URBAN SUSTAINABILITY CENTRE
Royal Victoria Dock
London E16

London Borough of Newham

Post-excavation assessment

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Urban Sustainability Centre
Royal Victoria Docks
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A Geoarchaeological Post–Excavation Assessment report

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Summary (non-technical)

This document reports on a geoarchaeological post excavation assessment undertaken for the site of the Urban Sustainability Centre, Royal Victoria Docks, Newham. Museum of London Archaeology (MOLA) were commissioned to undertake a series of archaeological and geoarchaeological investigations by Ove Arup Ltd, on behalf of the client, Siemens plc. The first phase of works consisted of monitoring the geotechnical works carried out by Ian Farmers Associates Ltd, with additional geoarchaeological specific boreholes undertaken by MOLA. Based on the results of these works, the GLAAS Archaeological Advisor to the London Borough of Newham recommended a further stage of investigations. The second phase of work involved carrying out a strip map and sample exercise, a watching brief and the excavation of an archaeological trench.

The strip map and sample, and watching brief were focused to identify significant structures/industrial heritage associated with the former industrial usage of the Victoria Dock basin. No significant features were identified during these works. The archaeological trench was placed to investigate the deeper alluvial deposits in an area of the site likely to be substantially impacted upon by piling.

The trench excavation, in conjunction with an assessment of environmental remains (ostracods, diatoms, forams, and pollen) was able to refine the stratigraphy presented in the previous geoarchaeological report. The basal deposits consisted of silts and sands deposited within a low energy distal part of a tidal creek. The base of the sequence was radiocarbon dated to Cal BC 3085–2900. As channel migration occurred towards the west, the site developed into an area of intertidal mudflats and low to mid salt marsh, which gradually transformed in to a drier upper to mid saltmarsh. A period of landscape stability, and mature soil formation was indicated by a thin organic layer (a preserved 'O' soil horizon), which appeared to overlie a possible 'A' horizon (the uppermost part of a soil). The soil was sealed by clays deposited by overbank flooding. The soil may have formed as a result of medieval drainage and land management in an attempt to protect and use the floodplain for agricultural activity. A radiocarbon date from the 'O' horizon produced a date of Cal AD 1445–1630, providing a guide to the date of the subsequent flooding that deposited the overlying clays

The report concludes that the trench sequence preserves a rare record of floodplain and landscape development from the Middle/Late Bronze Age to the post-medieval period – a period which is usually uninformative and characterised by the deposition of alluvial clay preserving few if any environmental remains. The sequence is also unusual in that it registers a Middle Bronze Age tidal influence on the floodplain preserved in fluvial deposits. Generally, peat is found (and indeed targeted) on east London floodplain sites of this date. By examining fluvial deposits, in contrast, the project has found evidence for tidal water, which suggests estuarine influence was present earlier than previously thought in this part of the Thames floodplain. The report recommends that further analysis is carried out in order to address a set of revised research questions, with the results published in an appropriate scientific journal.

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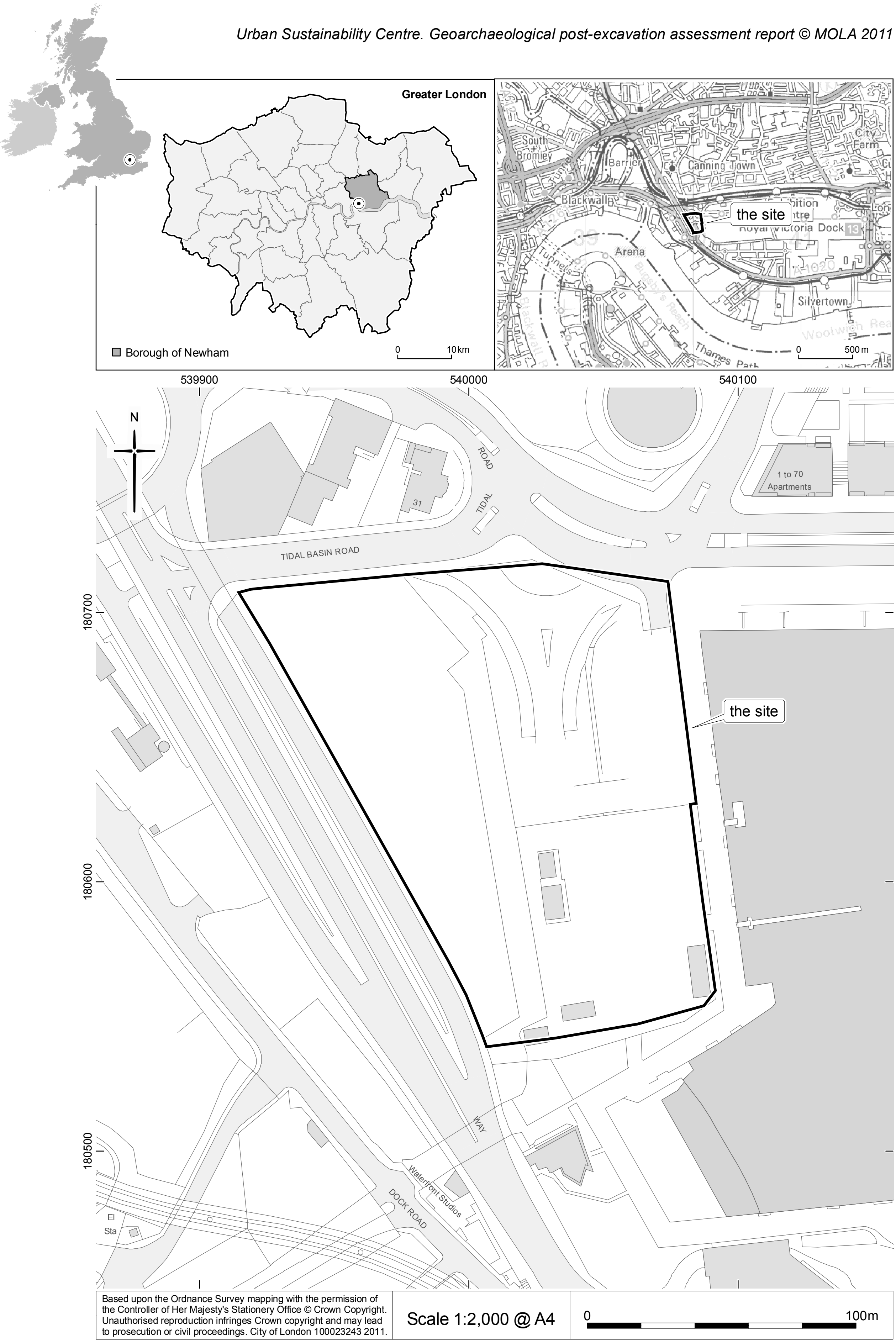

Fig 1 Site location

1 Introduction

1.1 Site Background

This document reports on the geoarchaeological and archaeological investigations undertaken on the Urban Sustainability Centre (referred to as USC within this report) hereafter called the 'the site'. The site code is USC10. The site is situated towards the western end of the Royal Victoria Docks, bound to the west by Silvertown Way, and to the north by Mace Gateway (Fig 1). It forms a parcel of land measuring approximately 3 hectares. The OS National Grid Ref. for the centre of the site is 540020/180640. The site lies in an Area of Archaeological Importance as designated by the London Borough of Newham.

The investigations consisted of two phases. The first (evaluation) comprised monitoring a series of geotechnical test pits and boreholes undertaken by Ian Farmers Associates Ltd. As part of the same phase, geoarchaeological specific boreholes were undertaken by MOLA to sample the natural floodplain stratigraphy. The results of these investigations were combined with previous geotechnical data to create a sub-surface deposit model for the site, which were reported on in *A Geoarchaeological and Archaelogical Evaluation Report* (Halsey 2010b). On the basis of these results the GLAAS Archaeoogical Advisor for the London Borough of Newham requested a further phase of archaeological work to be undertaken. This involved the excavation of an archaeological trench, a strip map and sample exercise and an element of watching brief work.

The archaeological trench was excavated to investigate the potential for dry land surfaces or wetland archaeology within the alluvial sequence. The strip and map exercise was carried out on an area of land adjacent to the Victoria Dock basin to ascertain the presence and/or absence of archaeological remains of industrial siginficance within the upper made ground deposits.

All work was undertaken in accordance with the *Written Scheme of Investigation* (WSI) for a *Geoarchaeologiocal and archaeological evaluation* (Halsey 2010a) and *Archaeological mitigation* (Halsey 2010c).

1.2 The scope of the project

The aim of this document is to report on the second phase of fieldwork results and to assess the archaeological and palaeoenvironmental potential of the sediments sampled and recorded within the archaeological trench and the previous geoarchaeological boreholes. The value of this data will be considered in terms of its potential to address archaeologically and / or palaeoenvironmentally driven research questions. Recommendations have been made for further analysis with the aim of presenting the findings in an appropriate publication.

1.3 Circumstances and dates of the fieldwork

The monitoring of the geotechnical works was undertaken from the 27th July to 17th August 2010 by one MOLA Senior Geoarchaeologist. The geoarchaeological borehole survey was undertaken on the 17th August 2010 by one Senior Geoarchaeologist, and a Terrier Rig crew sub-contracted from PJ Drilling Ltd. The findings from the investigations were presented in a previous report (Halsey, 2010b).

During the second phase of works an initial watching brief was undertaken on a cable trench by one Senior Archaeologist on the 25th and 26th November 2010. Between the 7th December 2010 and 19th January 2011, a strip map and sample exercise was undertaken adjacent to the frontage of the Victoria Dock basin. The archaeological trench was also excavated during this period. The work was undertaken by one Senior Archaeologist, one Senior Geoarchaeologist, one Assistant Geoarchaeologist and one Field archaeologist. The work was carried out in accordance with the procedures outlined in a *Written Scheme of Investigation for archaeological mitigation* (Halsey, 2010c)

1.4 Organisation of the report

A *Post-excavation assessment report* is defined in the relevant GLAAS guidance paper (Paper VI) as intended to 'sum up what is already known and what further work will be required to reach the goal of a well-argued presentation of the results of recording and analysis' (VI/1).

The principle 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). More recent GLAAS guidance has emphasised the need for this stage to be seen as 'brief and transitional', the document acting as a 'gateway' to further analysis and eventual publication (EH, GLAAS, 1999 VI/1). The document is divided into the following sections.

Section 2: Palaeoenvironmental and archaeological background
Describes the palaeoenvironmental and archaeological background to the site. This places the site into a wider regional context, with particular reference to sites in the immediate area which may be of a contemporary date. Thus the site can be understood in terms of its contribution to the archaeological and palaeoenvironmental record and what further information the data can provide.

Section 3: Original research aims
The original research aims as outlined in the *Written Scheme of investigation for archaeological mitigation* (Halsey 2010c) are stated in this section.

Section 4: Methodology
Describes the excavation and recording methods employed for the archaeological trench, strip map and sample, watching brief and the subsequent off site work. This section also describes the sampling policy adopted to assess the core and trench samples, listing the number of specialist samples taken from key stratigraphic horizons.

Section 5: Results of the investigations
Presents the stratigraphic data obtained from the archaeological trench investigation in tabulated form, and a summary of the watching brief and strip and map exercise.

Section 6: Quantification and assessment
An archaeological excavation aims to preserve the site in the form of plans, drawings, photographs and the artefacts found. This section reviews and quantifies this archive of information in order to assess its potential in answering the research questions. The results of the various specialist assessments are also presented within this section

Section 7: Synthesis of the data
This section presents a synthesis of the specialist assessment work with the stratigraphic data retrieved during the geotechnical monitoring, borehole survey and archaeological fieldwork to update and refine the facies model presented in the previous Geoarchaeological Borehole Survey (Halsey 2010b)

Section 8: Potential of the data

The data recovered is assessed for its potential to answer (1) the original research aims and (2) any additional research questions that the results of fieldwork have flagged up. Any further off-site work that will be needed to address these research questions is discussed.

Section 9: Significance of the data
This section assesses the information gathered in its wider context. It examines the potential of the site data to answer larger, longer-term, research objectives on both a regional and national scale.

Section 10: Publication project: aims and objectives
The proposed nature of the publication is determined in this section. This includes revised aims and objectives for the publication.

