in particular for reclamation or flood defences but the Neolithic and Bronze Age peats coupled with the brackish tidal environment of the alluvium is indicative of marine regression and transgression, respectively.

- *Is there any evidence for Saxon activity, in particular for water management, marginal wetland agriculture, flood defences and/or fishing?*

There was no evidence for Saxon activity.

- *What can be learned about the process of land reclamation and management of the area from the medieval period until the construction of the docks?*

No direct or indirect information about the process of land reclamation and management of the area from the medieval period until the construction of the docks was obtained during this assessment.

General discussion of potential

The Late East sites have provided an informative and corroborative addition to the geoarchaeological record of the lower Thames area providing insights into pivotal periods of environmental change, particularly in prehistory.

The Late East sites have produced a good pollen sequences radiocarbon dated variously from the Late Mesolithic and the Neolithic periods through to the Bronze Age. Typically from the Late Mesolithic, the area was dominated by Oak and Hazel woodland on the higher, drier ground, with Alder carr (damp woodland) on the floodplain which formed thick peat deposits across nearly all sites. In the Late Neolithic / Early Bronze Age however, pollen and diatom evidence pointed toward an increasingly saline / open salt marsh environment developing which covered the peats under slowly accreting alluvial deposits up until the post-medieval period.

Diatom and ostracod analysis was thorough but poor preservation hindered results and, as such, have little potential for further work. Both analyses however supported other palaeoenvironmental assessments in adding detail to the picture of the evolving landscape across the Late East area. The wider ecological assessment recorded in the ostracod work showed that high areas of gravels and sands generally remained high and dry throughout the Mesolithic and Neolithic and diatom work frequently noted the first onset of hydrological changes (particularly changes toward encroaching tidal environments) across the lower Thames area during the Bronze Age and later.

Furthermore, across the Late East area there has been both direct and indirect evidence pointing toward anthropogenic activity. Direct evidence of human activity in terms of flint debitage has been found in the sands overlying the gravels (at North Woolwich) and analysed through soil micromorphology, plant macrofossil and lithic assessments to indicate a midden deposit dating to the Late Mesolithic. Much indirect evidence was discovered through the palaeo-environmental assessments - particularly through the pollen and plant macrofossil assessments - where cereal production and possible clearance activity was clearly noted throughout the later prehistoric / historic periods.

The pollen, diatom, ostracod, plant macrofossilwood assessment, lithics and soil micromorphology data have provided a wide range of both indirect and direct evidence for the nature of the changing environment and human interaction across all the site areas. Further work will involve deposit modelling primarily (drawing in more of the borehole data) which, when coupled with the data from the assessment, will provide a suitable basis for the envisaged 'popular book' publication.

9 Significance of the data

The data gathered and evidence preserved in the samples collected from the site should be regarded as having local significance in understanding the site area through the prehistoric to the medieval periods. The results already obtained have provided information that has significance for reconstructing how this landscape was utilised and exploited.

10 Publication project: aims and objectives

Revised research aims

The post-excavation report has highlighted new areas of research, which have led to the following revised research aims (RA):

RRA01: How do the deposits recorded across the site contribute to current models of the Thames floodplain evolution?

Preliminary publication synopsis

Crossrail popular book

The story of the lower Thames area is one that reflects the evolving environment of southern Britain over the last 18,000 years. Over this time, which stretches from the end of the last Ice Age to the modern day, climatic change has led to sea level change, changes in fauna and flora and the re-introduction of peoples back across the British Isles. In part, this story has been seen in the sites across the Late East area - the results of which, when coupled with the evidence from a selection of other sites locally, will be used as a vehicle to introduce this historic tale to the wider public.

Once a free flowing, freshwater river but now an essentially canalised tidal channel, the picture we see today of the Thames is one that is markedly different to that of the past. By linking the Late East sites to other sites in the area including some on the higher, drier land of the river terrace, we can track how evolution of the environment has affected the wider floodplain area and how people have exploited the landscape or suffered through periods of change.

The floodplain has always provided a rich resource, whether exploited by Mesolithic hunter-gatherers, agrarian-based settlers on the high ground later in prehistory, or historic populations. The archaeology provides evidence of human survival in difficult conditions as dry landscapes were gradually inundated. The story of the Late East area is not simply a story of the past but, in an era of rapid climate change, one relevant to the future.

Chapters will include an introduction or background to research locally, the history of relative sea-level rise, archaeological timescales and periods, how the sediments accumulated across the valley floor, the ways we investigate the sediments and how all this has affected (or indeed has been affected by) the peoples of different periods.

Illustrations will include: a deposit model representing the early Holocene or Mesolithic land surface and illustrations how this has changed over time; transects illustrating the stratigraphy across the site area; and images of differing specialist materials/subjects (eg diatoms, pollen, plant images).

Provisional title: The evolution of the lower Thames environment from the Mesolithic to the post medieval period

Format: Crossrail popular book series

Total word count: c 10,000 words

- Foreword
- Contents
- List of figures
- Summary
- Acknowledgements

- Introduction
- Background research
- The history of relative sea-level rise
- Archaeological timescales and periods
- Deposit modelling the lower Thames
- The upper Palaeolithic (late Ice Age Thames)
- The early prehistoric (Mesolithic to Neolithic)
- The later prehistoric (Bronze Age to Iron Age)
- The historic period (Roman to post-medieval periods)
- The future
- Bibliography

Medieval boat journal publication

The publication of the of the medieval boat (appendix) warrant a short article in an appropriate subject journal (eg International Journal Maritime Archaeology). The results of the on-site and detailed off-site recording will be graphically combined and compared with a selection of other medieval clinker vessel assemblages from the region.

Publication project: task sequence

All work carried out on this project is subject to the health and safety policy statement of MOLA as defined in Health And Safety Policy, MOLA 2015. This document is available on request. It is MOLA policy to comply with the requirements of the Health and Safety at Work Act 1974, the Management of Health and Safety at Work Regulations 1992 and all Regulations and Codes of Practice made under the Act which affect MOLA operations.

Geoarchaeological method statement

Crossrail popular book

Task 1 Plan and organise the layout and procedures involved / task dissemination

Task 2 Review all assessment data

Task 3 Select other published site material and collate

Task 4: Extract raw data from sites for revised deposit model / early Holocene surface

Task 5 Purchase of any additional borehole data needed

Task 6 Input to Rockworks and update results of local deposit model, create transects.

Task 7: Create early Holocene surface

Task 8 Prepare illustrations for including cross sections, surface plots, location plans

Task 9 Compile publication text on flint assemblage and overview from study area

Medieval article

Task 10 Research and compile short article on the medieval boat

Graphics method statement

Medieval article

Task 11 Production of illustrations

Crossrail popular book

Task 12 Preparation of artwork illustrations of period reconstruction images (x3)

Task 13: Production of site location plans, topographic plots, photographs, transects, sections

Task 14 Photography of selected flints and timbers

Publication text method statement

Task 15 Research into study area

Task 16 Compile publication text

Task 17 Select other figures (historic or contemporary images, historic maps) to illustrate report

Review and internal edit

Medieval article

Task 18 MOLA sign off draft to Crossrail

Crossrail popular book

Task 19 Managing Editors edit

Task 20 Authors revisions to text

Task 21 Revisions to figures/illustrations

Task 22 MOLA sign-off first draft to Crossrail

Production

Crossrail popular book

Based on 10,000 words and c 25 figures

Task 23 External copy edit

Task 24 Design, layout, typesetting and production management

Task 25 Picture research, rights and acquisition

Task 26 Purchase external images

Task 27 Managing Editors proof sign off

Archive

Task 28 Prepare site records for deposition with the designated repository

Project management method statement

Task 29: Oversee project and administration

Task 30 Project liaison with Crossrail for publication monthly meetings and progress reports

Publication project: tabulated resources

Financial resources sufficient to cover the work proposed in this document will be secured via a separate document.

The project has been divided into five stage of work and tasks required are set out in the table below.

Task no	Task description	days	person
	Stage 1		
	Geoarchaeological method statement		
	Crossrail popular book		
1	Plan and organise the layout and procedures involved / task dissemination.	1	GS
2	Review all assessment data	1	GS
3	Select other published site material and collate	5	GS
4	Extract raw data from sites for revised deposit model / early Holocene surface	1	GS
5	Purchase of any additional borehole data needed	1	GS

6	<i>Input to Rockworks and update results of local deposit model, create transects.</i>	5	GS
Task no	Task no	days	person
7	<i>Create early Holocene surface</i>	3	GS
8	<i>Prepare illustrations for including cross sections, surface plots, location plans</i>	5	GS
9	<i>Compile publication text on flint assemblage and overview from study area</i>	5	JC
	Medieval article		
10	<i>Research and compile short article on the medieval boat</i>	3	DG
	Stage 2		
	Graphics method statement		
	Medieval article		
11	<i>Production of illustrations</i>	1	DO
	Crossrail popular book		
12	<i>Preparation of artwork illustrations of period reconstruction images</i>	10	DO
13	<i>Production of site location plans, topographic plots, photographs, transects, sections</i>	5	DO
14	<i>Photography of selected flints and timbers</i>	1	PHOTO
	Stage 3		
	Publication text method statement		
15	<i>Research into study area</i>	5	GS
16	<i>Compile publication text</i>	25	GS
17	<i>Select other figures (historic or contemporary images, historic maps) to illustrate report</i>	3	GS
	Stage 4		
	Review and internal edit		
	Medieval article		
18	<i>MOLA sign off draft to Crossrail</i>	1	DB
	Crossrail popular book		
19	<i>Managing Editors edit</i>	2	ME
20	<i>Authors revisions to text</i>	1	GS
221	<i>Revisions to figures/illustrations</i>	1	DO
22	<i>MOLA sign-off first draft to Crossrail</i>	1	DB
	Stage 5		
	Production		
	Crossrail popular book		
	Based on 10,000 words and c 25 figures		
23	<i>External copy edit</i>	EXT	CE
24	<i>Design, layout, typesetting and production management</i>	10	TW
25	<i>Picture research, rights and acquisition</i>	2	TW
26	<i>Purchase external images</i>	EXT	
27	<i>Contributors sign off</i>	GA	1
28	<i>Managing Editors proof sign off</i>	1	ME
	Archive		
29	<i>Prepare site records for deposition with the designated repository</i>	2	KT
	Project management method statement		
30	<i>Oversee project and administration</i>	5	DB
31	<i>Project liaison with Crossrail for publication monthly meetings and progress reports</i>	2	DB

Key to staffing

GA Graham Spurr
 JC Jon Cotton (external)

DG	Damian Goodburn
DO	Drawing office
PHOTO	Andy Chopping/Maggie Cox
DB	David Bowsher
ME	Sue Wright/Sue Hirst
CE	Copy Editor (external)
TW	Tracy Wellman
EXT	Third party contract
KT	Karen Thomas

11 Acknowledgements

The fieldwork was commissioned and managed for Crossrail by Iain Williamson and Jay Carver.

12 NMR Oasis archaeological report form

OASIS ID: molas1-211317

Project details

Project name	C263 Archaeology Late East
Short description of the project	This report is intended to provide an assessment and updated project design for the archaeological excavations and watching briefs took place at a series of six sites across the Crossrail Late East work area (site codes: XRW10; XSW11; XTI13; XSY11; XSV11 and XSW11). Situated across the wider Thames floodplain, all sites analysed were radiocarbon dated variously from the Late Mesolithic and the Neolithic periods through to the Bronze Age. Typically from the Late Mesolithic, pollen data indicated the area was dominated by oak and hazel woodland on the higher, drier ground, with alder carr (damp woodland) on the floodplain which formed thick peat deposits across nearly all sites. In the late Neolithic/early Bronze Age however, pollen and diatom evidence pointed toward an increasingly saline/open salt marsh environment developing which covered the peats under slowly accreting alluvial deposits up until the post medieval period. Much indirect evidence was discovered through the palaeo-environmental assessments - particularly through the pollen and plant macrofossil assessments - where cereal production and possible clearance activity was clearly noted throughout the later prehistoric/historic periods.
Project dates	Start: 01-01-2012 End: 01-01-2015
Previous/future work	Not known / Not known
Any associated project reference codes	C263 Archaeology Late East - Sitecode
Type of project	Environmental assessment
Site status	None
Current Land use	Industry and Commerce 1 - Industrial
Monument type	WATERFRONT Uncertain

Project location

Country	England
Site location	GREATER LONDON NEWHAM BOW C263 Archaeology Late East
Postcode	E16
Study area	10.00 Kilometres
Site coordinates	TQ 541058 180896 50.9410505238 0.193734569508 50 56 27 N 000 11 37 E Point
Height OD / Depth	Min: -2.81m Max: 1.05m

Project creators

Name of Organisation	MOLA
Project brief originator	Crossrail
Project design	MOLA

originator

Project director/manager David Bowsher

Project supervisor Graham Spurr

Type of sponsor/funding body Crossrail Ltd

Project archives

Physical Archive Exists? No

Digital Archive Exists? No

Paper Archive Exists? No

Project bibliography

1

Publication type Grey literature (unpublished document/manuscript)

Title Post-excavation assessment and updated project design Limmo Peninsula (XRW10), Victoria Dock Portal (XSX11), Custom House (XTI13), Connaught Tunnel (XSY11), North Woolwich Portal (XSV11) and Plumstead and Plumstead Portal and Depot (XSW11) (CRL12)

Author(s)/Editor(s) Spurr, G.

Date 2015

Issuer or publisher MOLA

Place of issue or publication MOLA

Description Grey literature (unpublished document/manuscript)

Entered by G.Spurr (gspurr@mola.org.uk)

Entered on 15 May 2015

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14 Appendix 1: Sample tables

Site Code	Height (mOD)	Height (m ATD)	Sample Code	Context	Monolith/Bulk Sample number
XRW10	-1.96	98.04	P1	83	33
XRW10	-2.10	97.9	P2	83	33
XRW10	-1.83	98.17	P3	82	34
XRW10	-2.05	97.95	P4	82	34
XSV11	-0.68	99.32	P1	3	3
XSV11	-1.13	98.87	P2	8	4
XSV11	-1.57	98.43	P3	9	15
XSV11	-1.89	98.11	P4	9	16
XSV11	-2.43	97.57	P5	19	31
XSV11	-2.53	97.47	P6	18	31
XSV11	-2.65	97.35	P7	17	31
XSV11	-2.81	97.19	P8	15	31
XSW11	0.7	100.7	P1	45	37
XSW11	0.6	100.6	P2	44	37
XSW11	0.04	100.2	P3	44	35
XSW11	0	100	P4	44	35
XSW11	-0.38	99.62	P5	44	35
XSW11	-0.45	99.55	P6	43	35
XSW11	-0.74	99.26	P7	43	34
XSW11	-0.8	99.2	P8	42	34
XSX11	-0.25	99.75	P1	9	20
XSX11	-0.78	99.22	P2	10	21
XSX11	-1.3	98.7	P3	11	30
XSX11	-1.93	98.07	P4	12	31
XSX11	-2.4	97.6	P5	13	39
XSX11	-2.73	97.27	P6	13	40
XSX11	-3.18	96.82	P7	14	46
XSX11	-3.4	96.6	P8	15	46
XSY11(Tr3)	0.3	100.3	P9	25	45
XSY11(Tr3)	-0.16	99.84	P10	26	46
XSY11(Tr3)	-0.99	99.01	P11	27	49
XSY11(Tr3)	-1.09	98.91	P12	26	59
XSY11(Tr3)	-1.24	98.76	P13	28	49
XSY11(Tr3)	-1.99	98.01	P14	29	61
XSY11(Tr3)	-2.29	97.71	P15	30	62
XSY11(Tr3)	-2.92	97.08	P16	30	69
XSY11(Tr1)	1.05	101.05	P1	4	2
XSY11(Tr1)	0.85	100.85	P2	6	2
XSY11(Tr1)	0.30	100.3	P3	8	3
XSY11(Tr1)	0	100	P4	9	4
XSY11(Tr1)	-0.46	99.54	P5	10	5

Site Code	Height (mOD)	Height (m ATD)	Sample Code	Context	Monolith/Bulk Sample number
XS _Y 11(Tr1)	-0.9	99.1	P6	11	6
XS _Y 11(Tr1)	-1.42	98.58	P8	13	7

Table 35: Subsamples submitted for pollen assessment

Site Code	Height (mOD)	Height (m ATD)	Sample Code	Context	Monolith/Bulk Sample number
XRW10	-1.96	98.04	CR1	83	33
XRW10	-2.10	97.9	CR1B	83	33
XRW10	-1.83	98.17	CR2	82	34
XRW10	-2.05	97.95	CR3	82	34
XSV11	-0.68	99.32	CR8	3	3
XSV11	-1.13	98.87	CR9	8	4
XSV11	-1.57	98.43	CR10	9	15
XSV11	-1.89	98.11	CR11	9	16
XSV11	-2.43	97.57	CR12	19	31
XSV11	-2.53	97.47	CR13	18	31
XSV11	-2.65	97.35	CR14	17	31
XSV11	-2.81	97.19	CR15	15	31
XSW11	0.7	100.7	CR16	45	37
XSW11	0.6	100.6	CR17	44	37
XSW11	0.04	100.04	CR18	44	35
XSW11	-0.04	99.96	CR19	44	35
XSW11	-0.38	99.62	CR20	43	35
XSW11	-0.74	99.26	CR21	43	34
XSX11	-0.78	99.22	CR22	10	21
XSX11	-1.3	98.7	CR23	11	30
XSX11	-1.93	98.07	CR24	12	31
XSX11	-2.4	97.6	CR25	13	39
XS _Y 11(Tr3)	-0.99	99.01	CR26	27	49
XS _Y 11(Tr3)	-2.29	97.71	CR27	30	62
XS _Y 11(Tr3)	0.3	100.3	CR28	25	45
XS _Y 11(Tr3)	-1.24	98.76	CR29	28	49
XS _Y 11(Tr3)	-1.99	98.01	CR37	29	61
XS _Y 11(Tr3)	-2.92	97.08	CR30	30	69
XS _Y 11(Tr1)	1.05	101.05	CR31	4	2
XS _Y 11(Tr1)	0.85	100.85	CR32	6	2
XS _Y 11(Tr1)	0.30	100.3	CR33	8	3
XS _Y 11(Tr1)	-0.46	99.54	CR34	10	5
XS _Y 11(Tr1)	-0.9	99.1	CR35	11	6
XS _Y 11(Tr1)	-1.1	98.9	CR36	12	7

Table 36: Subsamples submitted for diatom assessment

Site Code	Height (mOD)	Height (mATD)	Sample number	Context
XSW11	0	100	O1	44
XSW11	-0.8	99.2	O2	42
XSX11	-0.25	99.75	O1	9
XSX11	-2.73	97.27	O2	13
XSX11	-3.18	96.82	O3	14
XSX11	-3.4	96.6	O4	15
XSX11 (Tr1)	0.3	100.3	O1	8
XSX11(Tr 1)	-1.42	98.58	O2	13
XSX11 (Tr 3)	-0.16	99.84	O3	26
XSX11 (Tr 3)	-1.09	98.91	O4	28

Table 37: Subsamples submitted for ostracod assessment

Site Code	Sample Code	Monolith/Bulk Sample number	Context
XSV11	XSV/3/15/9	15	9
XSV11	XSV/2/59/32	59	32
XSV11	XSV/3/5/3	5	3
XSV11	XSV/3/17/8	17	8
XSW11	XSW/1a/4/2	4	2
XSW11	XSW/1a/3/2	3	2
XSW11	XSW/1b/16/7	16	7
XSX11	XSX/2/40/13	40	13
XSX11	XSX/2/29/11	29	11
XSX11	XSX/2/44/12	44	12
XSX11(Tr1)	XSX/1/6/11	6	11
XSX11(Tr1)	XSX/1/6/12	6	12
XSX11(Tr1)	XSX/1/7/12	7	12
XSX11(Tr3)	XSX/3/57/27	57	27
XSX11(Tr3)	XSX/3/61/28	61	28
XSX11(Tr3)	XSX/3/68/30	68	30
XTI13(WS1)	XTI13WS1-202	-	15
XTI13(WS1)	XTI13WS1-240	-	-
XTI13(WS1)	XTI13WS1-265	-	-

Table 38: Subsamples submitted for radiocarbon dating

Site	Context	Sample
XSV11	3	5
XSV11	8	7
XSV11	8	8
XSV11	8	17
XSV11	9	19
XSV11	9	20
XSV11	9	22
XSV11	11	14
XSV11	14	30
XSV11	15	32
XSV11	15	33
XSV11	15	34
XSV11	15	35
XSV11	15	36
XSV11	15	37
XSV11	15	38
XSV11	15	39
XSV11	15	40
XSV11	15	41
XSV11	15	42
XSV11	15	43
XSV11	15	44
XSV11	16	28
XSV11	17	45
XSV11	32	66
XSV11	32	67
XSV11	32	68
XSV11	32	69
XSW11	1	2
XSW11	2	3
XSW11	2	4
XSW11	4	8
XSW11	4	9
XSW11	5	10
XSW11	5	11
XSW11	5	12
XSW11	7	16
XSW11	8	15
XSX11	9	23
XSX11	9	25
XSX11	9	26
XSX11	10	27
XSX11	10	28
XSX11	11	29
XSX11	11	32

XSX11	11	34
XSX11	12	35
XSX11	12	38
XSX11	12	43
XSX11	12	44
XSX11	13	45
XSX11	14	47
XSX11	14	48
XSX11	26	50
XSX11	26	51
XSX11	26	52
XSX11	26	53
XSX11	26	54
XSX11	26	55
XSX11	27	56
XSX11	27	57
XSX11	28	58
XSX11	29	63
XSX11	29	64
XSX11	29	65
XSX11	30	66
XSX11	30	67
XSX11	30	68

Table 39: Plant macrofossil samples from XSX11; XSX11; XSX11 and XSX11.

15 Appendix 2: Lithics report

Jon Cotton

Introduction

In all 155 pieces of struck flint and 11 fragments of burnt unworked flint were presented for assessment (Tables 1 and 2). Closer examination showed that these comprised two separate groups of material principally recovered from contexts [11] and [15] – a series of sandy gley soil horizons sealed by peats.

A majority of the flints were hand excavated, although they also include a small number of pieces later recovered during wet sieving. In addition, a single piece of struck flint was recovered by hand from context [13] and a further piece from wet sieving of [14].

Characterisation of the lithic assemblages

Twenty-five pieces of struck flint were recovered from contexts [11a] and [11b], together with a further six from wet-sieving. The assemblage is dominated by debitage (flint waste) in the form of several partially worked flint cobbles, flakes/spalls, flake fragments and a number of blades and narrow flakes/blades. Diagnostic pieces are few but include part of a broken pyramidal bladelet core, and a single obliquely-backed basally-retouched point of 'Horsham' type (Clark 1934, class F), both from context [11b]. Horsham points are generally interpreted as flint armatures attached to wooden arrow-shafts and date to the late Early Mesolithic period (c 9000 – 8500 BP). A small number of burnt unworked flints hint at the presence of a hearth somewhere in the vicinity.

The second, larger, assemblage comprises 122 pieces of struck flint recovered from an area around 25 sq m in area (context [15]). This scatter is also dominated by debitage – principally tertiary flakes (some large and irregular in shape) alongside a few parallel-sided blades and fragments. As with the first assemblage there are only a couple of diagnostic pieces, comprising a single opposed-platform core expediently worked on a robust flake struck from a flint cobble, and a broken straight backed piece of possibly Later Mesolithic narrow blade type (c 8500 – 6000 BP) (Clark 1934, class B). The virtual absence of retouched pieces, and the size and irregularity of many of the flakes, suggests the expedient reduction of one or more river cobbles subsequently carried elsewhere for further reduction.

Cxt No	Flake (frag)	Blade (frag)	Flake/Blade (frag)	Spall	Core (frag)	Nod shatter	Other	Total
11a	2			1	(1) pwc		1 ?burin spall	5
11b	2 (4)	4	3	4	(1)	1	1 basally retouched piece	20
11 <14>	2		2 (1)	1				6
13			1					1
14 <30>	1							1
15	64 (25)	5 (7)	7 (1)	5	1 3 pwc	2	1 crested piece 1 straight backed piece	122
Total	71 (29)	9 (7)	13 (2)	11	4 (2)	3	4	155

Table 40 Struck flint, all contexts

Cxt No	Nos clasts	Wt (g)
11a	8	115.1
11b	1	3.4
13	1	6.5
15	1	4.9
Total	11	129.9

*Table 41 Burnt unworked flint, all contexts**Raw material and condition*

The raw material comprises cobbles of nodular flint of reasonable quality likely to have come from the local river gravels. The surviving surface cortex is thin and smooth and buff/off-white in colour; the flint a mottled grey/brown with darker staining. Edges are well preserved and feather sharp in most cases suggesting that the material is unlikely to have suffered much post-depositional disturbance.

Dating and affinities

The assemblage is dominated by fresh tertiary flakes with both plain and faceted platforms, a few of the latter bearing traces of abrasion – an indication of careful platform preparation. True, parallel-sided blades are few (one plunging example is >60mm in length), though there are a number of narrow flakes/blades. The two retouched pieces – a single Horsham point from context [11b] and a broken straight-backed piece from context [15] – suggest that both assemblages could be of Mesolithic date. Broad confirmation is furnished by the late Neolithic radiocarbon date of 2435-2150 cal BC (Beta-407270) from the overlying peat horizon, context [9].

Potential for further work

The small size of the two lithic assemblages limits the potential for further work. However, their association with other geoarchaeological data, in particular the soil micromorphology, makes them a useful addition to the sub-regional picture. A short report on the material based on this assessment ought to be prepared for incorporation in the published report, and the diagnostic flints illustrated.

Significance of the data

The small size of the two assemblages, together with the paucity of retouched pieces, limits their significance. However, the fresh condition and the tight distribution of at least one of the two assemblages within the soil horizon (ie that lying within context [15]) suggests that it could represent a single, short-lived and more or less *in situ* knapping episode sealed beneath Late Neolithic peats. The presence of unworked burnt flint and traces of charcoal may also indicate the presence of other anthropogenic activity connected with the use of hearths and/or the firing of the local vegetation. As such the data from XSV11 furnishes another strand in a complex web of human activity that was taking place within the dynamic Thames floodplain in the early-mid Holocene. Comparable fugitive evidence has been identified elsewhere within the local Thames floodplain and beyond (eg Stafford 2012, 116; Powell and Leivers 2012, 24-7, Sidell et al 2002, Lewis and Rackham 2011).

16 Appendix 3: Soil micromorphology images

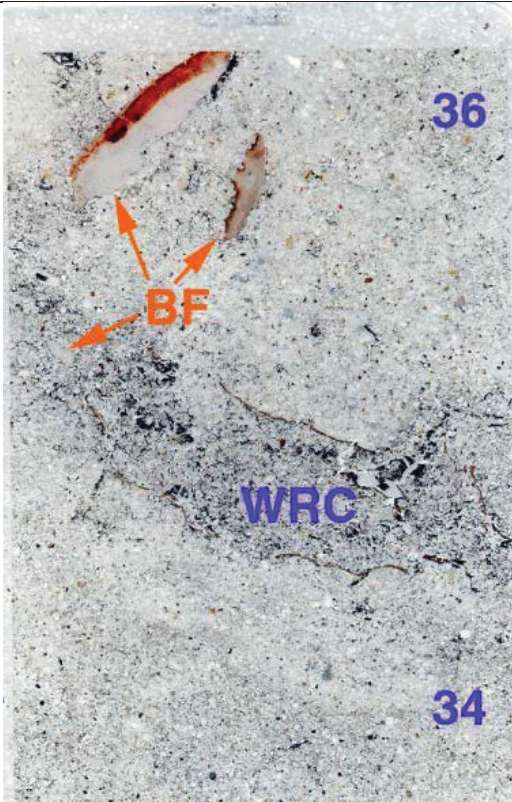


Photo 1 Scan of M63, with Context 36

humic midden with burned flint', separated by a woody root channel (WRC), from underlying Context 34 'humic sands'. Note burned flint (BF) occurs both in layer 36 and within the root channel disturbance. Frame width is ~50mm.