Section 11: Publication project: task sequence
The necessary tasks required to complete the publication and to answer the revised research questions are presented in this section

2 Palaeoenvironmental and archaeological background

BGS mapping of the area (Sheet No.257) shows that the site is situated on the floodpain of the Thames, where Holocene alluvium overlies Pleistocene gravels. The gravels, known as the Shepperton Gravel Formation, were deposited during the last major cold stage of the Devensian Glaciation (*c* 18–15000 BP, Gibbard 1985) and accumulated as mid channel bars within a cold climate unstable braided river system. The overlying alluvium accumulated over the past 10,000 years and comprises a sequence of fluvial to wetland and floodplain soil deposits.

Basal sands and silts represent the transition to a low energy meandering or anatomising river regime following the amelioration of the climate at the beginning of the Holocene. The sands and silts were deposited as lag sediments within lower lying threads and also as higher relief channel bars exposed during low flow discharge. Following stabilisation of the river system and localised channel incision in the early part of the Holocene, the higher relief channel bars developed into dry terrestrial landsurfaces, essentially forming eyots within the floodplain suitable for occupation.

From the late Mesolithic (*c* 7000 BP), the rapid increase in sea levels began to impact on the fluvial regime further upstream. 'Ponding back', caused by the upstream migration of the tidal head increased the river levels substantially, leading to the accumulation of freshwater mudflats, with peat deposits developing across waterlogged channel marginal areas. Fluctuations in the rate of relative sea level rise has caused minerogenic and organic peat deposits to develop at different times in different locations, depending on topographic location, localised changes in hydrology, and the overall basin wide effects of relative sea level rise.

This sequence of peats, organic and minerogenic deposits preserve a range of environmental proxy indicators which can be used to reconstruct the past palaeoecology, fluvial geomorphology, and hydrology of the Thames during the last 10,000 years. These deposits provide an important resource in reconstructing and understanding the causes and effects of climatic and landscape change, and the environmental context in which human occupation and activity took place. These deposits also preserve indirect evidence of human activity such as woodland clearance, the onset of agricultural practises and wetland management and exploitation.

Wetland environments were particularly attractive to Prehistoric populations due to the range of subsistence resources these ecologies provided, and the importance of the river itself as a means of transport and communication. Evidence of prehistoric wetland exploitation has been found within the Thames alluvium in the form of trackways constructed to traverse the wetlands, as well as jetties, wharfs, fish traps and boats.

Previous geotechnical works across the site were monitored for geoarchaeological purposes in 2002 (Ainsworth 2002). These works identified a series of minerogenic and laminated organics silts and clays thought to represent deposition within an intertidal river regime. No peat deposits were identified, indicating that the site boundary lay within an active channel area. The data from theses geotechnical investigations were incorporated in the previous geoarchaeological evaluation report (Halsey, 2010b)

More detailed investigations were undertaken directly to the south east of the site at West Silverton Urban Village (referred to in this report as WSUV; site code BWC96, Wilkinson *et al* 2000). These investigations identified a series of deposits related to the changing fluvial and environmental conditions present on the Thames floodplain during a large part of the Holocene.

At WSUV the basal deposits consisted of the Shepperton Gravels that formed an elevated area of land occurring at *c* -1m OD. Just to the south east of USC a palaeochannel feature was identified, which was infilled with a sequence of laminated silts and peat. The palaeochannel was dated to the Late Glacial/Early Holocene and provided radiocarbon dates ranging form c 12000–10 000 BP. With the upstream effect of rising river levels wetland peat deposits, indicative of sedge fen and alder carr environments began to develop across the site from the Early Neolithic (c 6000 BP). This peat formation continued into the Early Iron Age (c 2000 BP), by which time the rate of rising sea levels outstripped the rate of peat formation. Consequently the site was inundated by intertidal muds indicative of salt marsh and mudflat environments. The organic deposits preserved on the site provided a palaeoenvironmental resource (i.e. pollen and plant macrofossils) that could be used to reconstruct the Neolithic to Bronze Age landscape. However, the upper part of the sequence with the transition from the Bronze Age peats to intertidal muds provided little palaeoenvironmental material to reconstruct the wider landscape and the on site depositional environments.

In addition to the prehistoric potential of the alluvial deposits, the site also has the potential for post-medieval industrial archaeology within the made ground deposits. Such structures are likely to be associated with the Royal Victoria Docks which was constructed between 1853 top 1855. Immediately prior to this the site had existed as grassland floodplain meadows known on the historic maps as Plaistow marshes.

The first evidence of structures on the site occurs on the 1869 OS map, which shows a number of warehouses and sheds fronting onto the Royal Victoria docks. Residential buildings are also shown on the western periphery of the site. The 1896 map shows that the smaller warehouses and sheds were replaced by a large goods and coal depot which by 1910 was being utilised by the Midlands railway as a depot. In 1968 this structure was replaced by a second large warehouse which exited up until the 1990's. In addition to these structures cranes and railway sidings associated with these building may also occur on the site.

3 Original research aims

All research is undertaken within the priorities established in the Museum of London's *A research framework for London Archaeology*, 2002

The following archaeological research objectives have been compiled after consultation with appropriate specialists, the Arup's consultant archaeologist, and in particular with consideration of the results of previous archaeological investigations both on the site and in adjacent areas. The original research questions (ORA's) were first presented in the previous WSI's (Halsey, 2010a/b).

- ***(ORA1)–****Is there any evidence of prehistoric occupation and/or wetland exploitation (i.e. fishtraps, boats, jetties and trackways) within the alluvial sequence?*
- ***(ORA2)–****Can the results of the excavation refine the understanding of the post-glacial floodplain development of the site gained from the previous geoarchaeological borehole survey, with particular reference to reconstructing the environment of deposition and the evolution and time scale of floodplain formation?*
- ***(ORA3)–****How does the sites sedimentary sequence compare to present models of the Thames floodplain development and the impacts of vegetational change, rising sea levels and changing fluvial geomorphology?*
- ***(ORA4)–****How does the reconstructed landscape and topography refine the understanding of the wider prehistoric environment, and how past populations may have settled within, utilised, accessed or traversed this past landscape?*
- ***(ORA5)–****Are there any local remnants of Post-Medieval to mid 19th century agricultural activities and can the reason(s) for the pre-existing surface formations no longer being present be identified?*
- ***(ORA6)–****Can the mid 19th century site preparation processes, related to dock construction be identified and understood and placed in context of the tidal basin of Royal Victoria Dock.*
- ***(ORA7)–****Is there any evidence for occupation and informal activities on the eastern third of the site between tipping of dock spoil and the construction of the first phase of dock side buildings?*
- ***(ORA8)–****How was the site first developed, related to servicing the business requirements of the London Midland Railway company?*
- ***(ORA9)–****What remains on site of the mid to late 19th century to mid 20th century dock side facilities (including three or more phases of substantial sheds) and internal/external railway infrastructure?*

- ***(ORA10)–****How does the archaeology of this site confirm or change our perception of the archaeological resource of this part of Newham?*

- ***(ORA11)–****Are there structures and artefacts that if retained on site would support and celebrate the objectives of the development and cultural activities of Newham?*

4 Methodology

The methods employed during the excavation of the archaeological trench, the strip map and sample exercise, watching brief works and the subsequent off-site post-excavation assessment are described in the section below. All geoarchaeological on-site and off-site work, was carried out in accordance with the *Written Scheme of Investigation* (Halsey 2010c), the MOLA *Archaeological Site Manual* (MOLA 1994) and also guided by the recommendations outlined in the *English Heritage Guidelines for Environmental Archaeology and Geoarchaeology* (EH 2002; 2007 respectively).

4.1 Watching Brief

An archaeological watching brief was carried out on the excavation of a cable trench. The trench was located towards the eastern and southern edges of the site boundary (Fig 2). Hand written notes with approximate measurements were recorded along with digital photographs. An approximate sketch plan drawn at 1:200 was produced using measurements taken in the field.

4.2 Strip map and sample

The strip map and sample was carried out on an area of land adjacent to the Victoria Dock basin frontage (Fig 2). This area had a high potential to reveal evidence of warehouses and other features associated with the former industrial use of the Victoria Dock. Initially an exploratory trench, measuring 3m by 1.5m was opened up. This was followed by the excavation of a 1m wide, 20m long north to south trench within the area of the strip map and sample exercise. Hand written notes with approximate measurements were recorded along with digital photographs. An approximate sketch plan drawn at 1:200 was produced using measurements taken in the field.

4.3 Excavation of the archaeological trench

The archaeological trench was located within the footprint of the Urban Sustainability Centre in an area where extensive piling was likely to have a major impact on the buried archaeological / palaeoenvironmental resource (Fig 2). The trench was designed and constructed by the onsite sub-contractor (FDL). It consisted of a double trench box system with top extensions.

Prior to the construction of the shaft, the surrounding area was reduced, through approximately 1.5m of modern rubble, to allow for the enablement of the trench-boxes. The shaft measured 7m x 2m, and extended to a depth in excess of 6m below ground level (bgl). It was machine excavated in stages, whereby a half section of the shaft was reduced, under archaeological supervision, until a central face (*c* 1m deep) was exposed. The exposed section was cleaned, examined and recorded by MOLA geoarchaeologists, and assigned sedimentological unit numbers. Sections and plans were drawn on permatrace at scales 1:10 and 1:20 respectively.

A preliminary interpretation of the sediment characteristics was made to define the deposit sequence and identify soil and/or sediment processes. This followed standard sedimentary criteria, as outlined in Jones *et al* (1999) and Tucker (1982). This attempts to characterise the visible properties of each deposit, in particular relating to its colour, compaction, texture, structure, bedding, inclusions, clast-size and dip.

A continuous sequence of monolith samples (undisturbed columns of sediment) were taken through the deposits. These were taken to allow further detailed off-site recording, and to retrieve a range of microfossilss (i.e. pollen, diatoms). Bulk slab samples (*c* 10 Litres) were taken from the major stratigraphical units at intervals of *c* 0.10m. The bulk samples were taken to retrieve a range of ecofacts that included plant macro fossils, molluscs and ostracods.

Once the geoarchaeological sampling and recording was completed, machining resumed producing a *c* 1m deep section on the converse face. This allowed a continuous sequence of overlapping sections, measuring in total *c* 4.5m in depth, to be recorded and sampled down through the alluvial sequence.

The shaft did not reach the anticipated floodplain gravels, or the overlying sands. It was not possible to machine excavate past a depth of *c* 6m bgl. This was due to the restricted access within the trench, and a depth that exceeded both the reach of the machine excavator and the limit of the shoring. Consequently, a hand dug sondage was excavated to a depth of *c* 0.8m at the base of the excavation.

The trench location and section levels were determined by the use of GPS. Two 3D stations were set out on a baseline with differential GPS (Trimble 5800 rover receivers with TSCE 5700 data logger and mobile phone GSM data link). The location and levels were picked up with an optical total station instrument (Leica TCR802/05 Reflectorless EDM). Levels were recorded in m OD, and the location of the trench corners recorded to the six figure ordnance grid reference.

4.4 Off-site assessment

4.4.1 Trench records

The individual section records were combined to create a composite section through the entire trench sequence. The unit numbers for the individual sections were grouped together as conventional archaeological context numbers once the composite section was constructed. The composite section was logged in table format and entered into a digital (Rockworks 2006) database. The results were compared and correlated with the previous geoarchaeological/geotechnical boreholes to update the facies model presented in the *Geoarchaeological and Archaeological evaluation report* (Halsey, 2010b).

4.4.2 Sampling strategy

The samples taken through the trench sequence were selected for assessment. Although the trench was unable to sample the entire sequence down to the level of the Lateglacial/Early Holocene sands, the samples obtained were larger than those obtained within the borehole core samples, and provided suitable sample sizes for recovering a wide range of ecofacts (eg: snails, insects, seeds) useful for a palaeoenvironmental multi-proxy study. In addition to their relatively small size, the borehole samples suffered a degree of compaction, and in some cases poor retention of sediment, resulting in a less complete profile through the sedimentary sequence. The trench was also able to record and sample upper alluvial horizons of considerable interest not present within the core samples. A geotechnical borehole (USCBH2A) adjacent to the trench suggested that the trench sequence was perhaps little more than 0.3m short from the level of the Lateglacial/Early Holocene sands and gravels.