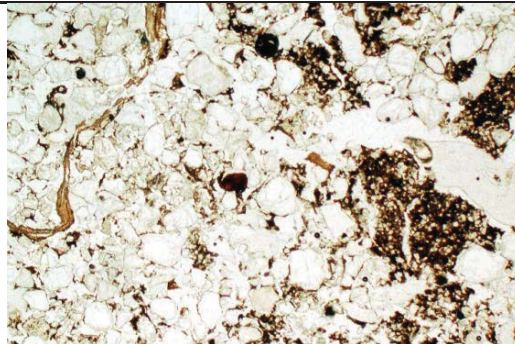


Photo 2 Photomicrograph of woody root channel disturbance in M63; woody root remains occur, and some voids are infilled with humic silts. Plane polarised light (PPL), frame width is ~4.62mm.

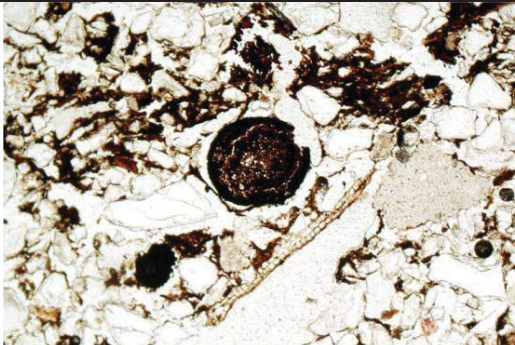


Photo 3 Photomicrograph of woody root channel disturbance in M63; silty humic soil-sediment and fungal sclerotium (centre). PPL, frame width is ~2.38mm.

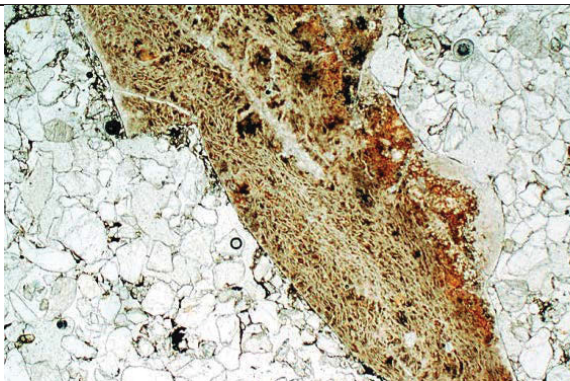


Photo 4 Photomicrograph of M63 (Context 36); calcined and slightly rubefied fire cracked flint fragment. Note very poorly humic fine and medium Thames River sands. PPL, frame width is ~4.62mm.

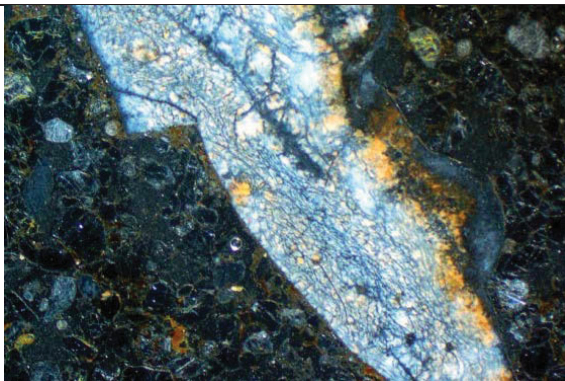


Photo 5 As photo 4, under oblique incident light (OIL); note fissuring in flint.

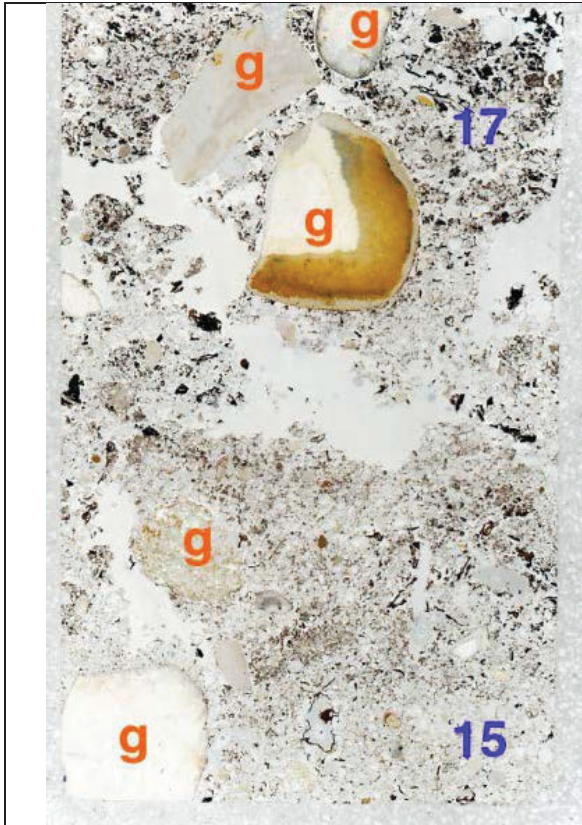


Photo 6 Scan of M31;
Diffuse rooted boundary between Contexts 15 ('Sand and gravel') and 17 ('peaty sand'), which also includes much gravel (g) at this level. Frame width is ~50mm.

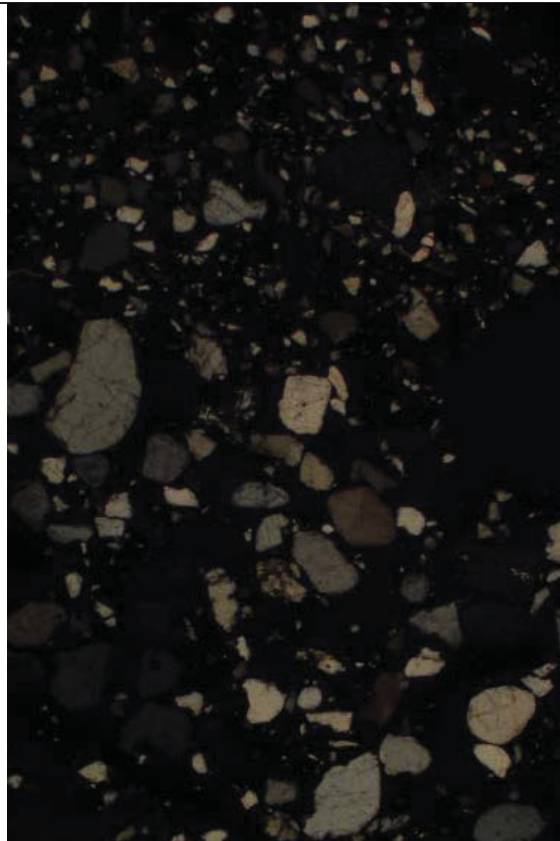


Photo 7 Photomicrograph of M31, Context 15
Sands – with channel fill of coarse silts. Crossed polarised light (XPL), frame height is ~4.62mm.



Photo 8 Photomicrograph of M31, Context 17;
Peaty sandy soil, with charred monocotyledonous (? arrowed) material. PPL, frame width is ~4.62mm.

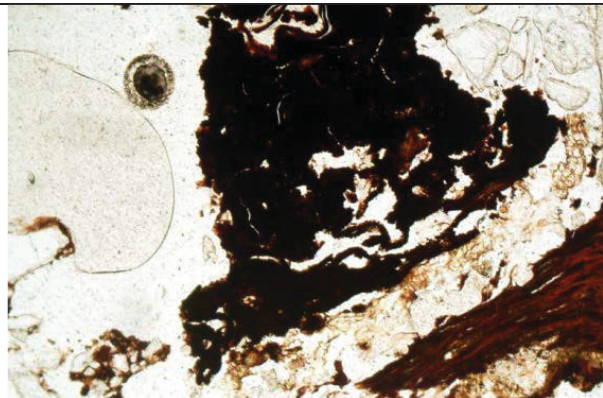


Photo 9 Photomicrograph of M31, Context 17;
Weakly ferruginised amorphous peat and possible woody root remains. PPL, frame width is ~2.38mm.

17 Appendix 4: Worked and charred prehistoric wood

Background

Prehistoric woodwork very rarely survives in Britain except in a few dispersed areas, some very localised and others larger zones such as the banks of the Thames Estuary. This means that there is a clear responsibility to investigate the material in detail to fill out a broader understanding of prehistoric life in Britain otherwise dominated by worked stone, a little pottery and monumental structures. The flood plain east of the City of London is latterly well known for its waterlogged prehistoric deposits. In these deposits a range of prehistoric structures of worked roundwood and timber have been found, mostly of the Bronze Age period. These structures occurred mainly in peat and clay silt deposits. The wooden structures are better known from the north side of the inner estuary of the Thames with a number of detailed records having been made and published from the Barking area and along side the A13 in particular (Meddens 1996, Stafford and Goodburn et al 2012). Prehistoric worked wood found includes, trackways, platforms, bridges, fences, possible building wall bases, portable objects, and areas of cut woodland in situ. However, these deposits are also well documented as containing naturally fallen trees and wood fragments, sometimes water sorted and often decayed. A small amount of prehistoric beaver cut wood and a beaver dam have also been found at Barking, that was initially mistaken for a trackway before detailed examination.

A smaller quantity of prehistoric worked wood and timber structures has also been found on the south side of the river east of the historic core of London. Several small scale studies have shown that material similar to that found to the north is also to be expected south of the current course of Thames. An example of this would be the Bronze Age wattle trackway and portable worked wood found at Erith Bronze Age Way just a little to the east of the XSW11 site and more recent discoveries at Bellmarsh (Bennell 1998).

Typically wetland woodland seems to have colonised areas of the flood plain when the water levels were low enough only to be drowned and killed by rising water levels at certain periods. Large trees so effected decayed slowly and sometimes whole groups of trees were blown over together by prehistoric storms to be preserved in the increasingly saturated deposits. The upper faces of lying logs were effected by extra decay, not being continually waterlogged which, combined with compression, often gives the appearance of having been flattened somewhat possibly by human action. When trees or boughs fall they may split or cause adjacent trees to split creating cleft surfaces resembling those made by deliberate human splitting, such as that needed for half logs for trackways etc. In wetlands these falling boughs can even sometimes embed themselves in surrounding soft deposits and give the appearance of having been humanly driven timbers, as was the case at this excavation which provided initial confusion, prior to careful exposure. These complicating factors mean that all worked and 'possibly worked' wood from excavations such as this are worthy of detailed examination.

Quantification and recording

A total of 16 double wrapped items were retained for examination. This material was cleaned and examined in good raking light for cut marks or other signs of ancient working. Some of the material was wood sp ID samples which were listed, reduced to manageable size and rebagged. Others sections of timbers or whole pieces of roundwood were examined thoroughly for working traces and natural shaping. Those naturally shaped, or probably naturally shaped by tree fall, differential decay etc, were recorded on pro forma Timber context sheets. Whilst the human-worked items were drawn to scale and recorded in full on Timber context sheets, with one half log [36] being reserved for detailed photography prior to discard. All the material was provided with a wood sp Id or tree ring samples which can also double as a C14 sample.

Summary

Site photographs of wooden uprights, set c 3m apart, being excavated in box sections were examined. Initially, the timbers appeared candidates for possible bridge piles, resembling those found during the A13 project but later were recognised as natural wood.

What appears to have been a possible plank-like cleft timber stake during the excavation, timber [10] was closely examined and found to be a fragment of wind torn timber from a large tree (probably alder). The section comprised a thin tapering and torn slice of sapwood and thick bark up to 240mm wide by up to 80mm thick and 0.75m long. It tapered to a feathered edge tip of sapwood and bark, with no cut marks visible. This was clearly a naturally shaped item.

However, lifted half log end [36], considered to be Alder, was not naturally broken but had one neatly bevelled end left from either cross cutting ('bucking') or felling with a metal axe. It was found set on its bark face with the flatter cleft side uppermost and had been c. 3m long as exposed on-site (PA Pers Com). The lifted section was 0.21m long by 175 mm wide and compressed down to c. 90mm thick. The smooth cut end was on the underside as found and had been heavily compressed by the overburden weight. However, very faint axe stop marks could be seen and traces of the uncut 'hinge' left at the end of cutting the original two, opposed 'V' cuts. The timber appeared to have been the end of a log, axe cut to length and then split in half. Initially, it seemed to bear faint traces of charring on the upper face but that proved uncertain after washing. Such a cleft and trimmed log could have had many uses, with use in a trackway or platform being the most likely. This lifted log end was drawn, sampled and set aside for further photography of the cut end. Like most of the material lifted it was soft, very fragile and had been pierced by later plant roots as is typical of much London prehistoric wetland woodwork.

A section of partially decayed, oak roundwood [37] was found in a near vertical position, apparently used as a stake. It was also found to have traces of working of a kind. The tip may have been roughly cross cut with an axe and was certainly charred leaving a blunt point. Although decayed it would appear that the stake had been made from a roughly cleft section of a small oak log where just over half the log was used. It survived 0.25m long by 80mm by 60mm.

It is possible that other horizontal logs found (eg [34]) may also have been worked but no clear worked surfaces were found on them off site.

Significance of the material

In sum, from the lifted woodworking evidence there is clear evidence of human activity in the area examined but it appears to have been low key. Perhaps the worked timbers were vestiges of something like a temporary platform used during hunting or foraging trips into the wet carr type woodland. Unfortunately the tool mark survival is too limited to suggest a broad dating on technological grounds, except to note that it must date to the broad period from the Early Bronze Age to Iron Age. However, as most of the London wetland woodwork found in these types of context has been of Bronze Age date this must be the most likely date bracket. Geo-archaeological assessment and C14 dating of relevant deposits has shown that the woodwork is of Middle Bronze Age date.

The very small size of the assemblage and its simple level of working indicate that it is of modest significance, that is, it is locally important only compared with other published material of similar date from the region.

18 Appendix 5: medieval boat hull assessment

Introduction

The historic organic bounty of the River Lea Valley

The location of this archaeological work, carried out ahead of Crossrail construction works, lay close to the modern confluence of the River Lea and the Tidal Thames. This area is essentially part of the inner estuary system of the Thames and its tributaries. The area lies at the estuarine end of what amounted to a delta at the southern end of the tidal river Lea (or Lee). This river lay outside the historic core of the City of London and Southwark to the east, but is well known as an important artery of trade to and from the City from later Medieval times onward, if not earlier. Importantly the river carried barges with essential goods to sustain medieval and early post-medieval London, particularly malt for making ale.

A long series of excavations in this area have demonstrated the richness of the Lea Valley zone in terms of a variety of preserved historic waterlogged woodwork, from prehistory to the early industrial period.