Samples were taken to retrieve plant macro fossils, ostracods, forams, diatoms, pollen and material suitable for radiocarbon dating. An organic lense within the basal sands of borehole USC10MoLBH3 was also submitted for radiocarbon dating. The sampling locations and lithology within the trench sequence are illustrated in Fig 5. This figure also includes a summary of the various specialist assessments to provide an interpretation of the environment of deposition.

4.4.2.1 Pollen sub-samples

Eight small pollen subsamples (prefix P) *c* 2cm^3 in volume were taken throughout the trench sequence. The samples were taken to target key stratigraphical horizons and interfaces. The aim of the assessment was to determine the preservation, presence, abundance and diversity of the pollen grains and their potential to identify differences and trends in the sites palaeoecology. The sample location information is presented in the table below.

Table 1: Pollen sub-samples taken through trench sequence

Pollen subsamples	Context	Sample height (m OD)
P1	15	-2.73
P2	15	-2.27
P3	15	-1.69
P4	12	-1.21
P5	9	-0.16
P6	7	0.29
P7	6	0.71
P8	5	0.97

4.4.2.2 Diatom sub-samples

Eight diatoms subsamples (prefix D), *c* 2 cm^3 in volume, were taken through the alluvial sequence. The aim of the assessment was to determine the preservation, presence, abundance and diversity of diatoms, and their potential to identify differences and trends, particularly in terms of salinity and eutrophication.

Table 2: Diatom sub-samples taken through trench sequence

Diatom subsamples	Context	Sample height (m OD)
D1	15	-2.73
D2	15	-2.27
D3	15	-1.69
D4	12	-1.21
D5	9	-0.16
D6	7	0.29
D7	6	0.71
D8	5	0.97

4.4.2.3 Ostracod/Foraminifera sub-samples

Eight grab samples (prefix O/F), *c* 2litres in volume, were taken from selected bulk slab samples. The samples targeted key interfaces and stratigraphic horizons within the alluvial sequence, and were taken in order to investigate the depositional and environmental conditions within the alluvial sediments. The sample location information is presented in the table below.

Table 3: Ostracod/Foram sub-samples taken through trench sequence

Bulk Sample Number	Ostracod/Foram subsample	Context	Sample height (m OD)
53	O/F1	15	-2.27
47	O/F2	15	-1.63
39	O/F3	12	-1.13
36	O/F4	11	-0.79
23	O/F5	9	-0.12
8	O/F6	7	0.37
12	O/F7	6	0.73
14	O/F8	5	0.99

4.4.2.4 Bulk environmental samples

A number of bulk samples taken through the trench section were asessed. The samples measured *c* 10 litres in volume and had been collected from each stratigraphic unit down to the base of the excavation, in order to retrieve plant macrofossils, molluscs and identifiable plant material suitable for radiocarbon dating. The plant macrofossils could be used to indicate the nature of the local palaeoecology, reconstruct the on-site vegetation and also provide data comparative to the pollen results. As the trench consisted of overlapping sampled sections, only certain bulk samples were selected for assessment to create a complete sampled section. The sample information is presented in the table below. The assessed samples are indicated by an asterix.

Table 4: Bulk environmental samples taken through trench sequence

Sample No.	Vol/Litres	Context Sampled
2*	10	2
3*	10	3
4*	10	4
7*	10	8
8*	10	7
9*	10	7
10*	10	6
11*	10	6
12*	10	6
13*	10	5
14*	10	5
15*	10	4
20	10	10
21	10	10
22	10	10
23	10	9

24*	10	9
25*	10	9
26*	10	9
27	10	8
28	10	7
29	10	6
32*	10	10
33*	10	10
34*	10	10
35*	10	11
36*	10	11
37*	10	11
38*	10	12
39*	10	12
40*	10	12
44*	10	13
45*	10	13
46*	10	14
47*	10	15
48*	10	15
49*	10	15
50*	10	15
51*	10	15
52*	10	15
53*	10	15

* = Samples selected for assessment

5 Results of the investigations

5.1 Watching brief

The cable trench measured *c* 190m in length and varied in width between 1.5 to 2m. It was excavated to a maximum depth of *c* 0.8m (see Fig 3a). The location of the trench is illustrated on Fig 2. The trench revealed mixed deposits of made ground consisting of fine to coarse gravels, yellow and orange sands, and clinker, often within a matrix of dark greyish brown silty clay. The deposits contained frequent yellow and red brick fragments (including yellow frogged 'Parco' bricks),

Approximately 90m from the northern end of the trench, a single course of red bricks at least two bricks wide was observed (see Fig 3b). The bricks were laid end to end on edge and rested on a concrete slab. The bricks were un-frogged, probably fire bricks, measuring 225mm x 100mm 70mm. These structural remains lay approximately 0.5m below the modern slab. This course of bricks may once have formed a structure associated with dockside loading and un-loading activities. This formed the only feature of note within the trench

5.2 Strip map and sample

The initial exploratory trench (3m x 1.5m), within the area of the proposed strip and map, revealed 2m of modern graded material (backfill/made ground) over disturbed natural clays at *c* 4m OD. Historic map evidence (i.e. OS map 1894–6) shows a bench mark at 19'6", or 5.94m OD, to the south of the dockside warehouse on the site. This is approximately the same as the present ground level, suggesting that only foundations should survive beneath the current ground slab.

To confirm whether any evidence of the warehouse buildings marked on the 1867 OS map survived, an additional 1m wide trench was machine excavated (Fig 4). The trench was excavated immediately south of the previous investigation slot. The trench extended for 20m from north–south to a depth of 1m within the area of the proposed strip and map. It crossed the area in which west-east walls were marked on the 1867 OS map.

Along the full length of the trench was a homogenous mid brown made ground deposit formed of well-sorted gravels with fine sand. This deposit suggested that the area of the proposed strip and map lay within an area of land that had been reduced and reformed to its original level with graded material.

5.3 Trench excavation

The log table below describes and interprets the major characteristics of the sedimentary sequence recorded in the trench section. The sequence was used to update and refine the facies associations presented in the previous geoarchaeological borehole survey (Halsey 2010b). A full discussion on the facies associations is given in section 7. The section and sampling locations are illustrated in Fig 5. The photograph in Fig 6 illustrates the upper part of the alluvial sequence. Fig 7 shows the trench section being examined by MOLA Geoarchaeologists.

Table 5: Sequence recorded in trench section

Top of recorded section at 1.71m OD

Unit No.	Context	Depth (m)	Deposit characteristics	Interpretation	Facies Association
1.1	1	0–0.2	Firm heterogeneous deposit consisting of soft dark brown **organic clay** and firm mid greenish grey **silty clay**. Occasional fine to medium gravel, occasional wood fragments, occasional sand lenses	Redeposited alluvium, mixed with dumped anthropogenic material	***Facies 7A***
Sharp					
1.51m OD					
1.2	2	0.2–0.39	Moderately firm mid grey **silty clay** with blocky ped structure, and occasional manganese staining	Alluvial accretionary soils, formed by seasonal overbank flooding, within a grassland floodplain environment.	***Facies 6C***
Diffuse					
1.3	3	0.39–0.52	Firm light grey **clay** with frequent manganese staining and occasional fine root channels		
Very diffuse					
1.4	4	0.52–0.71	Firm mid grey **clay** with frequent manganese staining, slight blocky ped structure		
Clear and diffuse					
2.4	5	0.71–0.98	Firm massive mid grey **clay** with occasional manganese staining		
Sharp					
0.73m OD					
2.3	6	0.98–1.29	Friable mid greyish brown humic **silty clay** with blocky fine ped structure and frequent manganese staining on ped faces. Occasional very fine brown hair roots visible. Very thin (c 0.01m) layer of compressed organics/yellowish brown grass stems at very top of unit, forming 'O' horizon. Represents period of floodplain stabilization and development of vegetated land surface.	Period of floodplain stabilisation with the formation of a fully terrestrial floodplain soil within the alluvial sediments. Context [6] likely to represent a preserved 'A' horizon. Upper organic band of compressed organic material represents preserved 'O' horizon	***Facies 6B***
Diffuse, clear					

Unit No.	Context	Depth (m)	Deposit characteristics	Interpretation	Facies Association
0.42m OD					
2.2	7	1.29–1.44	Firm dark grey **clay** with frequent yellowish grey calcareous inclusions present on ped faces and along fine hair root channels	Alluvial clays deposited within a mid to high salt marsh environment, regular inundation through tidal flooding. Transition to accretionray floodplain soils within upper part of the profile	***Facies 6A***
Very diffuse					
2.1	8	1.44–1.56	Firm light grey **clay** with frequent whitish grey calcareous inclusions present on ped faces and along fine hair root channels		
Very diffuse					
3.1	9	1.56–1.88	Firm massive mid grey **clay** with frequent greyish white calcareous flecking		
Diffuse and clear					
4.3	10	1.88–2.51	Soft massive light grey **clay** with occasional greening grey mottling		
Diffuse					
4.2	11	2.51–2.84	Soft mid to dark grey **clay** with frequent manganese flecking		
Clear					
-1.13m OD					
4.1	12	2.84–3.18	Soft light brownish grey slightly **clayey silt**, with fine laminations, occasional very fine sand, very occasional detrital organics, very fine rootlets, occasional fragmented stems	Marginal intertidal mudflats with elements of low to mid saltmarsh. Discontinous silt lenses indicate flow of intertidal flood waters through minor runnels, dissecting the mudflats, as tidal waters recede. Areas episodically cut off from the tidal influence allowing the formation of vegetated pools of water in back swamp areas.	***Facies 5B***
Diffuse					
5.4	13	3.18–3.34	Soft light brownish grey **clayey silt** with occasional detrital organics. Thin discontinuous, wavy parallel laminations, dipping at c 30 degrees angle. Consist of medium silts, possible tidal couplets (?), fills of minor runnels		
Diffuse					
5.3	14	3.34–3.42	Soft greenish blue **organic clayey silt,** with occasional detrital organics		
Diffuse					
-1.71m OD					
5.2	15	3.42–4.12	Soft pale brownish grey fine **silty sand**, with faint horizontal bedding, occasional detrital organics, small plant fragments	Fluvial silts deposited within main channel belt of tidal creek. The deposits generally display a fining up sequence as indicated by the increase in clay content up through the profile. Suggests waning flow conditions and drop in channel velocity, as the transition to intertidal marginal mudflats occurs	***Facies 5A***
Diffuse					
5.1	16	4.12–4.54	Soft pale bluish grey **clayey silt**, with moderate detrital organic inclusions		

6 Quantification and assessment

6.1 Post-excavation review

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

- Contexts (assigned to the archaeological trench) and unit numbers (assigned to the boreholes) have been correlated and grouped together into site wide facies associations. This updates the facies model determined in the previous Geoarchaeological and Archaeological evaluation report (Halsey 2010b)
- The borehole and trench data has been entered into the Rockworks 2006 digital database
- The trench deposit sequence was subsampled and assessed for ostracods, forams, diatoms, plant macro fossils and radiocarbon dating material.
- One radiocarbon date has been obtained for the basal sand deposits within USCMoLBH3, and two for the deposits in the trench section

6.2 The site archive and assessment: stratigraphic

Table 6: Stratigraphic archive

Stratigraphic archive			
Type	**Description**	**Quantity**	**Notes**
Contexts	Excavation	16	Trench contexts
Plans	'A4' 1:20 (no. of sheets)	2	Trench plan
	'A4' 1:200 (no. of sheets)	4	Strip map and watching brief area
Sections	'A4' 1:10	5	Trench, 5 detailed geosections
	'A4' 1:20	1	Trench, composite section of the 5 geosections
Photographs		Colour (54)	Trench section and working shots
		Colour (9)	Strip map and sample exercise
		Colour (67)	Watching brief on cable trench
Other records	Borehole logs	5	5 log tables describing the geoarchaeological boreholes

6.3 Site archive: finds and environmental, quantification and description

This section quantifies the palaeoenvironmental and artefactual material recovered from the site and presents the results of the various specialist assessments.

Table 7 Finds and environmental archive general summary

Bulk environmental samples	One archive box; 30 wet flots
Finds	No finds

6.3.1 Diatoms

Dr Nigel Cameron, Environmental Change Research Centre, UCL

6.3.1.1 Introduction

Eight sediment sub-samples have been assessed for diatoms as shown in the table below.

Table 8: Sub-samples assessed for diatoms

Diatom Sample	Sample Height (m) OD	Context	Sediment type
D1	-2.73	15	silty sand
D2	-2.27	15	silty sand
D3	-1.69	15	silty sand
D4	-1.21	12	clayey silt
D5	-0.16	9	clay
D6	0.29	7	clay
D7	0.71	6	clay
D8	0.97	5	clay

The purpose is to assess the potential to use diatom analysis of the trench section for environmental reconstruction. Of particular interest in the geoarchaeological evaluation is the comparison of the USC10 sediment sequence with the Lateglacial sediments, and overlying Holocene alluvial sequence found at the Silvertown site (Wilkinson et al 2000). The diatom assessment takes into account the numbers of diatoms, their state of preservation, species diversity and diatom species environmental preferences.

6.3.1.2 Methods

Diatom preparation followed standard techniques (Battarbee 1986, 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 x400 and x1000 under phase contrast illumination.

Diatom floras and taxonomic publications were consulted to assist with diatom identification; these include Hendey (1964), Werff & Huls (1957-1974), Hartley et al (1996) and Krammer & Lange-Bertalot (1986-1991). Diatom species' salinity preferences are discussed using the classification data in Denys (1992), Vos & de Wolf (1988, 1993) and the halobian groups of Hustedt (1953, 1957: 199), these salinity groups are summarised as follows:

- Polyhalobian: >30 g l^{-1}
- Mesohalobian: 0.2-30 g l^{-1}
- Oligohalobian - Halophilous: optimum in slightly brackish water
- Oligohalobian - Indifferent: optimum in freshwater but tolerant of slightly brackish water
- Halophobous: exclusively freshwater
- Unknown: taxa of unknown salinity preference.

6.3.1.3 Results & Discussion

The results of the diatom assessment for the site are shown in Table 9 and the diatom species recorded are shown in Table 10 along with their halobian classifications.

Table 9: Summary of diatom evaluation results

Sample No.	**Diatoms**	***Diatom numbers***	**Quality of preservation**	**Diversity**	**Assemblage type**	**Potential for % count**
D1	present	mod	mod to poor	mod	bk fw	good
D2	present	mod	mod to poor	mod	fw bk	good
D3	present	mod	mod to poor	mod	bk fw	good
D4	present	mod	mod to poor	mod	bk	good
D5	present	very low	very poor	2 fragments	unknown	none
D6	absent	-	-	-	-	none
D7	present	very low	very poor	low	aero fw	none
D8	absent	-	-	-	-	none

(mod – moderately high, fw – freshwater, bk – brackish, mar – marine, hp – halophilous, aero - aerophilous)

Table 10: Diatom species classification

	Laboratory Sample Number					
Diatom Taxon	**D1**	**D2**	**D3**	**D4**	**D5**	**D7**
Polyhalobous						
Biddulphia sp.			1			
Coscinodiscus sp.		1				
Cymatosira belgica		1	2	2		
Dimeregramma minor	1					

Diatom Taxon	Laboratory Sample Number					
	D1	D2	D3	D4	D5	D7
Paralia sulcata	1	1	1	2		
Plagiogramma vanheurckii		1				
Podosira stelligera	1					
Rhaphoneis amphiceros				1		
Rhaphoneis minutissima	1	1	3	1		
Rhaphoneis sp.			1	1		
Rhaphoneis surirella	1		1	1		
Polyhalobous to Mesohalobous						
Actinoptychus undulatus		1	1			
Ardissonia crystallina			1			
Cocconeis scutellum			1			
Navicula flanatica		1				
Mesohalobous						
Achnanthes delicatula	1					
Bacillaria paradoxa	1					
Campylodiscus echeneis	1					
Cyclotella striata	3	2	2	3		
Diploneis aestuari	1					
Navicula gregaria	1		1	1		
Navicula salinarum				1		
Nitzschia hungarica			1			
Nitzschia navicularis		1				
Synedra tabulata				1		
Mesohalobous to Oligohalobous Halophilous						
Actinocyclus normanii	2	1	2	2		
Nitzschia levidensis	2	2		2		
Oligohalobous Halophilous						
Cyclotella atomus		1	1			
Diatoma tenue		1				
Navicula mutica				1		
Oligohalobous Halophilous to Indifferent						
Epithemia sorex			1			
Gomphonema olivaceum	1					
Oligohalobous Indifferent						
Amphora pediculus		1	1			
Cocconeis placentula & var.		1	1	1		
Diatoma vulgare	1					
Ellerbeckia arenaria	1					
Fragilaria brevistriata		1				
Fragilaria construens var. venter				1		
Fragilaria pinnata	3	3	3	3		
Hantzschia amphioxys						2
Navicula hungarica				1		
Navicula perpusilla						1
Nitzschia amphibia				1		

Diatom Taxon	Laboratory Sample Number					
	D1	D2	D3	D4	D5	D7
Pinnularia borealis						1
Unknown Salinity Group						
Achnanthes sp.			1			
Cymbella sp.			1			
Denticula sp.	1					
Navicula sp.	1	1	1	1		
Nitzschia sp.	1	1		1		
Pinnularia sp.						1
Surirella sp.		1		1		
Indeterminate centric fragment					1	
Indeterminate pennate fragment					1	

Diatoms are present and relatively well preserved in the four lower samples (-2.73 m OD to -1.21 m OD) in the trench section sequence. In these four samples the moderately high numbers of diatoms and species diversity indicates that there is good potential for percentage diatom counting and further diatom analysis. However, in the top four samples (-0.16 m OD to 0.97 m OD) from this sequence, diatoms are absent from samples D6 and D8, whilst only two small indeterminate diatom fragments were recorded in D5. The poorly-preserved diatom assemblage present in D7 is composed entirely of aerophilous, freshwater diatoms. There is therefore no further potential for diatom analysis of the samples from -0.16 m OD to 0.97 m OD).

The four lower samples (D1-D4) contain diatom assemblages that are a mixture of mesohalobous, oligohalobous indifferent and polyhalobous taxa. All four of these samples (from Contexts16, 15 and 12) show that the environment of the lower River Lea/Thames confluence was tidal at this stage. The (allochthonous) marine, polyhalobous element, including diatoms such as *Cymatosira belgica, Paralia sulcata* and *Rhaphoneis* spp. appears to be most common in samples D3 and D4. Mesohalobous diatoms, particularly the planktonic, estuarine species *Cyclotella striata*, are common or abundant in all four samples. Other estuarine taxa that are common in these samples are the planktonic species *Actinocyclus normanii* and the benthic diatom *Nitzschia levidensis* (both classified in the mesohalobous to halophilous halobian group). The most abundant oligohalobous indifferent (freshwater) diatom is *Fragilaria pinnata*. However, this diatom has broad salinity tolerance, though it has optimal growth in freshwater. Other, non-planktonic, freshwater diatoms include *Cocconeis placentula* and *Amphora pediculus*.

The diatom assemblage in D7 (Context 6) is associated with sediments thought to represent a period of floodplain stabilisation and the development of a vegetated land surface. The aerophilous species (*Hantzschia amphioxys, Pinnularia borealis, and Navicula perpusilla*) identified in D7 are diatoms that are typical of soils and are consistent with this interpretation.

Although radiocarbon ages were not available at the time of writing, comparison with the Lateglacial sediments at the Silvertown site (Wilkinson *et al.* 2000) may be relevant. The basal sediments from Silvertown, analysed for pollen, are associated with the Loch Lomond Stadial (Wilkinson *et al.* 2000). However, the presence and dominance of polyhalobous (marine) and mesohalobous (estuarine) taxa in the Royal Victoria Dock sequence indicate that a pre-Bronze Age date is unlikely for the base of the trench deposit sequence section.

6.3.1.4 Conclusions

- Diatoms are present in lower four samples from the trench sequence. Diatoms are absent from samples D6 and D8 and only indeterminate fragments are present in D5. An aerophilous, freshwater diatom assemblage of limited diversity is present in sample D7.
- There is good potential to make percentage diatom counts and to carry out diatom analysis for the bottom four samples (D1-D4). There is no potential for further diatom analysis of the top four samples (D5-D8)
- The four lower samples show that the lower River Lea/Thames confluence was tidal during this period. The dominant component of the assemblages is one of estuarine plankton with some estuarine benthic taxa present too. Allochthonous marine diatoms are also present, and these polyhalobous taxa are particularly common in samples D3 and D4. The most common freshwater species, present throughout the lower part of the section, has wide salinity tolerance.
- The diatom assemblage of sample D7 contains diatoms typical of soil.
- The brackish-marine, estuarine diatom assemblages present at the bottom of the section indicate that a basal date earlier than the Bronze Age is unlikely for these sediments.

6.3.2 Ostracods

Dr John E. Whittaker

6.3.2.1 Introduction

Eight samples were examined for foraminifera and ostracods in order to see how the depositional sequence compares palaeoenvironmentally with the West Silvertown site (Wilkinson *et al,* 2000).

6.3.2.2 Material and methods

Sub-sample no.	Bulk sample no.	Context	Sample height (m OD)	Weight (grams)
OF1	53	15	-2.27	200
OF2	47	15	-1.63	200
OF3	39	12	-1.13	200
OF4	36	11	-0.79	200
OF5	23	9	-0.12	200
OF6	8	7	0.37	200
OF7	12	6	0.74	200
OF8	14	5	0.99	200

Some 200g was taken from much larger sediment samples, in each case, and broken up by hand into small pieces and placed in ceramic bowls. They were then dried thoroughly in an oven. A little sodium carbonate was added (to help remove the clay fraction) and boiling water was poured over the sample. After soaking overnight each sample was then washed through a 75 micron sieve with hot water and the resulting residue decanted back into the bowl for drying in the oven. As some of the samples were rather organic this process had to be repeated to achieve a satisfactory breakdown. After final drying the samples were placed in labelled plastic bags. Picking was undertaken by first dry-sieving each sample into >500, >250, >150 and >75 micron fractions, then sprinkling a little of each fraction at a time onto a picking tray. A representative fauna of foraminifera and ostracods, where present, was then picked out into a 3x1” faunal slide and a semi-quantitative estimate of each species made by experience and by eye (on a several specimens/common basis). These data were then logged on a spreadsheet and notes were also made of other important organic remains in each of the samples and also logged on the same figure, this time merely on a presence/absence basis.