Terms of reference of this summary assessment report

This report provides a summary of the work carried out to record and sample the medieval boat remains, and a brief, preliminary discussion of their significance and wider importance for further analysis leading to a targeted publication. This contribution briefly summarises the woodworking details of the hull section such as, species used, methods of working, fastening and waterproofing etc. The possible origin of the hull section is also considered briefly and initial comment is made as to the type of vessel that the fragments may have derived from.

Methodology

The works programme required observation of controlled machine excavation of the alluvial deposits in this part of the site. During this work a mechanical excavator exposed the edge of the timbers discussed here. Machine excavation was halted and the last 200mm of overlying alluvial deposits were removed by hand over the clearly old blackened oak timbers. The timbers were found to be partially overlapping at their edges where they were fastened with iron rivets. These features were immediately recognised as diagnostic of an early clinker-built vessel.

The articulated hull section was found lying steeply sloping with the uppermost parts at 96.35m ATD (-3.65m OD), against the northern limit of excavation, whilst the disturbed southern end lay 0.5m lower at 95.83m ATD (-4.17m OD). The dating of the timbers to the 13th century would suggest that the general occupation level or height of the adjacent sea walls would have been between +102.0- 1022.5m ATD. This is based on recent findings along the Thames in the region (such as excavations on the City waterfront and the east Greenwich tide mill built just before 1200 AD) and a reappraisal of archaeological and documentary evidence found earlier (Goodburn and Davis 2010). This updated tidal information indicates that though the timbers were buried deeply in alluvial deposits it is likely that the upper parts may have been briefly accessible at low spring tides. This could have meant that the highest elements of articulated structure such as, other boards or framing timbers might have been salvaged as were some removable parts of the Blackfriars No. 3 boat which sunk about 1400 AD and was found at similar depth. No other timbers such as revetment piles were found in the vicinity.

On-site recording

A detailed plan of the slab of hull timbers was made at a scale of 1:10 by the site team which characterised the main features of the hull remains. Following this work the slab of planking was carefully undermined, cut through at the limit of excavation and slid on to a plywood bearer, with a layer of underlying sediment underneath it. The uppermost face as found was what would have been internal ('inboard') in the parent boat or ship, as could be seen from the location of the washer plates or 'roves' which were used on the inboard ends of the rivets. The timbers and support were then wrapped and brought to MOLA facilities for further cleaning and detailed recording.

The site plans were checked and the slab of planking carefully inverted. The underlying, mainly sandy, alluvial deposits were gently removed and the surfaces washed. This outboard face was then drawn in detail at 1:10 and a cross section prepared. Notes and photographs were also taken of constructional details. Slice samples were then taken of accessible sections of the boards for tree-ring studies and dating. Samples of the tarred animal hair waterproofing used in the laps was also taken for species identification and another for C14 dating. This work was broadly in line with guidelines in the Museum of London Archaeological Site Manual woodwork recording section and English Heritage Guidelines on Waterlogged Wood (Brunning 1996).

Dating the timbers

It was immediately apparent that on technological grounds, such as the form of rove nails used and way the oak planking was made the hull remains were almost certainly dated to the later medieval period ie c 1100–1550 AD, and a tentative estimate of c 14th century was suggested. Several of the oak boards had c 50 annual rings or more and some sapwood and so were viable for tree-ring dating. Five sample slices were taken and three proved potentially matchable but unfortunately none could be dated, even though one sample had 114 annual rings. Due to this a sample of the tarred hair waterproofing material was sent for C14 dating. This produced a C14 calibrated date range of c 1223–90. As the hull boards were heavily worn and repaired before deposition we can suggest that this took place between the mid 13th and early 14th centuries.

Results

Waterfront archaeology in the London region, ship and boat finds and reused nautical timbers

The archaeology of the historic port of London has been systematically investigated over the last 40 years producing evidence of waterfront structures and how they changed through time. These structures include; river walls, quay fronts, dock inlets, jetties, bridges, slip-ways, warehouses, tide mills and more rarely watercraft or reused or abandoned parts of vessels. Sections of clinker planking have been found reused as shuttering in revetment type features such as riverwall, wharf frontages, and timber lined drains. Although finding sections of vessel hull, largely complete hulls or reused boat and ship timbers are not every day occurrences, a substantial corpus of evidence has been gathered for the medieval period in the London region, other parts of Britain and the near by parts of NW Europe to provide some comparative evidence. This corpus of actual timbers and detailed records have been studied by several nautical archaeologists, including this writer (Goodburn 1991, Marsden 1996, Goodburn 2002) and some features of planked boat and ship construction in the region, are now well defined.

Clinker style construction was introduced to England by Germanic settlers coming from the east. The technique involves assembling a hull of partially overlapping boards most often riveted together along the overlaps. Into the hull shell of boards frame timbers were then inserted. The earliest dated evidence from England of the system of planked boat building, found so far, dates to the end of the 6th century AD and developed forms of the basic building technique are still occasionally used right up to the present day. However, there have been many detailed changes over the 1400 years or so of its use, and also variations linked to the use and status of the vessel.

Boat finds and nautical timbers from the Lea Valley specifically

Civil engineering works and archaeology projects have revealed a small number of finds of near complete boats and barges dating from the early 20th century at Waltham Abbey gunpowder works, back to late Saxon times at Clapton park. These comprise several small dugout boats of early medieval date, two capsized clinker built barges of early post-medieval date, a Georgian period rowing boat and several gunpowder punts of around 1900. Reused nautical timbers found were previously all post-medieval in date comprising sections of 'westcountry-style' barge hull and parts of larger 'carvel-built' vessels. No other fragments of medieval plank built craft have previously been found which is surprising in such a large waterlogged zone.

(Also note the early 19th-century small boat fragments found at this Crossrail site near the Thames Iron Works slip way and covered in a separate assessment report- Goodburn 2013).

The basic features of the medieval clinker boat hull structure

The lifted section of articulated clinker vessel side [79], totalled 1.65m long by 0.94 m wide but it is clear that originally the hull section was both longer and wider. It comprises parts of five courses or 'strakes' of planking, with two end to end or scarf joints and one repair patch or 'tingle'. The oak hull boards were all heavily worn in board and outboard showing the vessel had been used for some time before it ended up in the alluvial deposits in the Lea mouth area.

It is clear that the boards and repair tingle were of oak and had all been made by being radially cleft and axe trimmed to a maximum thickness of c 25mm. The over laps or 'lands' were waterproofed ('luted') with rolls of tarred animal hair and the scarf joints with a matt of similar material. Only inside one of the scarf joints did faint axe marks survive. The direction of the two thru-splayed scarf joints shows that the section was part of the starboard side of the parent vessel towards the bow. The scarves were almost always cut to open backwards on the outboard hull. The position of three original frame timbers was indicated by the presence of empty holes for the special wooden pegs or 'treenails' that were used for fastening them. These would have been set on centres c.0.40 to 0.45m apart. Most of the treenail holes were only c. 20mm in diameter, ie relatively small. Some slightly larger treenail holes were also found and may indicate repair of the framing.

Two features showed that the parent vessel was originally very cheaply built and used until it was worn out. Firstly, in much of the original planking a great deal of sapwood had been left on the edges, more than other medieval clinker hull planking from London. This would have resulted in weak rot prone plank edges. Secondly, one of the original boards was worn all the way through and replaced by a very poorly fitted repair tingle that was very lightly fastened, risking rapid leaking with the slightest damage. This probably means that the boat was only used in very sheltered conditions of the river Lea rather than the lower Thames estuary or beyond at the time.

The parent boat appears to have been of modest size perhaps it was a small barge or fishing vessel? The c 20mm diameter treenails used to fasten in what would have been lower, original frame timbers in the parent vessel are of small size and probably indicate she was a boat rather than a small cargo barge

The evidence recorded is not totally clear on whether this section of hull side was part of a damaged and dispersed wreck, displaced from an abandoned hulked vessel or had been washed out of a riverside revetment where it had been re used as shuttering. The latter possibility is perhaps the most likely as the treenail holes were all empty, the planking that would have been lowest in the boat was found lying highest and no frame timbers were found.

Conclusions

These remains though small have been recorded in detail and capable of more study and publication to shed light on the construction of smaller medieval clinker built vessels in the Thames/ Lea region. They are atypical in the amount of sapwood left on the edges of the boards which may indicate quite lowly origins for the craft. The remains can be compared with other examples of clinker boat hull finds from the region to better understand their likely status and function of the parent vessel. This section of hull also starts to fill out the evidence for the range of vessels now documented archaeologically from the Lea Valley currently covering the last 1000 years and a range of quite different building techniques from dugout boats, through clinker built craft and 'west country' style barges to large carvel built ships.

This small hull section is certainly locally and regionally important. Nationally the remains of smaller clinker planked vessels of this period are rather less common than the remains of larger vessels.

Although a small hull section the detailed recording allows it to be compared with other finds including more complete vessel remains from the period to gain a better grasp of what the parent vessel was and how distinctive features of its construction were. It is already clear that its insubstantial repair also provides insights into aspects of its use and how it was valued by its owners. It is also clear that crew safety was a low priority late in the life of the craft. Finally, although boats, barges and even ships were key parts of the past of the River Lea , particularly its lower reaches, relatively little has been published on this evidence.

Fig 1 Site location

Fig 2 Site and intervention locations

Fig 3 XRW10 Limmo Peninsula assessed section: Sections 5 and 6 auxiliary shaft

Fig 4 XSX11 Victoria Dock Portal assessed section: Trench 2 north facing

Fig 5 XSY11 Connaught Tunnel assessed section: Trench 1 south facing

Fig 6 XSY11 Connaught Tunnel assessed section: Trench 3 south facing

Fig 7 XSV11 North Woolwich Portal assessed section Trench 2 south facing

Fig 8 XSV11 North Woolwich Portal assessed section: Trench 3 south facing

Fig 9 XSV11 North Woolwich Portal assessed section: Trench 4 south facing

Fig 10 XSW11 Plumstead Portal assessed section: Trench 2 north facing

Fig 11 XRW10 Limmo Peninsula pollen diagram

Fig 12 XSX11 Victoria Dock Portal pollen diagram

Fig 13 XSY11 Connaught Trench 1 pollen diagram

Fig 14 XSY11 Connaught Trench 3 pollen diagram

Fig 15 XSV11 North Woolwich Portal pollen diagram

Fig 16 XSW11 Plumstead Portal pollen diagram

Fig 17 Early Holocene surface

Fig 18 Early Holocene surface (insets)