Table 11: Ostracods and Foraminifera classification

Organic remains

Context	***5***	***6***	***7***	***9***	***11***	***12***	***15***	
Sample no.	**OF8**	**OF7**	**OF6**	**OF5**	**OF4**	**OF3**	**OF2**	**OF1**
Height (m OD)	**0.99**	**0.73m**	**0.37**	**-0.12**	**-0.79**	**-1.13**	**-1.63**	**-2.27**
plant debris + seeds	**x**	**x**		**x**	**x**	**x**	**x**	**x**
insect remains	**x**	**x**				**x**	**x**	**x**
earthworm granules	**x**		**x**	**x**				
slug plates	**x**							
fish/amphibian bone	**x**							
molluscs	**x**		**x**	**x**		**x**	**x**	**x**
brackish/marine foraminifera	**x**		**x**	**x**	**x**	**x**	**x**	**x**
freshwater ostracods	**x**		**x**	**x**	**x**	**x**	**x**	**x**
brackish/marine ostracods			**x**	**x**	**x**	**x**	**x**	**x**
charophyte oogonia			**x**			**x**		
Diatoms					**x**	**x**	**x**	**x**

Ecology	***Semiterrestrial. Vegetated with adjacent freshwater. Limited brackish component in silt grade washed in.***	***Intertidal vegetated mudflats of open estuary (with fringing saltmarsh). Strong marine influence with evidence of storm surges (and sea-level rise), ultimately waning. Freshwater component from adjacent ditches introduced by overbank flooding and ?reworking.***

Brackish estuarine foraminifera

Context	***5***	***6***	***7***	***9***	***11***	***12***	***15***	
Sample no.	**OF8**	**OF7**	**OF6**	**OF5**	**OF4**	**OF3**	**OF2**	**OF1**
Height (m OD)	**0.99**	**0.73m**	**0.37**	**-0.12**	**-0.79**	**-1.13**	**-1.63**	**-2.27**
***Ammonia* sp. (brackish)**	x		x	xx	xx	xxx	xxx	xxx
Haynesina germanica	x		x	x	x	xxx	xxx	xx
Elpidium williamsoni	o			x	xx	xxx	xxx	xxx
Elphidium waddense						x	x	
Jadammina macrescens					x	x	x	x
Trochammina inflate						x	xx	x
	calcareous foraminifera of low-mid saltmarsh and tidal flats				**agglutinating foraminifera of mid-high saltmarsh**			

Marine Foraminifera

Context	***5***	***6***	***7***	***9***	***11***	***12***	***15***	
Sample no.	**OF8**	**OF7**	**OF6**	**OF5**	**OF4**	**OF3**	**OF2**	**OF1**
Height (m OD)	**0.99**	**0.73m**	**0.37**	**-0.12**	**-0.79**	**-1.13**	**-1.63**	**-2.27**
Nonion depressulus				x	x	xx	x	xx
Lagenids				x	x	x	x	x
Elphidium margaritaceum				x	x	xx	x	x
Miliolids						xx	xx	xx
Patellina corrugate						x	x	x
Elphidium excavatum						x		
Discorbids						x		
Planorbulina mediterranensis							x	x
	essentially marine species, but can penetrate outer estuaries							

Brackish estuarine ostracods

Context	*5*	*6*	*7*	*9*	*11*	*12*	*15*	
Sample no.	**OF8**	**OF7**	**OF6**	**OF5**	**OF4**	**OF3**	**OF2**	**OF1**
Height (m OD)	**0.99**	**0.73m**	**0.37**	**-0.12**	**-0.79**	**-1.13**	**-1.63**	**-2.27**
Loxoconcha elliptica				x	x	x	xx	x
Cyprideis torosa					x	x	x	x
Leptocythere porcellanea					x	xx	x	xx
Leptocythere psammophila						xx	x	xx
Leptocythere castanea						x	xx	x
Leptocythere lacertosa						x	xx	x
Xestoleberis nitida						o	x	x
	brackish ostracods of tidal flats and creeks							

Marine ostracods

Context	***5***	***6***	***7***	***9***	***11***	***12***	***15***	
Sample no.	**OF8**	**OF7**	**OF6**	**OF5**	**OF4**	**OF3**	**OF2**	**OF1**
Height (m OD)	**0.99**	**0.73m**	**0.37**	**-0.12**	**-0.79**	**-1.13**	**-1.63**	**-2.27**
Hirschmannia viridis			o	x	x	x	x	x
Cytheropteron nodosum			o		o		o	
***Semicytherura* spp.**				x	o	x	xx	xx
Pontocythere elongate				o		x	x	x
Urocythereis Britannica				o			o	
***Paradoxostoma* spp.**					o	xx	xx	x
Hemicythere villosa						x	xx	x
Cythere lutea						x		x
Palmoconcha guttata						x	x	x
Leptocythere tenera						x	x	x
Leptocythere pellucid						o	x	x
Heterocythereis albomaculata						o	x	x
Palmoconcha laevata							x	x
Loxoconcha rhomboidea							x	
Pontocypris mytiloides							x	
***Bythocythere* spp.**							x	x

essentially marine species, but can penetrate outer estuaries

"Exotic" ostracods

Context	***5***	***6***	***7***	***9***	***11***	***12***	***15***	
Sample no.	**OF8**	**OF7**	**OF6**	**OF5**	**OF4**	**OF3**	**OF2**	**OF1**
Height (m OD)	**0.99**	**0.73m**	**0.37**	**-0.12**	**-0.79**	**-1.13**	**-1.63**	**-2.27**
Robertsonites tuberculatus								**x**
Elofsonella concinna								**o**
Carinocythereis whitei						**x**	**x**	**x**
Aurila convexa						**o**	**x**	**x**
Jonesia acuminate						**x**	**x**	**x**
Anchistrocheles acerosa						**x**	**x**	**x**
Neonesidea globosa						**o**	**x**	**x**
	cold "northern" marine species			**warm "southern" marine species**			**shelf-living species, brought in by tidal surges**	

Freshwater ostracods

Context	***5***	***6***	***7***	***9***	***11***	***12***	***15***	
Sample no.	**OF8**	**OF7**	**OF6**	**OF5**	**OF4**	**OF3**	**OF2**	**OF1**
Height (m OD)	**0.99**	**0.73m**	**0.37**	**-0.12**	**-0.79**	**-1.13**	**-1.63**	**-2.27**
***Candona ?neglecta* (juvs)**	x		x			x	x	x
***Pseudocandona* sp. (juvs)**			x		x			x
Limnocythere inopinata					o	xx	xx	xx
***Ilyocypris* spp.**					o	x	x	x
Darwinula stevensoni					o	o	o	
Prionocypris zenkeri						o		
Cypria ophtalmica						o		
Cryptocandona vavrai						o		
Cypridopsis vidua								o

Cold/cool freshwater

Context	***5***	***6***	***7***	***9***	***11***	***12***	***15***	
Sample no.	**OF8**	**OF7**	**OF6**	**OF5**	**OF4**	**OF3**	**OF2**	**OF1**
Height (m OD)	**0.99**	**0.73m**	**0.37**	**-0.12**	**-0.79**	**-1.13**	**-1.63**	**-2.27**
Candona candida				x	x			
Cytherissa lacustris						x	x	x

cold/cool freshwater ostracod indicators

Foraminifera and ostracods are recorded: o - one specimen; x - several specimens; xx - common; xxx - abundant/superabundant

6.3.2.3 Results

Table 11 shows the results of the microfaunal analysis. The uppermost table shows the "organic remains". Seven of the 8 samples contained plant debris and seeds and some, especially from OF1-4, were very organic. Seven out of eight also contained foraminifera and ostracods, as will be discussed in detail later. Molluscs were found in six, although most were either scraps or as in OF1-3, juvenile spat. Insects remains were found in five samples. Large diatoms (>75 microns diameter) were seen in the four lower samples. Earthworm granules were found in three, charophyte oogonia (fruiting bodies of the stonewort) were found in two, and slug plates and fish/amphibian bone in one only (OF8).

The sequence is discussed from top to bottom. Taking the uppermost three samples first, OF8 (Context 5) was characterised by very common earthworm granules, fish/amphibian bone and a few slug plates. There was also plant debris and many small insects. This would seem to indicate a near-terrestrial environment with some vegetation, probably no more than wet grass, reeds and sedges, with small pools and near to the river; an early soil perhaps had developed. The molluscs remains are probably also terrestrial or freshwater, but are probably too fragmentary for even a specialist analysis. The one conundrum is the co-occurence of some extremely small brackish foraminifera indicative of a tidal mudflat. Earthworm granules would not be expected if the site was indeed brackish and foraminifera, on the other hand, cannot live in freshwater. The size of the foraminifera may indicate transport in the silt fraction of high tides from a brackish site nearby.

OF7 (Context 6) was very organic and contained much plant debris (often peaty) and seeds. Insect remains, especially small "bugs" were very common. There was nothing calcareous in the residue at all and a careful search did not reveal any agglutinating foraminifera (indicative of saltmarsh) that would be preserved in even the most inhospitable and reducing of environments. This appears to represent a well vegetated surface, in a probable riverine environment.

OF6 (Context 7) was similar to OF 8 except for the sediment. Earthworm granules were again very common as were mollusc fragments (and these seemed to be the remains of large gastropods). There were also many charophyte oogonia indicative of a small still freshwater body. The colour of the oogonia and earthworm granules was orange-brown as was the sediment, which preserved many clay-like structures around rootlets (but not typical true rhizolith tubes). They probably, however, indicate the same "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. Rhizoliths, along with other calcrete types, are typically used to indicate the existence of a dry climate, either a semi-arid climate or a humid climate with pronounced dry months". …Candy (*in* Ashton et al 2005: 16). A few brackish foraminifera (as in OF8), now joined by a few ostracods and both very small indeed, still indicate spring tides may have reached the site, albeit in the silt fraction. Freshwater ostracods, that might be considered indigenous in a fresh/near terrestrial environment, are surprisingly rare.

Real change is then indicated by the samples below. First, OF4 (Context 11) and OF3 (Context 9) contain common (but low diversity) brackish foraminifera and ostracods (colour-coded grey and lime-green respectively in Table 11). These are indicative of tidal mudflats and creeks. Sample OF4 also contains the first foraminifera (*Jadammina macrescens*) indicative of mid-high saltmarsh (Table 11, colour-coded blue-green). A few marine and outer estuarine foraminifera and ostracods are also found, but as discussed later, these represent the waning influence of storm surges and sea-level rise that typifies the earliest part of the sequence. On the other hand it can be said, from what has been described above, the interval between samples OF5 and OF 6 (-0.12m and 0.37m OD must mark the end of real tidal influence at the site.

The lowest three samples from OF1 (Context 15) to OF3 (Context 12) are remarkable in containing some of the most diverse microfaunas, in my experience, seen in the lower Thames estuary. The species lists in Table 11 are extensive, but they could have been much longer, many species being grouped together (e.g. lagenids, miliolids, *Semicytherura* spp., etc.) for convenience. What is certain they are not an indication of a freshwater fluvial environment, as was initially suggested by the sedimentological evidence

These microfaunas contain three components. First, an abundant brackish mudflat and saltmarsh component as indicated by the colour-coding in Table 11 (grey for calcareous foraminifera of low-mid saltmarsh and tidal flats; blue green for agglutinating foraminifera of mid-high saltmarsh) and lime green for brackish ostracods of tidal flats and creeks. Large diatoms are very common which suggests a healthy *in situ* foraminiferal population at least, as diatoms are both the food supply of foraminifera as well as some species having a symbiotic relationship.

The second component comprises the freshwater ostracods, which apart from *Limnocythere inopinata* are not common. Most can indeed tolerate low salinities and they appear to represent weedy pools and ditches that would have existed behind the tidal flats and might then have been introduced by rain storms and overtopping tides. More interestingly it contains two species usually recognised as cold/cool indicators (although both live in Britain today). The first is *Candona candida* which had occurred in OF4 and 5, but it is perhaps the occurrence of *Cytherissa lacustris* in OF1-3 that might be of more significance as this is usually associated with cold deep water and is common in Devensian deposits in the Bognor area (Bates et al 2009). Perhaps this is evidence of the reworking from the Lateglacial channel fills that were recorded by Wilkinson et al (2000), at Silvertown nearby.

It is however the third component, the marine event, that is indeed the most interesting. Its signature is marked by the influx of many ostracods and some foraminifera (colour-coded blue) that are “essentially marine species, but can penetrate outer estuaries”, together with a significant number of “exotic” ostracods. These latter include two “northern” forms (colour-coded bright blue), albeit in ones and twos, which today live no further south than North Britain, associated with two “southern” species (colour-coded yellow) which at the present day are at their northern limit of distribution along the English South Coast. Curiously, these “non-analogue” faunas are a feature of most South Coast marine interglacials and this may also have been the case in the early Holocene, but today they would not be found living together off SE England. Finally, also amongst the “exotics” there are three offshore shelf species (colour-coded orange) which could only have been brought in by storm or tidal surges, which would be the necessary accompaniment to a marine transgression with its vast input of sediment. There may be some reworking from older sediments, if they occur in the area; this cannot be ruled out. However, very similar microfaunas have been seen by the author from several boreholes on the Isle of Grain, Thames-Medway, of which their onset is reliably dated in one borehole (based on the AMS dating of foraminifera) (Whittaker, 2007) to 4200 yrs

BP. The flooding of that part of what is now coastal Kent, must have produced a much more open lower Thames estuary, less protected and prone to the extreme storminess, that would have accompanied these turbulent times (post-4200 yrs BP). Perhaps in a regional context the present day tidal and current patterns of the southern North Sea vis-à-vis the English Channel were becoming fully established, especially after the loss of Doggerland to the north at about *c.* 6000 yrs BP (Ward et al 2006). These authors, interestingly, also quote Shennan et al (2000), as stating that… "the highest relative sea-level along the east coast of the UK occurred around 4 ky…". We are clearly dealing with a significant period of time, if the oldest part of the Royal Victoria Dock sequence can indeed be dated to this period of time. Some form of radiocarbon dating of this lower sequence now is clearly paramount.

6.3.3 The botanical samples

Karen Stewart, MOLA

6.3.3.1 Introduction/methodology

Forty bulk environmental samples were taken and 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 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. The following two scales were used to record this material:

Abundance 1 = 1–10 items, 2= 11–50, 3 = 50+ items

Diversity 1 = 1–3 items, 2 = 4–7 items, 3 = 7+ items

Table 12 and Table 13 below, present the processing details and composition of each sample.

Plant material was preserved by charring and waterlogging.

6.3.3.2 Results

6.3.3.2.1 WATERLOGGED REMAINS

Waterlogged rootlets and possible stems were the most common of the plant remains noted in the samples. Mosses were also noted in low concentrations in a number of the samples.

Waterlogged seeds were also common, with the assemblages throughout the sequence dominated by taxa that prefer clean wet environments, such as crowfoots (*Ranunculus* subgenus Batrachium). Taxa such as sedge (*Carex* ssp) and rushes (*Juncus* ssp) were also common in most of the samples.

The earliest deposits of the section, representing context [15], contained the widest variety and best preserved plant remains, including crowfoots and alder (*Alnus glutinosa*). This suite of remains may indicate that an alder carr type environment was present during the deposition of the sediments represented in context [15]. The variety and richness of the plant remains decreased moving up the section, perhaps indicating a decrease in the level of waterlogging present, and thus preservation.

However, although the assemblages were not rich or diverse, they do indicate scrubbier, drier environments developing alongside the continuing wetland taxa, with the appearance of taxa such as Asteraceae, blackberry (*Rubus fruticosus*) and nightshades (*Solanum nigrum*).

6.3.3.2.2 CHARRED REMAINS

Charcoal was the only charred plant material present in the samples, and in all cases in very low concentrations. It first appears in the uppermost sampled portion of context [15], then in contexts [12], [7], [6], [5] and [4].

6.3.3.2.3 FAUNAL REMAINS

Ostracods were noted in samples representing contexts to [15] to [9].

6.3.3.3 Analysis of potential

The plant remains have the potential to aid in the reconstruction of the depositional environment through the sequence at the site.

6.3.3.4 Significance of the data

The data is of significance to the site only, but may be useful in comparison with other deposits of similar age in the area, and with other forms of environmental evidence from the site itself.

Table 12: Bulk environmental processing details

Context	Sample No.	Bulk Vol (L)	Vol. Retained (L)	Residue Vol.	Flot Y/N	Flot Vol (ml)
2	2	8	2	0	Y	25
3	3	8	2	0	Y	25
	4	8	2	0	Y	40
4	15	8	2	0	N	20
	13	8	2	0	Y	30
5	14	8	2	0	Y	10
	11	8	2	0	N	10
6	12	8	2	0	Y	60
	8	8	2	0	Y	10
7	9	8	2	0	Y	5
8	7	8	2	0	Y	10
	24	8	2	0	N	5
9	25	8	2	0	Y	10
	23	8	2	0	Y	5
10	33	8	2	0	Y	1
	35	8	2	0	Y	20
	36	8	2	0	Y	5
11	37	8	2	0	Y	15
	38	8	2	0	N	5
	39	8	2	0	N	10
12	40	8	2	0	Y	30
	44	8	2	0	Y	10
13	45	8	2	0	N	10
14	46	8	2	0	Y	40
	47	8	2	0	N	15
	48	8	2	0	N	30
	49	8	2	0	N	20
	50	8	2	0	Y	50
	51	8	2	0	Y	50
	52	8	2	0	Y	30
15	53	8	2	0	Y	25

Table 13: Plant remains by sample

Context	Sample	Constituent	Abundance	Diversity	Comment
2	2	terrestrial molluscs	1	1	
		miscellaneous waterlogged	1	1	RT,ST
		seeds	2	1	RAN,JUN
3	3	terrestrial molluscs	1	1	
		miscellaneous waterlogged	1	1	RT, ST
		seeds	2	1	RANACBURE, RANSC,POL
4	4	charcoal	1	1	
		miscellaneous waterlogged	1	1	
		seeds	1	1	RANACBURE
	15	miscellaneous waterlogged	1	1	
		seeds	1	1	RANACBURE
5	13	charcoal	1	1	
		terrestrial molluscs	1	1	
		miscellaneous waterlogged	2	1	RT,ST
		seeds	2	1	RAN, CAR,SOLNI,ASTE,JUN
	14	miscellaneous waterlogged	1	1	RT,ST
6	11	charcoal	1	1	
		miscellaneous waterlogged	2	1	RT,ST
		seeds	2	2	RUB,RANBA,RAN,STE,ELE
	12	miscellaneous waterlogged	3	1	RT,ST
		seeds	1	1	RAN
7	9	charcoal	1	1	
		miscellaneous waterlogged	1	1	ST,RT
8	7	miscellaneous waterlogged	1	1	RT,ST
		seeds	1	1	1RAN
9	24	miscellaneous waterlogged	1	1	
	25	ostracods	1	1	
		miscellaneous waterlogged	1	1	RT,ST

Context	Sample	Constituent	Abundance	Diversity	Comment
		seeds	1	1	RANBA, JUN
10	23	miscellaneous waterlogged	1	1	RT,ST
	33	miscellaneous waterlogged	1	1	ST,RT
11	35	miscellaneous waterlogged	2	1	RT,ST
		seeds	1	1	RUB
	36	miscellaneous waterlogged	1	1	
		seeds	1	1	
	37	ostracods	1	1	
		miscellaneous waterlogged	2	1	
		seeds	1	1	ALNGL
12	38	charcoal	1	1	
		miscellaneous waterlogged	2	1	RT
		moss	1	1	
		seeds	2	1	RANSC,JUN,CAR, ALI, RUB
	39	ostracods	1	1	
		miscellaneous waterlogged	1	1	
		seeds	1	1	CAR, RUB
	40	miscellaneous waterlogged	1	1	RT,ST
		seeds	1	1	POL
13	44	miscellaneous waterlogged	2	1	RT,ST,LF
	45	miscellaneous waterlogged	1	1	
		seeds	1	1	
14	46	ostracods	2	1	
		miscellaneous waterlogged	3	1	RT,ST
		seeds	1	1	RANSC, JUN
15	47	charcoal	1	1	
		ostracods	2	1	
		miscellaneous waterlogged	2	1	RT,ST
		seeds	2	2	RANSC,CHE,RANBA,VEROF
	48	ostracods	2	1	

Context	Sample	Constituent	Abundance	Diversity	Comment
		miscellaneous waterlogged	2	1	
		moss	1	1	
		seeds	1	1	JUN, POL
	49	ostracods	2	1	
		miscellaneous waterlogged	3	1	RT, ST, BD, LF
		seeds	2	2	SON, RAN,ALN,RUB,JUN,RANBA
	50	ostracods	3	1	
		miscellaneous waterlogged	1	1	
		seeds	2	1	HYD,JUN,APIA,ALNGL
	51	ostracods	1	1	
		miscellaneous waterlogged	3	1	RT,ST,LF,MOSS
		seeds	2	2	ALNGL,RUB,JUN
	52	ostracods	3	1	
		miscellaneous waterlogged	3	1	RT,ST,MOSS
		seeds	2	2	ALI,RANSC,POL,ALNGL,JUN
	53	ostracods	1	1	
		miscellaneous waterlogged	2	1	RT,ST,WD
		seeds	2	2	2 ALNGL,RANAC,API,RUM,CAR,POL,ALI,LYC

Table 14: Plant remains in relation to initial geoarchaeological interpretation

Context	Deposit characteristics	Interpretation	Plant remains
1	Firm heterogeneous deposit consisting of soft dark brown **organic clay** and firm mid greenish grey **silty clay**. Occasional fine to medium gravel, occasional wood fragments, occasional sand lenses	Redeposited alluvium, mixed with dumped anthropogenic material	N/a
2	Moderately firm mid grey **silty clay** with blocky ped structure, and occasional manganese staining	Alluvial accretionary soils, formed by seasonal overbank flooding.	Roots, buttercups, rushes
3	Firm light grey **clay** with frequent manganese staining and occasional fine root channels		Roots, buttercups, crowfoots
4	Firm mid grey **clay** with frequent manganese staining, slight blocky ped structure		Roots, buttercups
5	Firm massive mid grey **clay** with occasional manganese staining		Roots, buttercups, black nightshade, daisy, rushes. Charcoal.
6	Friable mid greyish brown **silty clay** with blocky fine ped structure and frequent manganese staining on ped faces. Occasional very fine brown hair roots visible. Very thin (c 0.01m) layer of compressed organics/yellowish brown grass stems at very top of unit, forming O/A horizon. Represents period of floodplain stabilization and development of vegetated land surface.		Charcoal. Bramble, buttercups, crowfoots, spike-rush, roots.
7	Firm dark grey **clay** with frequent yellowish grey calcareous inclusions present on ped faces and along fine hair root channels		Roots, charcoal
8	Firm light grey **clay** with frequent whitish grey calcareous inclusions present on ped faces and along fine hair root channels		Roots, buttercups.
9	Firm massive mid grey **clay** with frequent greyish white calcareous flecking	Intertidal muds ?deposited within a mudflat or salt marsh environment	Roots, crowfoots, rushes, ostracods towards base.
10	Soft massive light grey **clay** with occasional greening grey mottling		Roots
11	Soft mid to dark grey **clay** with frequent manganese flecking		Roots, brambles, ostracods and alder towards base

Context	Deposit characteristics	Interpretation	Plant remains
12	Soft light brownish grey slightly **clayey silt**, with fine laminations, occasional very fine sand, very occasional detrital organics, very fine rootlets, occasional fragmented stems	Fluvial silt. Freshwater ?. Sediments generally appear to fine upwards through the sequence with an increase in clay content up through the profile. Indicative of waning flow conditions, drop in channel flow velocity.	Charcoal towards top. Roots, buttercups, rushes, sedge, bulrush, fewer remains towards base.
13	Soft light brownish grey **clayey silt** with occasional detrital organics. Thin discontinuous, wavy parallel laminations, dipping at c 30 degrees angle. Consist of medium silts, possible tidal couplets (?), fills of minor runnels		Roots, leaves.
14	Soft greenish blue **organic clayey silt,** with occasional detrital organics		Roots, rushes, celery-leaved crowfoots, ostracods.
15	Soft pale brownish grey fine **silty sand**, with faint horizontal bedding, occasional detrital organics, small plant fragments		Charcoal at top only. Ostracods throughout. Alder carr type plants throughout, including alder, crowfoots, moss, sedge etc.
16	Soft pale bluish grey **clayey silt**, with moderate detrital organic inclusions		

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6.3.4 Pollen

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6.3.4.1 Introduction

A series of pollen samples taken from contexts (15,12, 9,7,6 and 5) spanning 2.7m of sediment from –2.73m OD to 0.97m OD have been examined for their sub-fossil pollen and spore content. It was perceived that these sediment archives could provide a useful record of the environment of deposition history, development of this site and data on the past vegetation and wider environment. Pollen and spores have been recovered, identified and counted from all of the samples and a pollen diagram has been produced (Fig 8). This report details the results of this pollen assessment study.

6.3.4.2 The pollen data

A series of 8 samples was selected from the various contexts of this 2.7m sediment sequence. Sub-samples of 1.5ml were processed using standard techniques for the extraction of the sub-fossil pollen and spores (Moore and Webb 1978; Moore et al 1991). Overall, pollen is sparse in these sediments. However, assessment counts/pollen sums of 150-180 grains per level were obtained from which a pollen diagram, has been constructed). Percentage calculations used for the sum and sub-groups are as follows.

Sum = % total dry land pollen (tdlp)
Marsh/aquatic herbs = % tdlp + sum of marsh/aquatics
Spores = % tdlp + sum of spores
Misc. = % tdlp + sum of misc. taxa (pre-quaternary and other microfossils; *Pediastrum*).