Fig 19 West to east transect

Fig 20 Proposed study area for publication

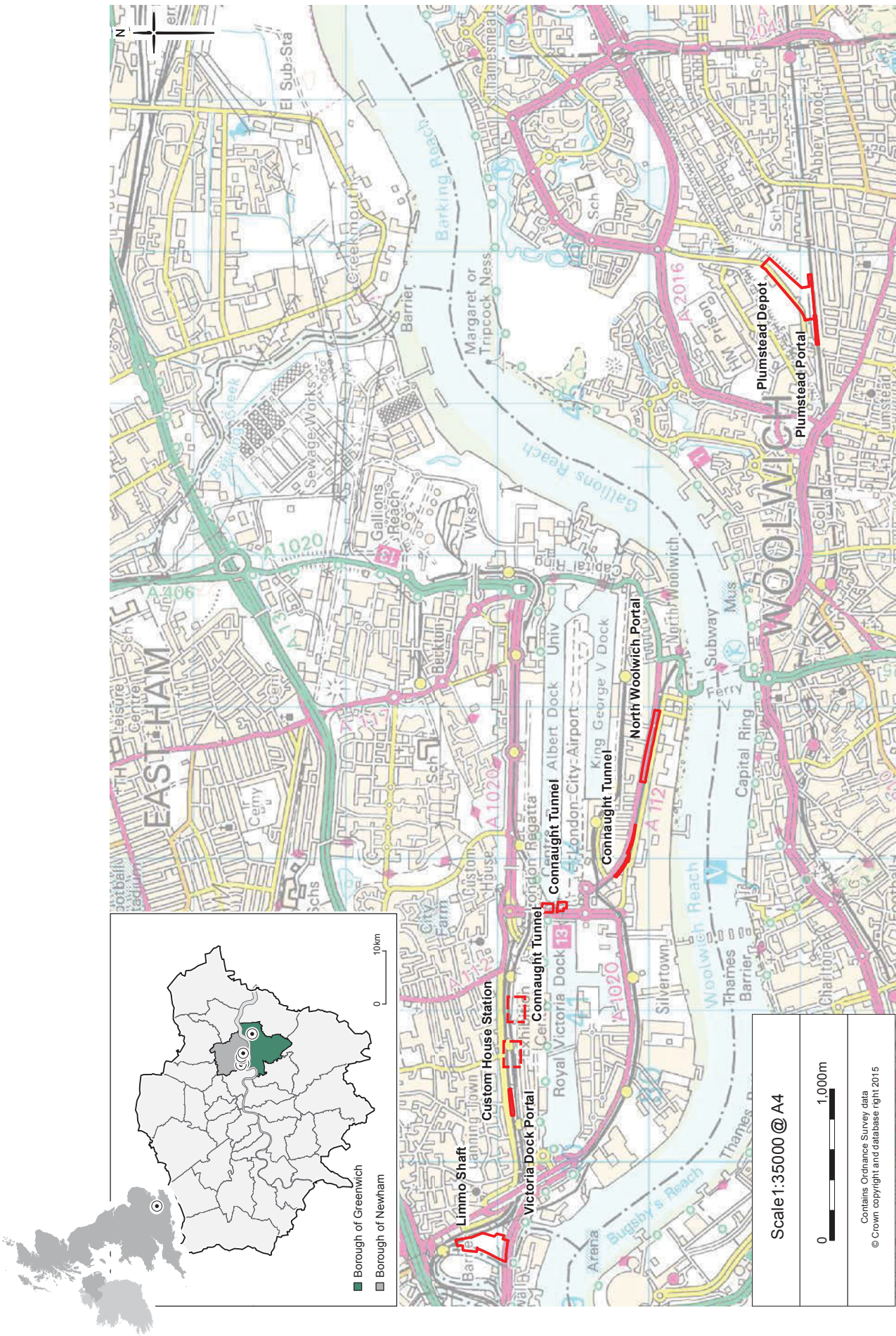


Fig 1 Site location

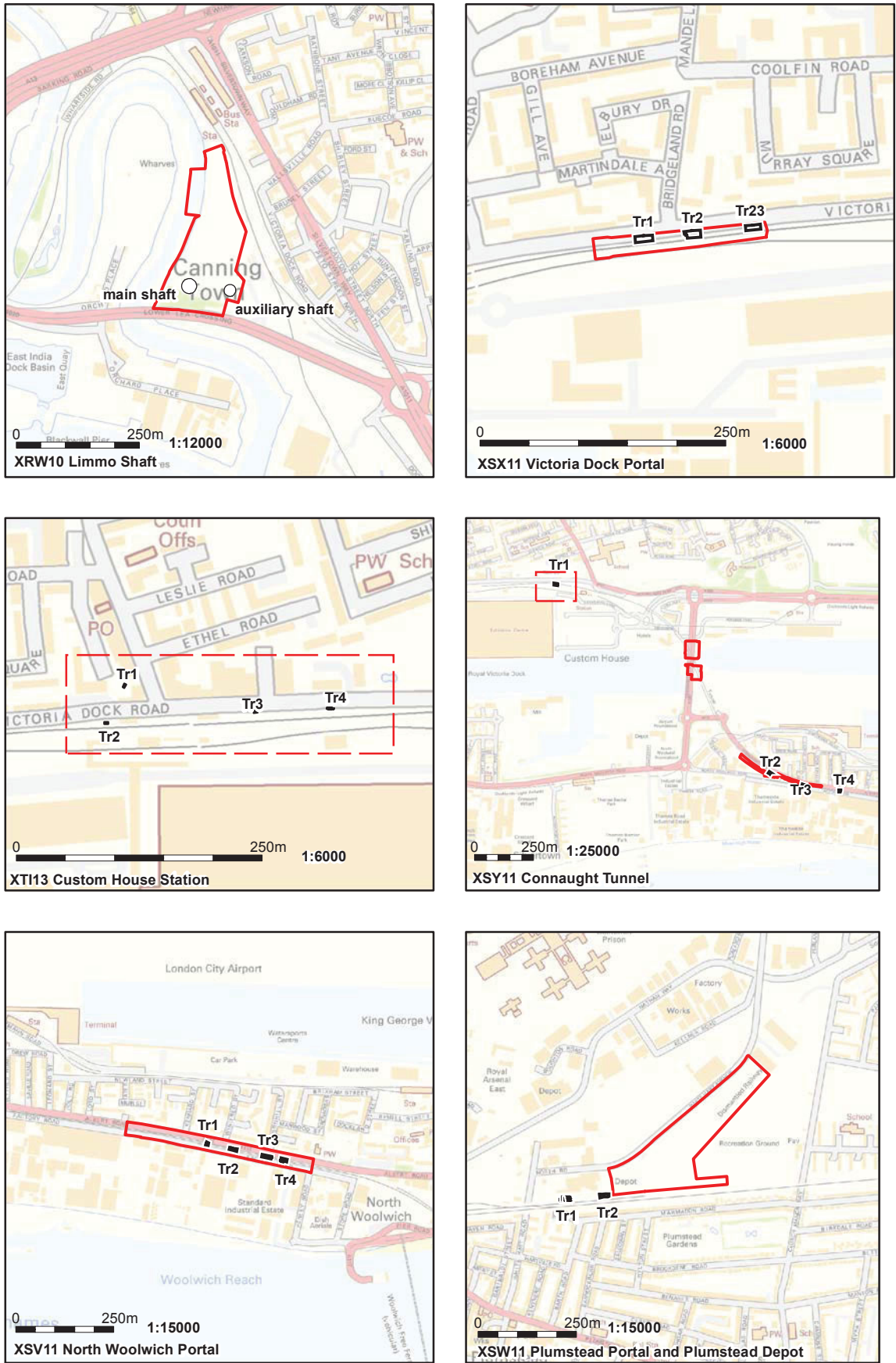
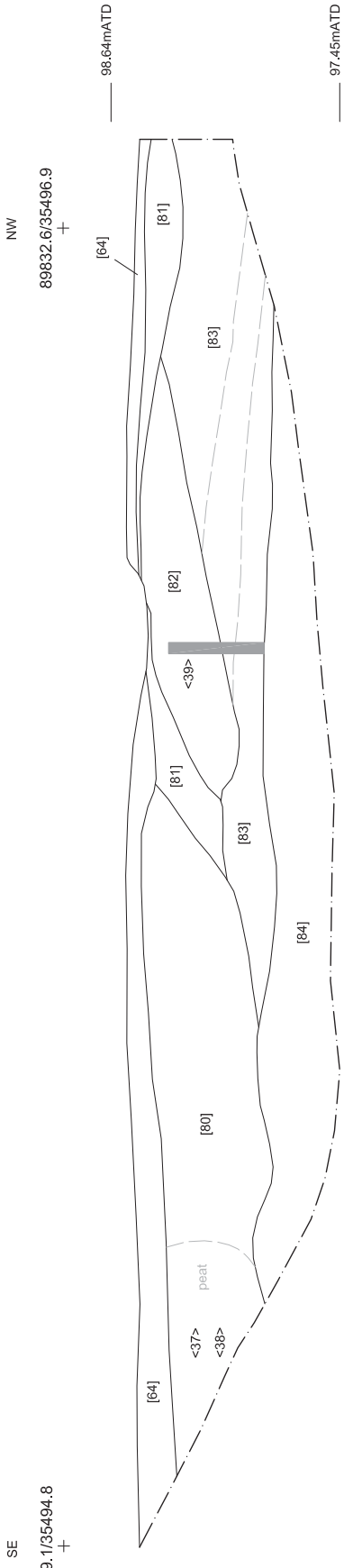
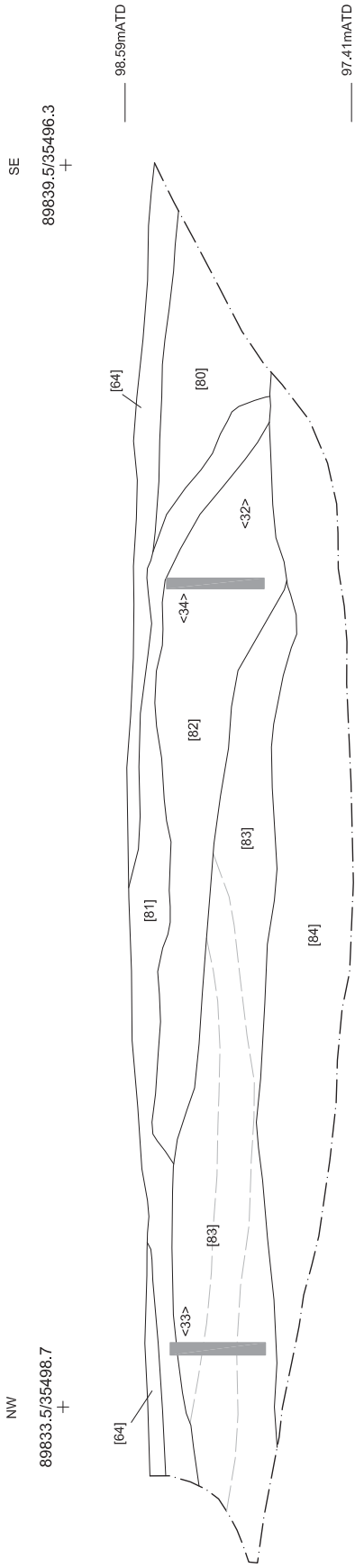


Fig 2 Site and intervention locations



- [64] grey estuarine alluvial silt with laminations of fine sand
- [80] grey clay containing peat clasts and banded with gravel
- [81] grey gravel band
- [82] grey clay containing sizable peat clasts
- [83] very fine light grey sand with laminations and bands of grey silt
- [84] fairly fine sandy and gritty flinty gravel



Limit of excavation
Archaeological deposits
Bulk Samples

Fig 3 XRW10 Limmo Peninsula assessed section:
Sections 5 and 6, Auxiliary Shaft

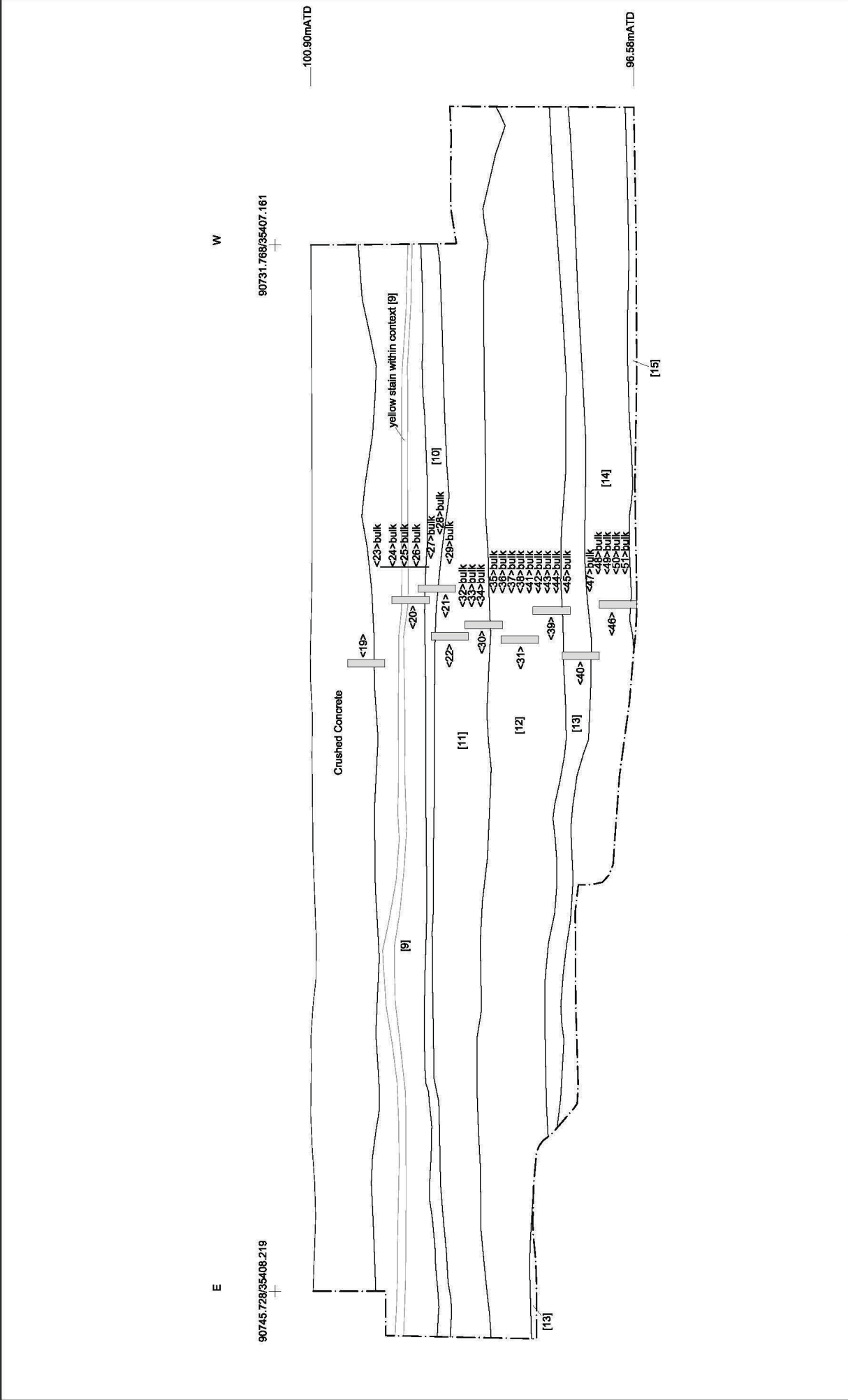


Fig 4 XSX11 Victoria Dock Portal assessed section:
Trench 2 north facing

Limit of excavation
Geographical context
Sample tins and sample numbers
Levels in mATD

1:50 @ A3
0 2.5m

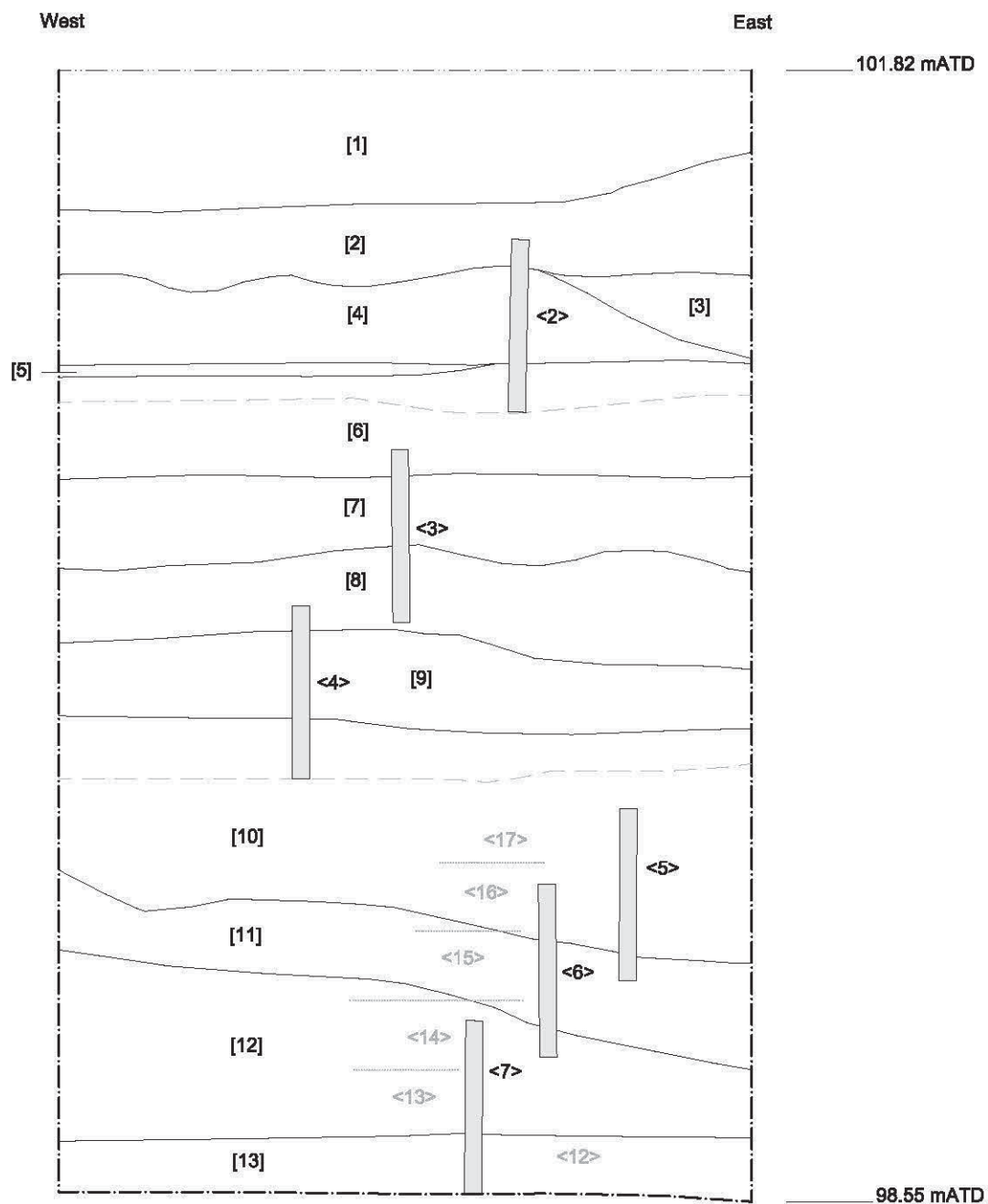


Fig 5 XSY11 Connaught Tunnel
assessed section: Trench 1 south
facing

- Limit of excavation
- Modern truncation
- [11] Archaeological contexts
- <100> Bulk sample positions
- <100> Geoarchaeological sample tins