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

Table 15: Details of local pollen assemblage zonation

l.p.a.z. 2	Defined by a substantial reduction in the tree and shrub pollen of l.p.a.z. 1 and an increase of herb pollen numbers although diversity is

Contexts [5] [6] [7] 75cm to 0cm 0.20m OD to 0.97m OD	less (poorer preservation). Herbs remain dominated by Poaceae (to 65%) with *Ranunculus* type (8%), Brassicaceae (peak to 43% at 0.97m OD) (5), Lactucoideae (11%) and cereal type (16%). There are small numbers of fen taxa with Cyperaceae (declining) and *Typha angustifolia/Sparganium* type. There are increases in spores with *Dryopteris* type (to 25%), *Polypodium* (1-2% at base) and derived pre-Quaternary palynomorphs (30% sum + misc.). *Ascaris* (intestinal parasite) is present at 0.71m OD.
l.p.a.z. 1 Contexts [9] [12] [15] 270cm to 75cm -2.73m OD to 0.16m OD	Defined by greater numbers of tree and shrub pollen than in l.p.a.z.2 above including *Quercus* (to 15%), *Alnus* (av. 20%; peak to 37%) and *Corylus avellana* type (15%). The overall assemblage is diverse also with small numbers/sporadic occurrences of *Betula, Pinus, Ulmus Tilia, Fraxinus, Fagus, cf. Taxus, Salix* and *Viburnum*. Herbs are dominated by Poaceae (20-30%) with Chenopodiaceae (2-3%) and sporadic occurrences of a number of types including cereals and a single occurrence of *Cannabis sativa* type. There are very few aquatic/marsh taxa of which Cyperaceae (to 4%) is most important. *Potamogeton* type and *Pediastrum* occur in the upper levels of this zone. There are few spores with only small numbers of *Pteridium, Dryopteris* type and *Polypodium.*

6.3.4.3 The past vegetation and environment

The pollen assemblages can be considered and interpreted in relation to the on-site vegetation and that coming from nearby, drier land and from more regional sources. In common with pollen obtained from differing sedimentary regimes, the changing taphonomy will also have influenced the character and content of the pollen assemblages.

6.3.4.3.1 THE ON-SITE VEGETATION

There are two distinct sedimentary habitats indicated by the pollen assemblages. These equate to the lower, fluvial silts which change into floodplain (? overbank deposition) alluvium with possible evidence of marine ingress.

Initially (context 15; the lower part of l.p.a.z. 1), there is little evidence of freshwater fluvial conditions. Grasses are dominant with some sedge. It is difficult to characterise this depositional environment but given the sediment character it appears that this was either a floodplain or, more probably, a river channel fringed by marginal aquatic, fen herbs and also some alder and willow. It should be considered that fluvial transport of pollen might also have played a role in the pollen assemblages.

Towards the top of l.p.a.z. 1 (15 & 12) there is evidence of increasingly wet conditions shown by incoming *Pediastrum (alga)* also with increases in sedges (Cyperaceae), bur reed and/or reed mace (*Typha angustifolia* type) and *Potamogeton* type (probably pond weed but possibly also arrow grass). This is in accord with the geoarchaeological interpretation of the stratigraphy suggesting a slow flowing, low energy environment.

From *c* 80cm (9) there is an expansion of pollen of Chenopodiaceae (goosefoots, oraches and samphire) that may be halophytes from salt marsh and upper mud flat (Salicornia). This is similarly in accord with suggestions made for the stratigraphy.

Contexts (7, 6, & 5; l.p.a.z. 2) show a clear change in the sedimentary environment and resulting changes in the pollen taphonomy. Preservation is poorer in these upper sediments with evidence of differential preservation in favour of those taxa with robust exines (the pollen wall). These include typically Brassicaceae (charlocks) and Lactucoideae (dandelion types), along with spores of ferns (*Dryopteris* type) and much older, derived geological palynomorphs, the latter from reworking of older sediment and erosion of bedrock. However, other less robust taxa remain, including grasses (Poaceae) which, given the substantial numbers/percentages, probably come from on-site growth in salt marsh or in a fen habitat on the river floodplain. If this was a floodplain with overbank flooding, there may also have been ephemeral brackish water inundation.

6.3.4.3.2 THE TERRESTRIAL ZONE

The fact that lime (*Tilia*) pollen is almost absent provides a strong indication that the lowest part of this profile dates to the very late prehistoric (late Bronze Age) period at earliest. Prior to *c* 3500 BP, *Tilia* was widespread and dominant or co-dominant (with oak) over much of London (Scaife 2000a, 2000b) and indeed southern and eastern England (Moore 1977). Its decline due to clearance for agriculture, although asynchronous, generally occurred within the late Neolithic and especially the middle Bronze Age (Scaife 2000a; Wilkinson *et al.* 2000). After this event, oak and hazel, as seen here, remained important with their pollen probably derived from remaining regional woodland and copses growing on heavier soils on lower valley slopes. This is the case here in l.p.a.z. 1, (contexts 15 to 9). Other tree taxa recorded in l.p.a.z. 1 include small numbers of birch (*Betula*) and pine (*Pinus*) which probably also come from more regional or long distance sources (being copious producers and anemophilous). Sporadic occurrences of ash (*Fraxinus*), lime (*Tilia*) and beech (*Fagus sylvatica*) are by comparison, poorly represented in pollen spectra/assemblages. Their presence here possibly suggests some local, occasional growth. Alder (*Alnus*) and willow (*Salix*) as noted would have been fringing the edge of the floodplain/marsh.

During l.p.a.z. 1 (15 - 9) the herb assemblages are dominated by grasses with a small number of other taxa; the taxonomic diversity is low. Although a proportion of the former will have come from the on-site fen/marsh, pollen from surrounding grassland may also be present. There are also small numbers of cereal pollen, obviously indicating arable activity although numbers of pollen and associated segetals are small in this lower zone. Hemp and/or hop (*Cannabis sativa* type) is present at –1.21mOD and may be from cultivation of hemp for fibre. However, this pollen taxon includes both hop and hemp and cannot usually be separated in sub-fossil form due to similar pollen morphology. Hop is a native of fen carr woodland and it is also possible that its presence is associated with the fringing alder.

There is a clear change in the pollen taphonomy from 0.29mOD upward (l.p.a.z. 2) (contexts 7-6) with change to a regime of probable overbank alluvial sedimentation. It is also possible that there is a hiatus in the sediment resulting in a strong change in the pollen assemblages. Woodland appears to be of much lesser importance with negligible quantities of even oak, hazel and alder. Slightly greater numbers of pine reflect both the poorer preservation in these upper sediments and also the propensity for over representation of pine in alluvial/fluvial sediments. In contrast, herbs are important and dominated by grasses also with significant numbers of cereal pollen. Because these are sediments, the pollen may have been fluvially transported from some distance. Furthermore, the cereal pollen may also be from secondary sources such as anthropogenic material (domestic waste including food and faecal material, offal, floor covering or crop processing waste) which was dumped on the flood plain or in the river. The latter is a strong possibility because an ovum of *Ascaris* (intestinal round worm) was also recovered from this zone context 6) at 0.71m OD.

6.3.4.4 Age and Comparison with other sites

There are two published pollen sites from Silvertown at Fort Street (Crockett et al. 2002) and (Wilkinson et al. 2000). Whilst these might act as comparisons from data obtained from the Urban Sustainability Centre, these sites date to much earlier periods with sediments back to the early Holocene at the latter and peat of Neolithic age forming between 4410+/-60 BP (3340-2910 cal BC) and 3250+/-60 BP (1680-1420 cal BC). These profiles show the importance of trees and woodland throughout most of the pollen profiles, including Tilia during the late prehistoric period (noted as more or less absent in USC site). However, the upper levels of these sites, in common with the majority of late-prehistoric London Thames floodplain sites, show increasing wetness and change from alder carr floodplain woodland to a wet grass-sedge fen and subsequently the deposition of floodplain alluvial sediments. This was the result of rising relative sea level with rising base levels instigating a negative hydrosere. The widespread deposition of riverine alluvium occurred in the late Bronze Age-Iron Age and it appears that data presented here form part of this later phase of sedimentation (pollen zone E of Scaife in Wilkinson et al. 2000).

6.3.4.5 Summary

The following principal points have been made.

- The depositional environment described from sedimentological examination is broadly verified by the palynology.
- This profile appears to be of late Bronze Age date or later as indicated by the absence of lime/linden pollen in any substantial numbers.

- Initially, a probable alluvial floodplain existed. This became wetter with growth of a fringing, herb dominated fen (12-9) which probably had standing or slow flowing water.

- The increase of Chenopodiaceae pollen (goosefoots and oraches) from *c*. 0.16m (9) may be come from halophytes indicating brackish water or local salt marsh.

- There is a major change in the palynology between 0.16m OD and 0.29m OD (l.p.a.z. 1-2) which may also be a stratigraphical hiatus with a change to alluvial sediments (contexts 5-7) with possibility of occasional brackish water ingress.

- The pollen taphonomy also changes with a sharp increase in numbers of thick walled pollen grains indicating differential preservation and over representation of these taxa.

- The pollen sequence, as noted above, post-dates periods of earlier lime importance. Oak and hazel pollen remain the predominant taxa through most of the profile (l.p.a.z 1) (15-9) probably coming from remaining woodland/copses. Ash and beech and occasional lime may have been growing within the pollen catchment (both airborne or fluvial sources).

- The uppermost contexts (5-7) (l.p.a.z. 2) appear almost devoid of tree and shrub pollen apart from a slight increase of birch and pine which are not considered of significance (i.e. they are a long distance and over represented component).

- Evidence for agriculture is sparse in l.p.a.z. 1 with only occasional cereal pollen as an indication of some cereal cropping. Pastoral activity is always more problematic in interpretation because of the catholic nature of grasses and their high pollen productivity. However, small numbers of ribwort plantain and the importance of grasses would suggest at least some terrestrial grassland/pasture component.

- A single grain of hop/hemp type may be from cultivation of the former for fibre or from natural hop growth in a wooded fen environment.

- After the change to l.p.a.z. 2 (5-7) there is a sharp increase in cereal pollen. This may have come from local cultivation or from secondary sources such as dumped domestic waste of various sorts especially human and animal faecal material and butchers offal. This is indicated by the intestinal parasite *Ascaris* at 0.71mOD.

6.3.4.6 Recommendations

This pollen profile spans the very late prehistoric period at its earliest and more probably the early historic period. This period has not been examined in detail at other Silvertown and near sites where sediments have been of predominantly prehistoric age. This site/sequence therefore fills this lacuna in the sedimentary and environmental history of this region. If publication of these data is planned, fuller pollen analysis will be required. This should comprise a closer sampling interval and with increased numbers of pollen grains identified and counted. This would provide greater bio-stratigraphical resolution and taxonomic detail.

6.3.5 Radiocarbon dating

Introduction

After death, living organisms cease carbon exchange with the biosphere and the naturally occurring radioactive isotope of carbon (^{14}C) in the organism begins to decay to ^{14}N. Measuring of the ratio of the amount of the ^{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 conventional radiocarbon age, quoted with a plus or minus sign reflects the number of radiocarbon years before 1950 ('the present' [BP]) based on an assumed constant level of ^{14}C in the atmosphere. The conventional radiocarbon age is sometimes called the radiocarbon determination or raw radiocarbon age to avoid confusion with a true calendar date.

Method

Identifiable plant macro fossils obtained from two of the bulk samples within the trench excavation were submitted to ^{14}CHRONO Centre, Queens University Belfast for AMS dating. The samples were taken to date the base of the trench sequence, and the possible soil horizon that had formed within the upper minerogenic alluvial deposits.

One bulk sample was submitted to Beta Analytic for standard radiometric dating on the total humin fraction. Unfortunately there was not enough organic material within this sample for radiometric dating. Therefore the plant macro fraction of the samples was submitted for AMS dating. As the plant remains within this sample were fragmentary and unidentifiable the dating of this sample should be treated with caution.

The AMS technique separates the particles within the sample by charge so that the number of atoms of the radioactive isotope of carbon (^{14}C) can be counted. This increases the sensitivity of radiocarbon dating and enables small samples to be analysed. The organic fractions of the sediments were pre-treated with acid washes to eliminate carbonates that can hold old, inorganic carbon.