0 1:20 @ A4 1m

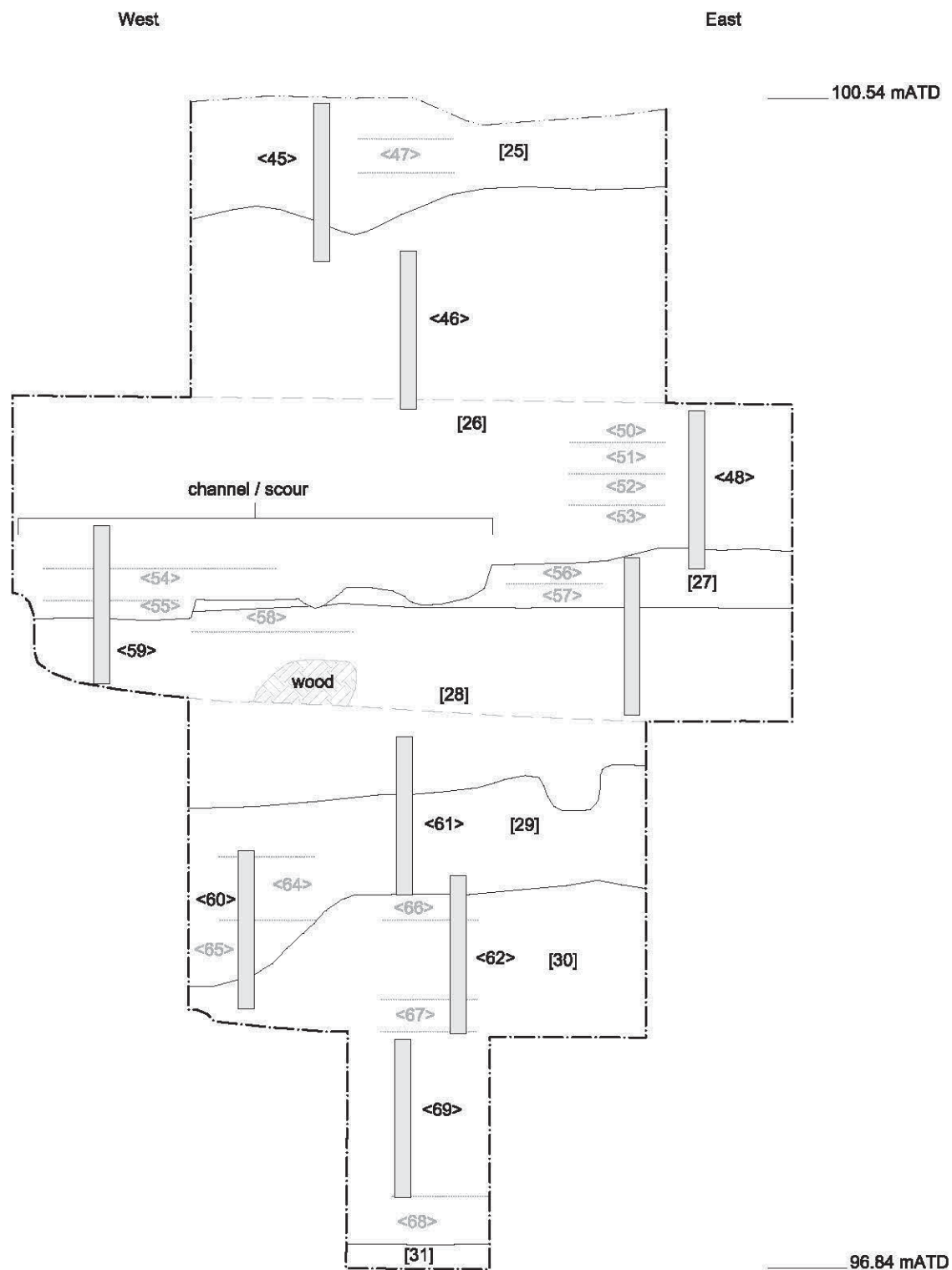


Fig 6 XSY11 Connaught Tunnel
assessed section: Trench 3 south
facing

- Limit of excavation
- Modern truncation
- [11] Archaeological contexts
- <100> Bulk sample positions
- <100> Geoarchaeological sample tins

0 1:20 @ A4 1m

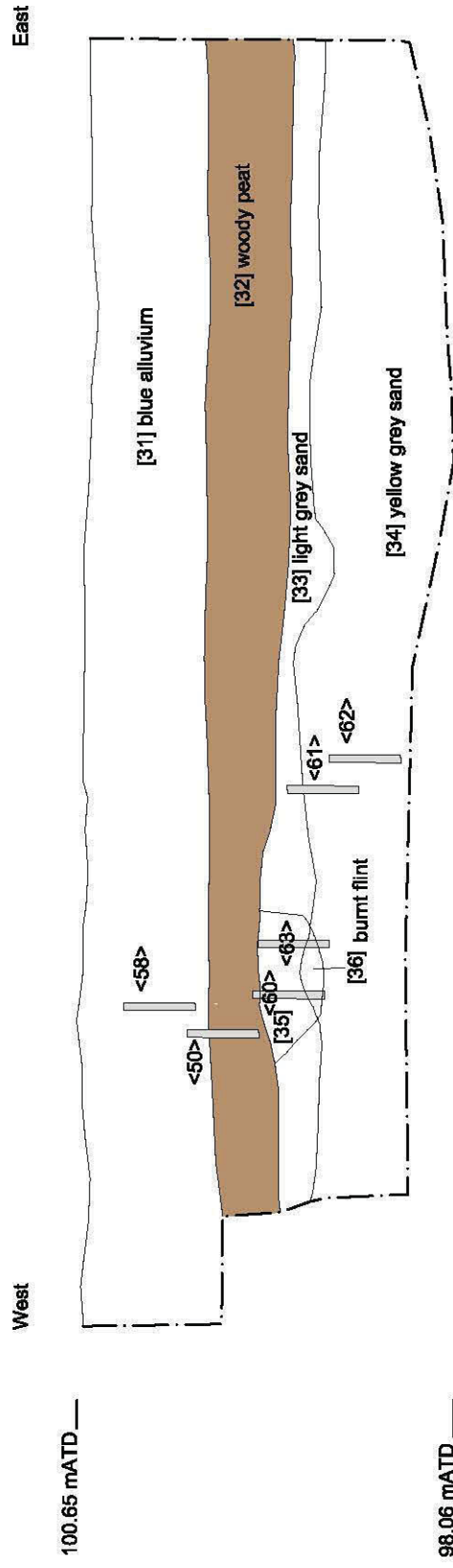
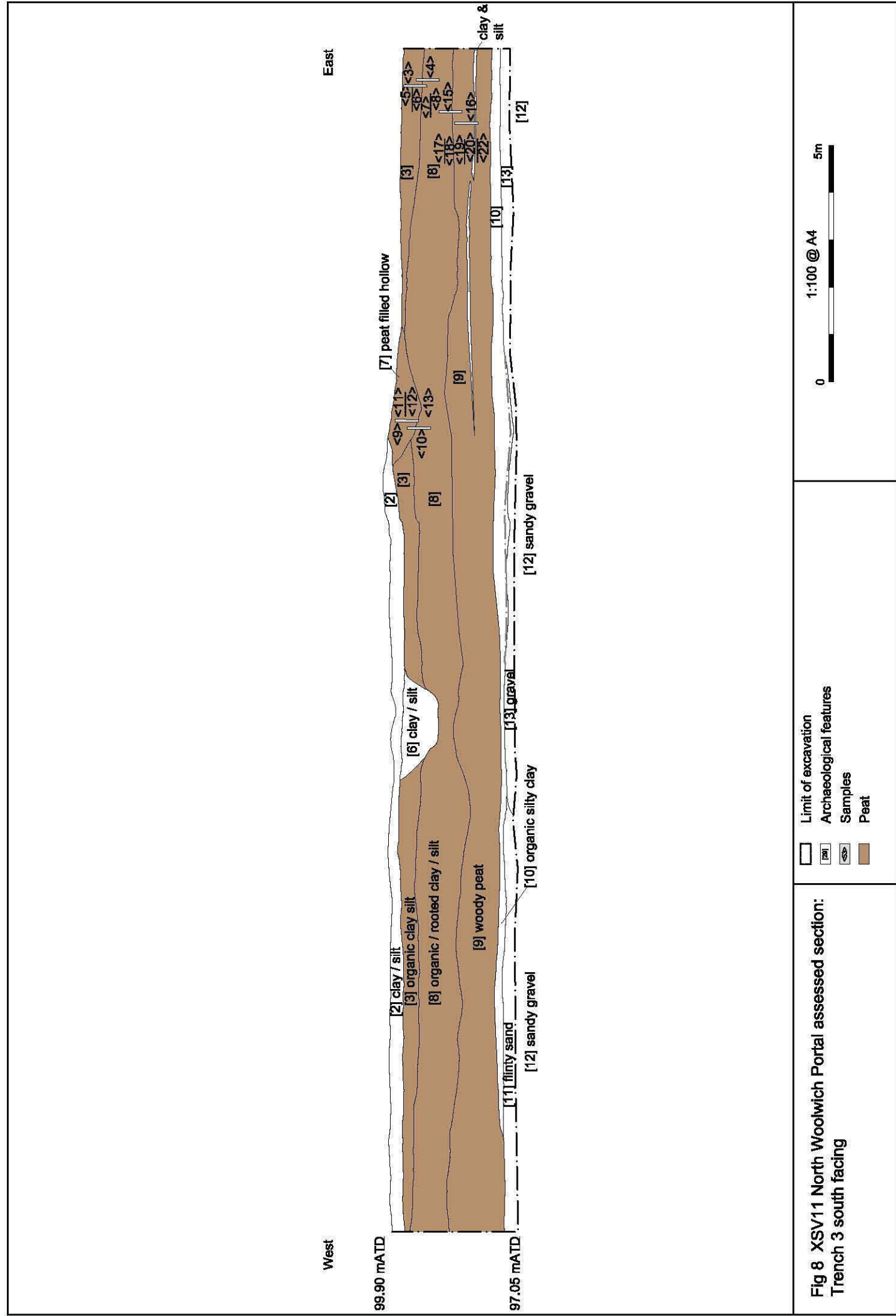


Fig 7 XSV11 North Woolwich Portal assessed section
Trench 2 south facing

Limit of excavation
Archaeological features
Samples
Peat



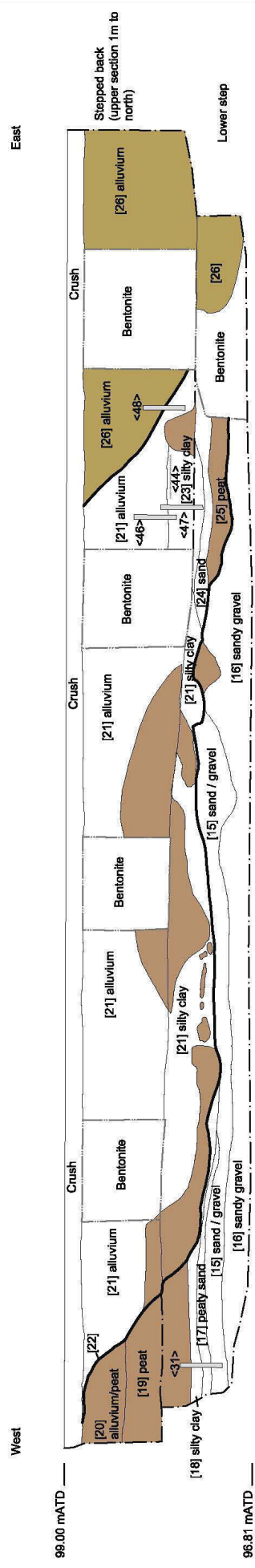


Fig 9 XSV11 North Woolwich Portal assessed section:
Trench 4 south facing

Limit of excavation
 Archaeological features
 Samples
 Peat
 Fill of later channel

0 1:50 @ A3 2.5m

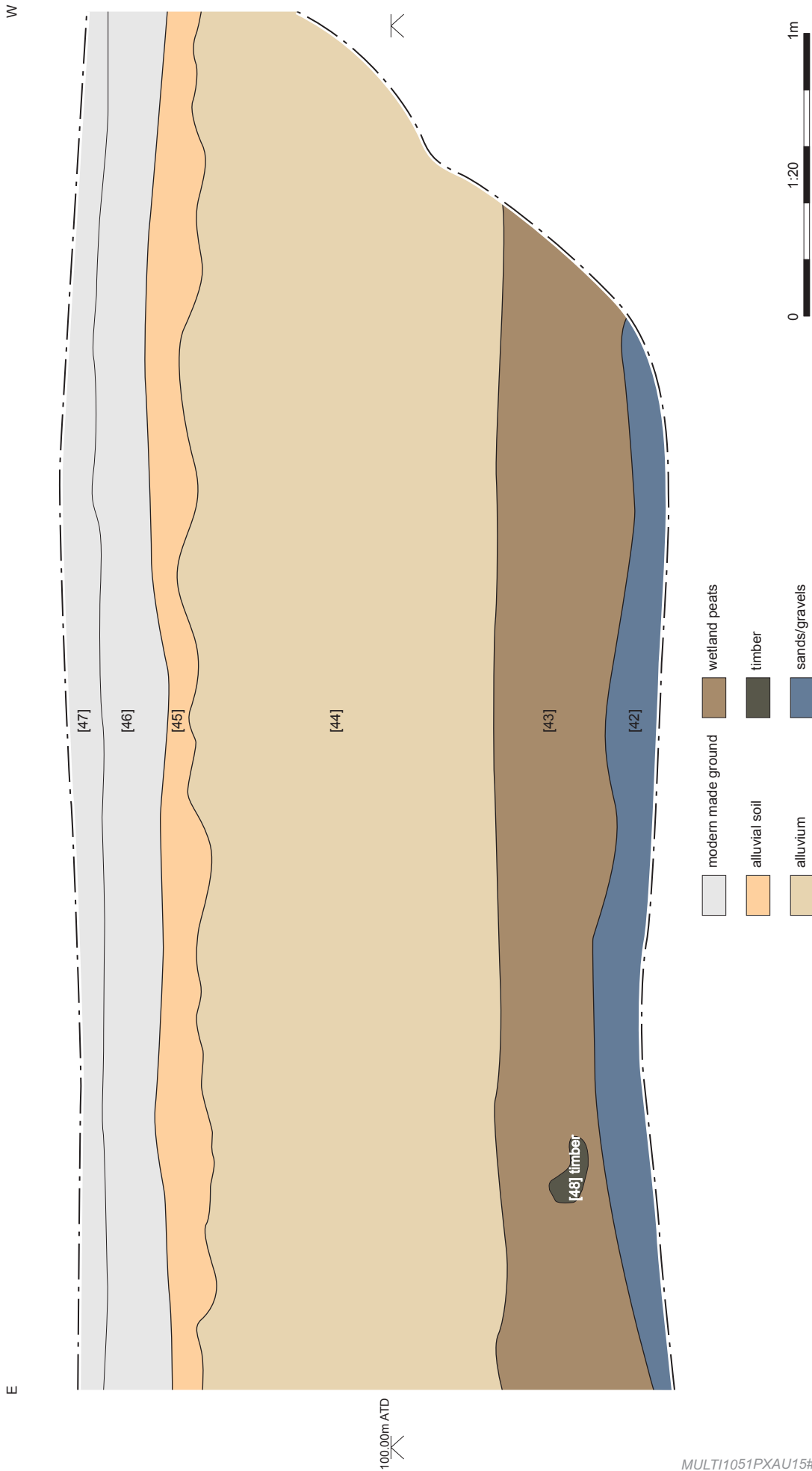


Fig 10 XSW11 Plumstead Portal assessed section: Trench 2 north facing

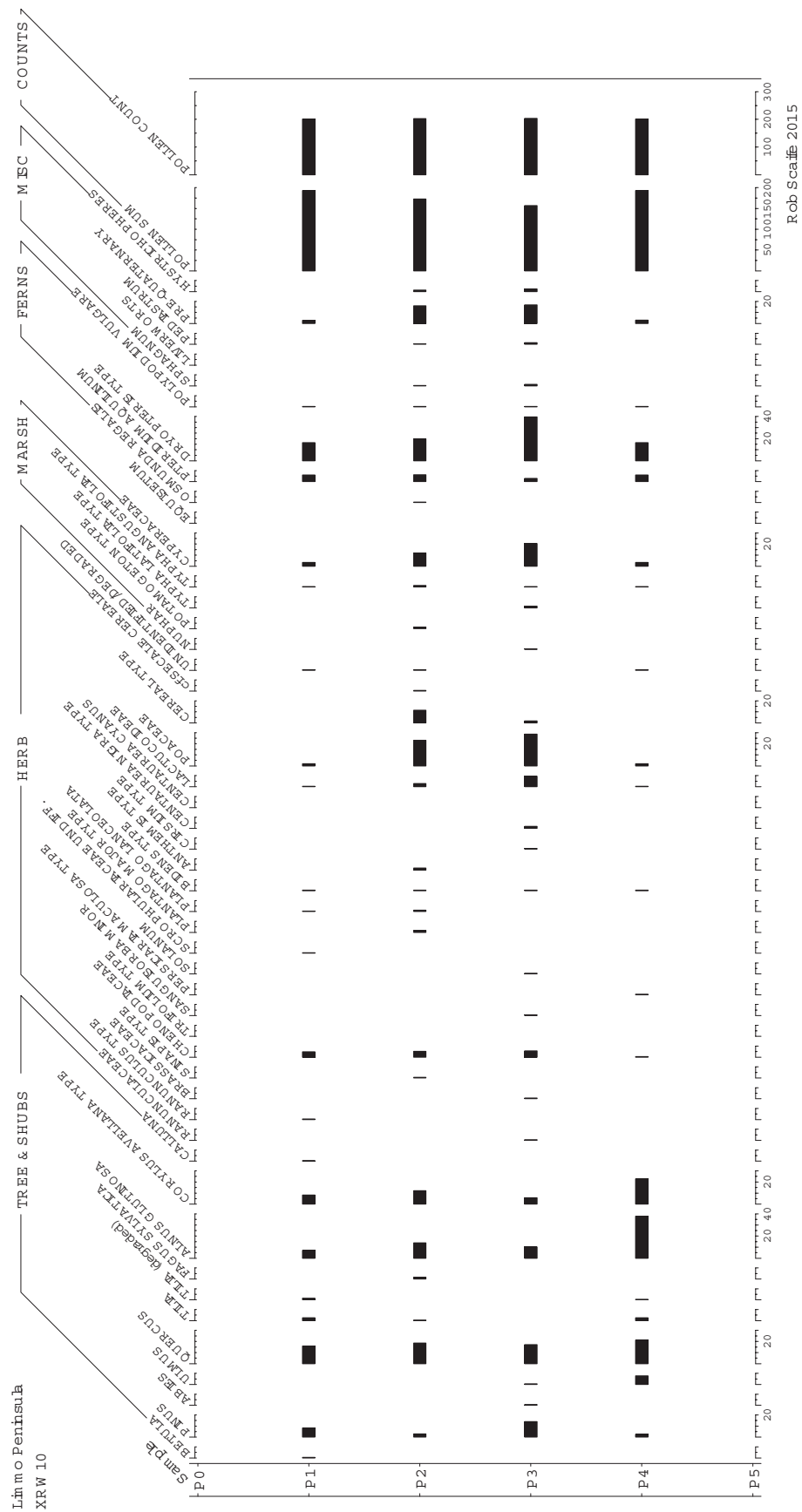


Fig 11 XRW 10 Linn o Penninsula pollen diagram



Fig 12 XSX11 Victoria Dock PortalpoLen diagram



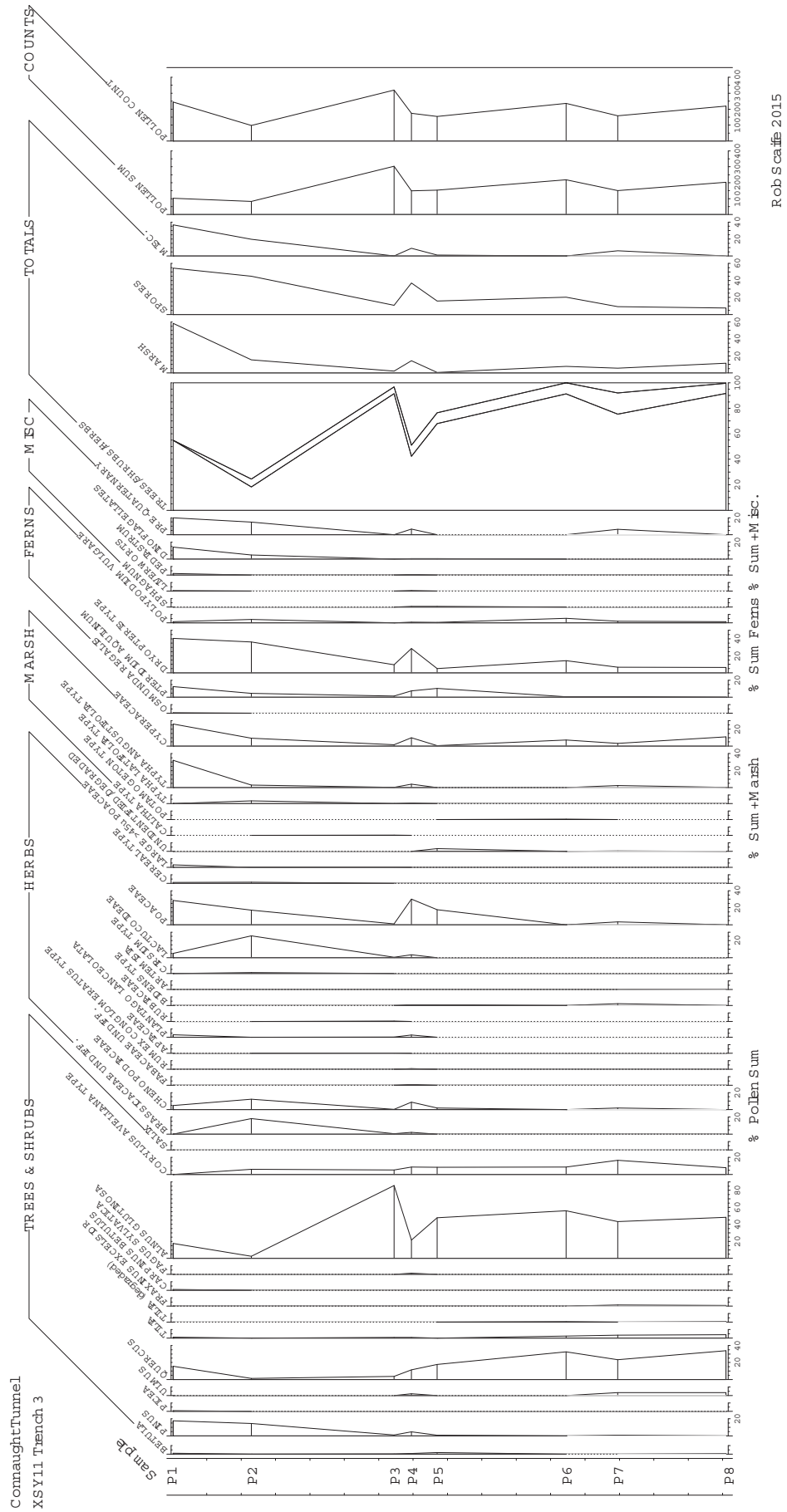


Fig 14 XSY11 ConnaughtTrench 3 pollen diagram

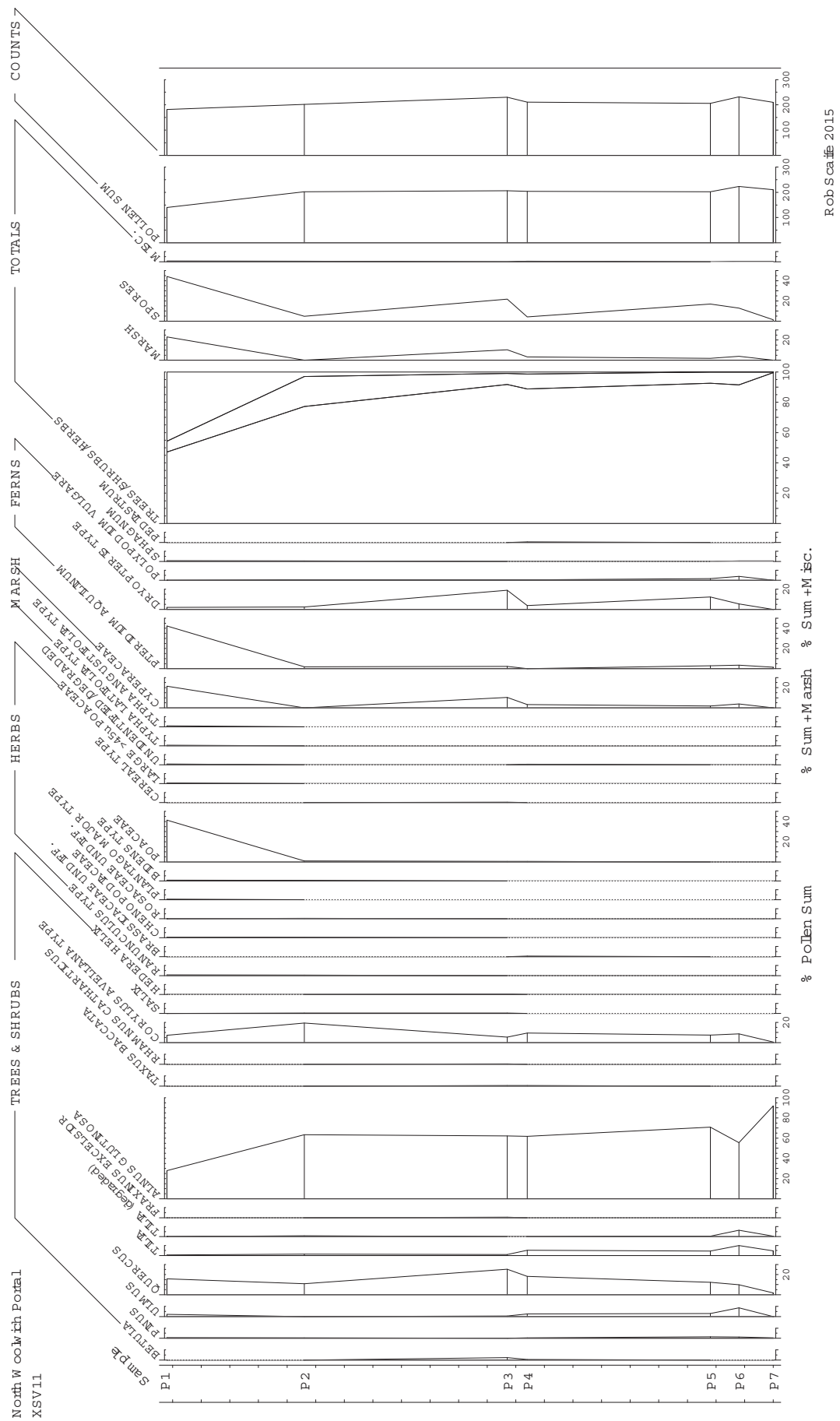


Fig 15 XSV11 North Woolwich Porta pollen diagram

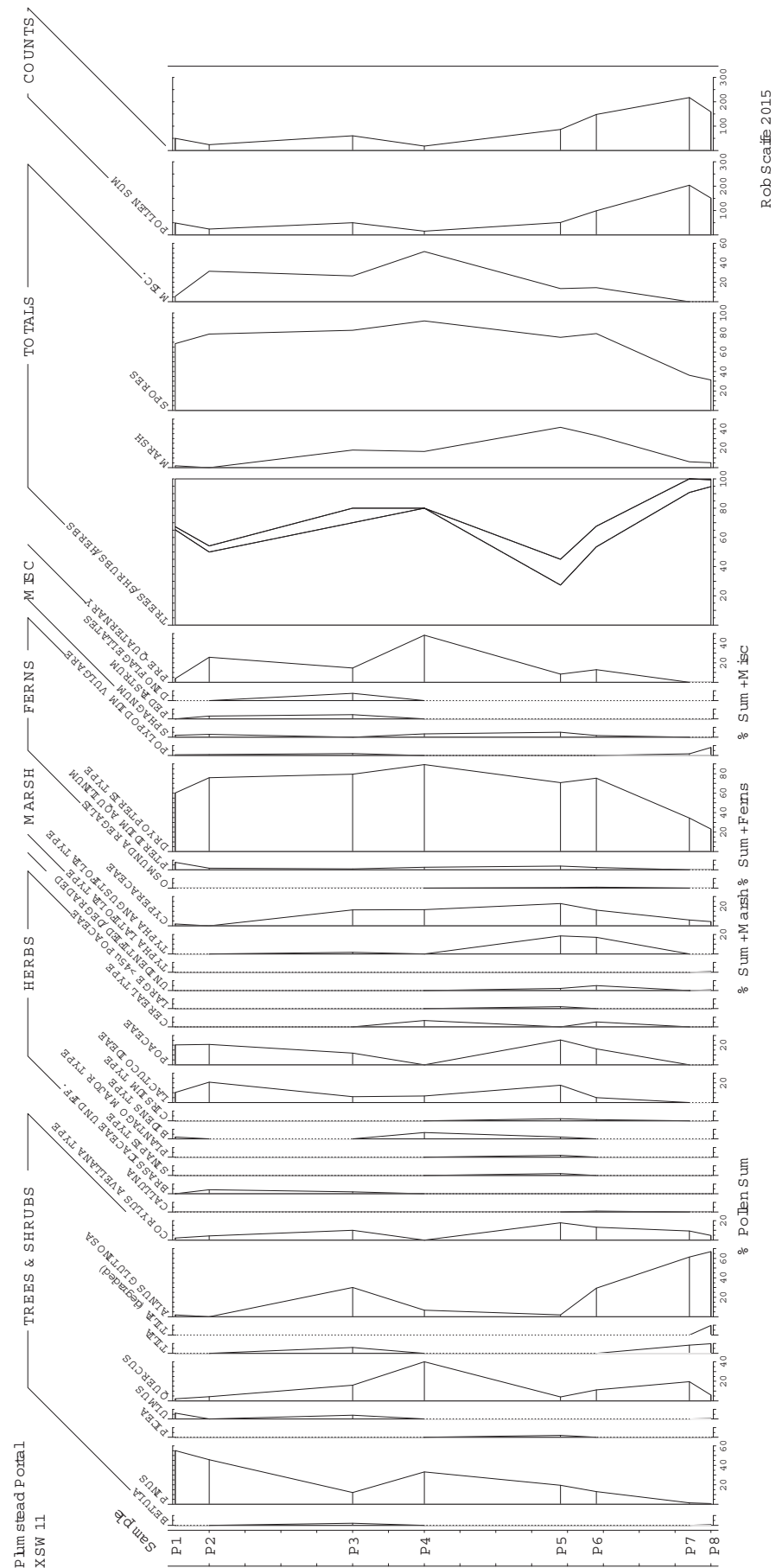
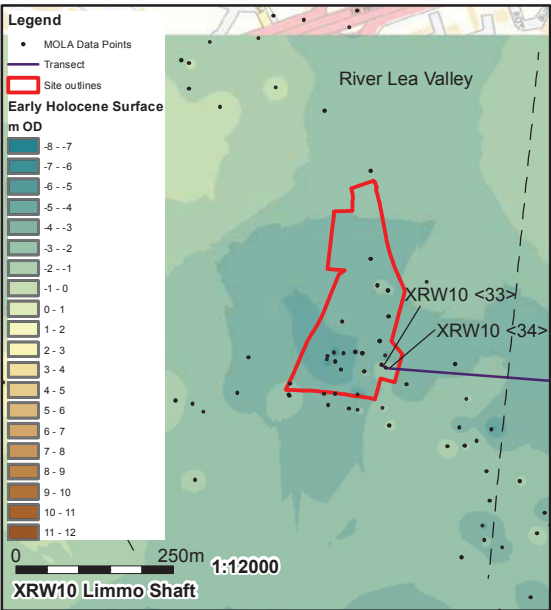


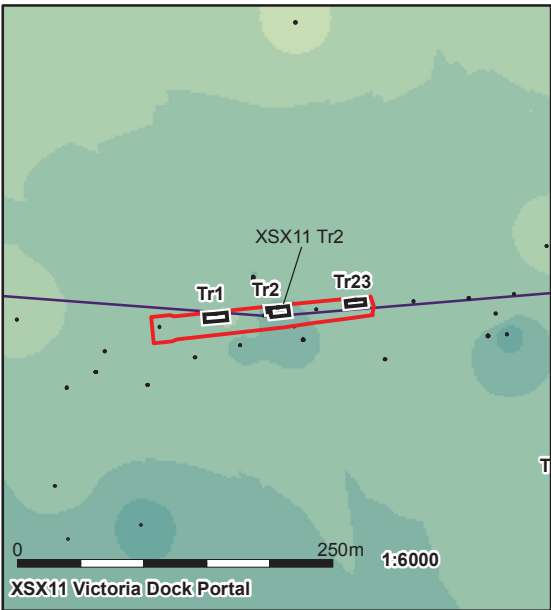
Fig 16 XSW 11 Plumstead Portal pollen diagram



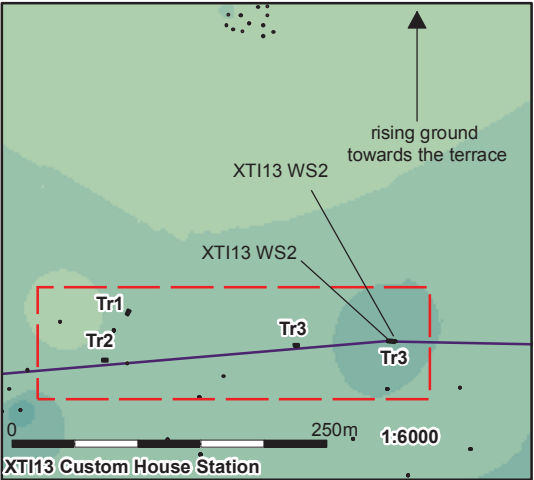
Inset A



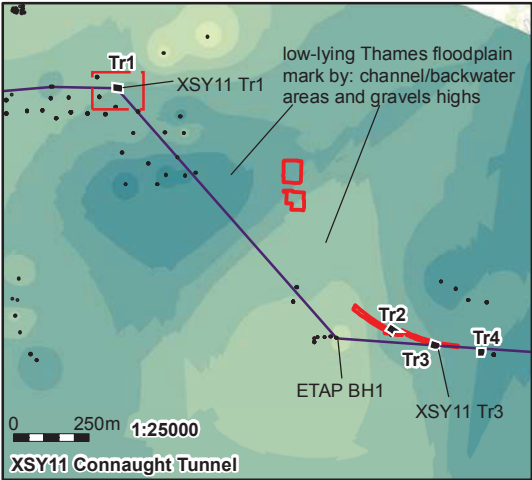
Inset B



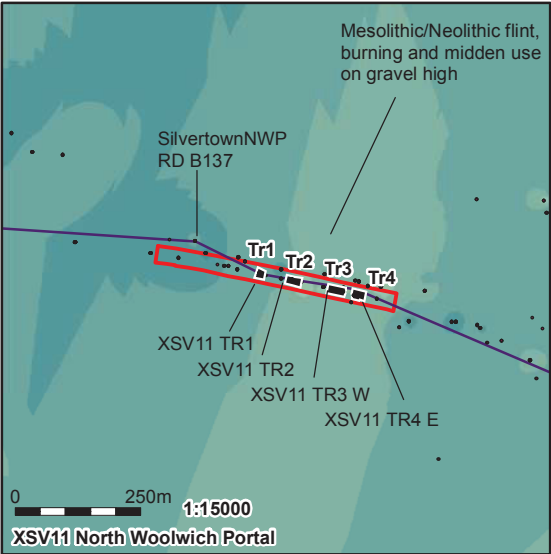
Inset C



Inset D



Inset E



Inset F

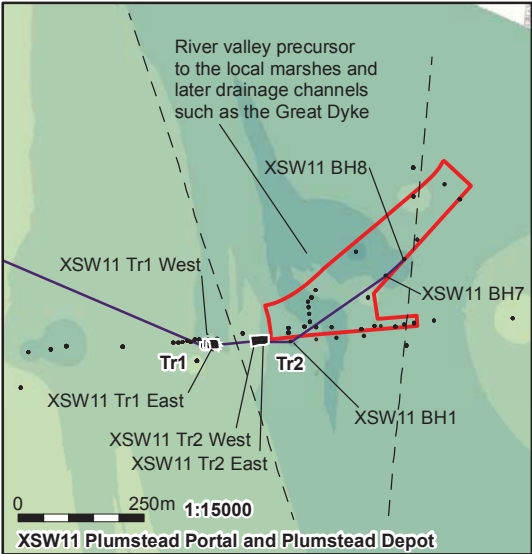


Fig 18 Early Holocene Surface (insets)

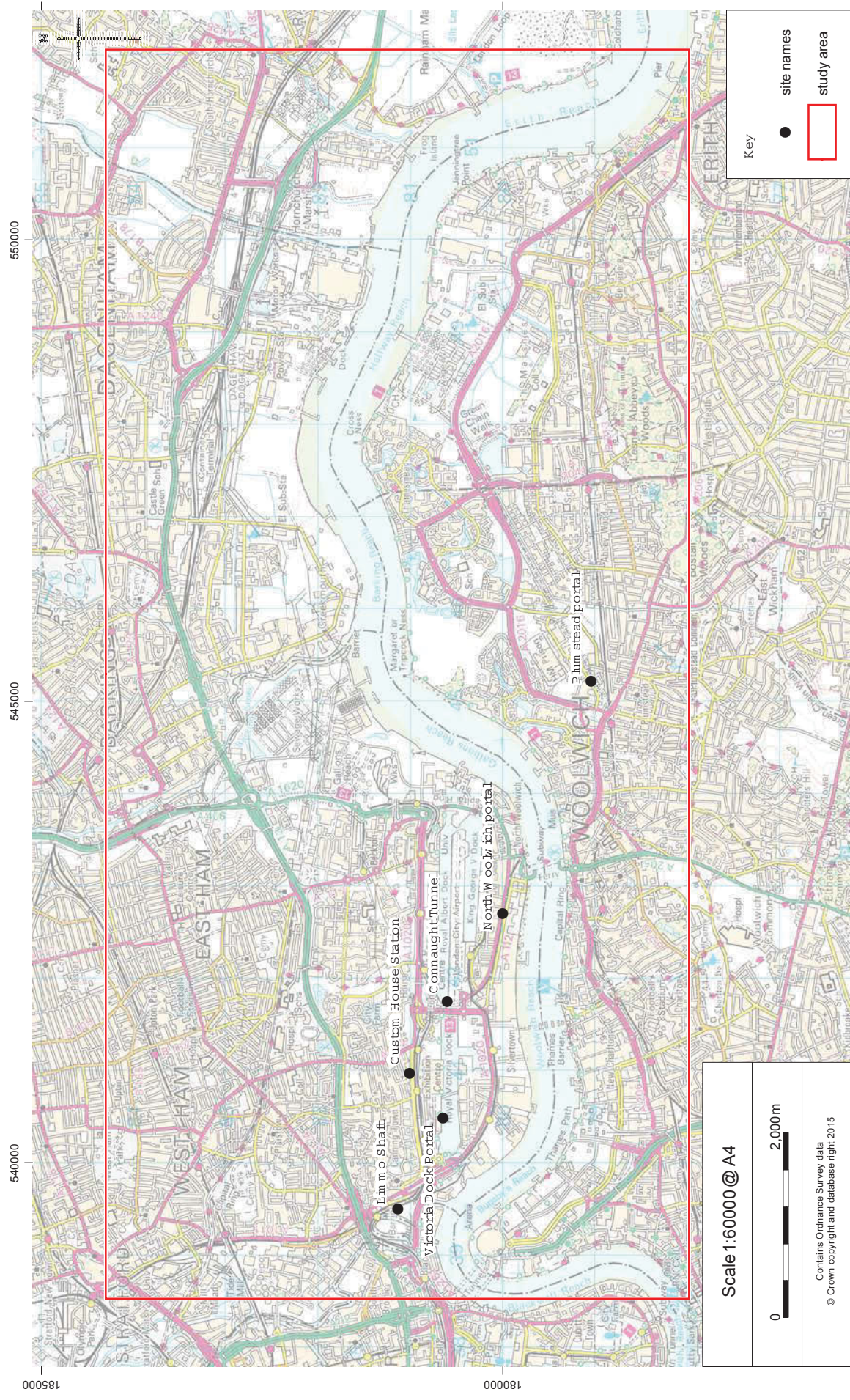


Fig 20 Proposed study area for publication