The error (± 40 etc) represents the statistical uncertainty or 'precision' of the method (a range of 2 relative standard deviations from the mean [2σ]). Precision is often increased when AMS, as opposed to radiometric technique, is employed.

Results and Discussion

The results of the radiocarbon dating are presented in Table 16. The sampling locations are illustrated on Fig 5 and Fig 9. As radiocarbon has fluctuated markedly over time[1], radiocarbon determinations require calibration. Calibration curves compare the radiocarbon determination with measured fluctuations in radiocarbon[2] to obtain calendar ages. Calibrations were made using Oxcal 4.1.7 (Bronk Ramsey, 1995, 2001, 2010) with the IntCal04 calibration curve (Reimer *et al.*, 2009).

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[1] Due to long-term variations in the production of ^{14}C in the upper atmosphere and various global carbon reservoirs (the biosphere, atmosphere and hydrosphere)

[2] tree ring series, varved lake deposits, speleothems, coral and deep ocean records

Table 16: 14C results

MOLA ref	Lab No.	Height (m OD)	Sample type/Method/Pre-treatment	Taken from/context, unit no.	δ13C (‰)	Uncalibrated date (BP)	Calibrated date (2σ) (95% probability)
USC10BH3	Beta-298683	*c* -3.10	Detrital organics within sediment/AMS dating/acid and alkali washes	Organic lenses within basal sands, unit 3.5, facies 3	-27.1	3680+/-30	Cal BC 2191–1965
USC10S16	UBA-17721	*c* 0.73	Buttercup seeds/AMS dating/acid washes. Recovered from bulk sample {16}	'O' soil horizon within upper alluvial trench sequence, context 6, facies 6B	-22.4	379+/-30	Cal AD 1445–1632
USC10S53	UBA-17722	*c*-2.20	Alder wood fragment/AMS dating/ acid washes. Recovered from bulk sample {53}	Basal fluvial silts within trench sequence, context 15, facies 5A	-21.3	4356+/-32	Cal BC 3086–2901

7 Synthesis of the data

In this section the deposits are discussed in terms of the defined facies associations, from the oldest to the most recent. The results of the specialist assessments and radiocarbon dating are synthesised here with the sedimentological evidence to refine the stratigraphy and deposit chronology presented in the previous evaluation report (Halsey, 2010b).

The facies associations and lithology recorded within the boreholes and the archaeological trench are illustrated in the transect drawn across the site (Fig 9). A key to the facies associations and the individual lithologies is provided with the transect.

The trench deposit sequence and the sampling locations are also illustrated in Fig 5. This figure also provides a useful summary and synthesis of the palaeoenvironmental evidence to infer the environment of deposition represented by each context. Dates in BP are quoted in calibrated years (before present, i.e. before 1950). Where specific radiocarbon dates are referred to lab references are given along with the publication and/or report reference. Definitions for the geoarchaeological terms highlighted in bold are given in section 13.

The reader should note that facies associations not present within the site boundary are also discussed within the text, with particular reference to the archaeological investigations undertaken on the West Silvertown Urban Village development (WSUV, Wilkinson *et al* 2000). The correlation between the deposits on USC and WSUV is fundamental in understanding the wider floodplain landscape, and the chronology and environments of deposition represented by the suite of deposits preserved on the USC site.

7.1 Facies 1: Late Pleistocene Shepperton floodplain gravels c 18,000 –15,000 BP

The interpretation and characteristics of Facies 1 remains as stated in the previous evaluation report. These deposits were not encountered during the excavation of the archaeological trench.

The basal deposits consisted of mid greyish brown moderately sorted sandy gravels. These deposits are associated with the **Shepperton Gravel** formation and accumulated within a cold climate **braided** river environment during the **Last Glacial Maximum** of the Late Devensian (Gibbard, 1985, 1994). The accumulation of these gravels occurred during a final phase of floodplain incision and aggradation before the present temperate **Holocene** epoch.

The morphology of the braided river system consisted of high relief longitudinal bedforms (or channel bars) interspersed with lower lying channel threads infilled with gravel lag deposits or finer grained sands (Miall 1985, 1996). These environments are characteristically unstable and are constantly subjected to rapid channel shift and bank erosion (Gibbard & Lewin, 2002). This occurs due to a high sediment supply coupled with high discharges and stream power during the seasonal melts of the periglacial landscape.

With the amelioration of the climate during the **Lateglacial**/Early Holocene transition discharge rates began to stabilise leaving behind a relict gravel topography consisting of these gravel highs and low points. This gravel topography dictated the course of later channels and influenced patterns of fluvial activity and sediment accumulation through to the mid Holocene period. Across the site itself the gravel topography occurs at *c* -2.7m OD towards the north sloping gently down in the centre to *c* -3.2m OD. On the southern periphery of the site a marked drop occurs to *c* -4.6m OD in the south.

A plot of the Early Holocene surface, (produced for the previous report, and included here for reference) places this topography into a wider landscape setting. Beyond the north east of the site in the vicinity of Victoria Dock station the gravel topography rises to *c* -1 to -0.5m OD. Beyond the south east a similar level of raised gravel topography exists. When considered in relation to the wider landscape the USC site appears to lie within a former channel thread that may be associated with a former course of the Lea rather than the Thames. The present course of the Lea flows *c* 400m to the west of the site, and it is therefore likely that the site fell within the wider braidplain of the Lea during the late Pleistocene period. The gravel low which exists on the southern periphery of the site is projected from the geotechnical data to form a main channel thread flowing on a north east to south west axis. This channel thread is probably a remnant of the braidplain surface although partial incision into the relict braidplain surface during the Lateglacial/Early Holocene transition may have enhanced the feature. The chronology of this deeper southern channel is discussed further in section 7.2 below.

7.2 Facies 2: Lateglacial/Early Holocene fluvial fine grained deposits with lenses of organic silts and clays, (Late Upper Palaeolithic, Mesolithic) fluvial sands *c* 15000–12000 BP

This facies was recorded to the south of the USC site boundary within a single borehole undertaken on West Silverton Urban Village (see borehole WSUVBH8, Fig 9, Wilkinson *et al* 2000). It consisted of a series of thickly laminated minerogenic deposits interspersed with organic mud lenses, occurring between *c* -2.5m to -1.4m OD. The deposits were interpreted as representing phases of in-channel fluvial activity, separated by episodes of channel cut-off allowing the formation of partially vegetated backswamp environments.

This activity was thought to be associated with a single threaded palaeochannel to the north of the WSUV site. A number of radiocarbon dates taken from the base of this deposit at between *c* -2.5 to -2.2m OD indicated a date of *c* 12 800–10 300 BP. A palynological analysis of these deposits confirmed the chronology, indicating the transition from the open tundra scrub of the cold climate Lateglacial, to the colonisation of more thermophilious species such as pine and birch reintroduced from their glacial refugia.

The topographic plot of the Early Holocene surface indicates an area of low lying gravel within the southern boundary of the USC site, which may have formed the main route of flow of the Lateglacial/Early Holocene channel postulated to exist from the WSUV investigations.

The initial interpretations of the borehole data obtained from the USC investigations tentatively correlated the Lateglacial channel fills of Facies 2 with a series of similar laminated silt and organic deposits identified on USC (see Facies 5). This was based merely on sedimentological grounds and suggested that the Lateglacial channel fills may have extended across the majority of the USC site. However, the radiocarbon dates and palaeoenvironmental evidence now indicates that the laminated silts and organics on the USC site are much later in date. It is therefore likely that the Lateglacial channel observed on WSUV was confined to the lower lying gravel topography indicated by the plot of the Early Holocene surface.

7.3 Facies 3: Lateglacial (?) to Mid Holocene (Late Upper Palaeolithic to Early Bronze Age) fluvial sands and silts c 15,000 – 4000 BP

A small number of the boreholes recorded a well sorted pale grey/greenish grey fine to medium sand above the gravels. Although not dissimilar in sediment characteristics to Facies 2, the bounding surface with the underlying gravels, and the occurrence of peat/organic sediment 'rip-up' clasts within the sand matrix suggested these fluvial deposits were of a later date.

A sharp erosional interface occurred between the sands and gravels, suggesting that a hiatus may exist in the deposition. The gravels and overlying sands of the Thames floodplain often display a gradational boundary indicating a continuous chronology. The fining up sequence present in these deposits is often interpreted as relating to waning stream power and flow velocity following the transition from the cold climate Dimlington Stadial, to the temperate episodes of the Lateglacial (i.e the Windermere Interstadial).

The presence of eroded peat clods along with other detrital organics within the sands is also uncharacteristic of the Late Devensian/Late Glacial transition. Deposits of this age are virtually free of organic material due to the arctic desert that existed during this time. A radiocarbon date was obtained for a peat clast recovered from within the sands in Borehole USCMoLBH3 (see Fig 9). This material produced a radiocarbon date of 3680 +/- 30 BP (4140–3915 cal BP). Although this date does not give an actual date for the deposition of the sands, as the peat is likely to be derived from an older eroded deposit, it does demonstrate that fluvial sands were accumulating across the site some time after the Early Bronze Age.

7.4 Facies 4: Mid Holocene peat formation, within alder carr wetland environment fringing channel areas (Neolithic to Early Iron Age) c 6,000 – 2,500 BP

This facies was not recorded on the USC site itself, but was recorded during the investigations on WSUV across the raised gravel topography towards the south east of the site. However, consideration is given here to this facies as it aids in understanding the sedimentary sequence recorded on the USC site and its landscape position within the wider floodplain.

Across WSUV this facies consisted of a sequence of humified and woody peats indicative of sedge fen and alder **carr** wet woodland environments (Wilkinson *et al* 2000). Its upper surface occurred at *c* 1m OD across the majority of the site. Within WSUVBH8 the initiation of the peat formation was dated to *c* 5900–5600 BP ceasing at around *c* 2700–2350 BP (i.e. early Neolithic to Early to Middle Iron Age). The peat formation is related to increases in Relative Sea Level (RSL) further down the Thames estuary which caused 'ponding' back in the upper freshwater reaches of the channel. This impeded drainage and thus caused waterlogging of previously dry terrestrial landsurfaces across the gravel high points, leading to peat formation by paludification. A palynological analysis of these sediments revealed evidence of the elm decline at *c* 5900–5600 BP (Beta-120960, Wilkinson *et al* 2000) and the lime decline at *c* 3400-3080 BP (Beta-120959, *ibid*), as well as woodland clearance due to agricultural intensification during the Bronze Age.

While these alder carr wetlands were forming across the higher ground towards the south east, the area within the USC site boundary remained within an active channel belt. Sands (Facies 3) continued to be deposited within active high energy proximal parts of the channel. As will be discussed later, silts (Facies 5) were also begining to accumulate within low energy marginal areas of the channel, and also across adjacent mudflats, during the formation of the peat.

7.5 Facies 5: Mid Holocene fine grained deposits, accumulating within low energy marginal areas of a tidal creek (5A) and across adjacent mudflats, and low to mid salt marsh (5B), *c* 5,000 – 3,500 BP

Facies 5 forms what could be considered the most intriguing deposit encountered on the site. The evaluation report concluded that the facies accumulated through fluvial deposition in a freshwater channel, possibly with episodic channel cut off that allowed colonising vegetation to take hold. Based on sedimentological grounds it was postulated that the facies could be cotemporary with the laminated silts and organic fills of the Lateglacial channel identified on WSUV. However, the larger window onto these deposits provided by the trench excavation, coupled with the radiocarbon dating and palaeoenvironmental evidence has aided in refining and reinterpreting the facies substantially.

The facies has now been divided into two sub-facies, Facies 5A and 5B.

Facies 5A defines the lower part of the deposit. It generally consists of moderately fine grained silts and sands with occasional detrital organics throughout. The sedimentary structure tended towards massive, although very fine laminations were present towards the top of the deposit. A radiocarbon date was obtained for the lower part of the deposit from within the trench section. An AMS date on a piece of alder wood produced a radiocarbon age of 4355 +/- 32 BP (5035–4850 cal BP), placing the deposit within the Mid to Late Neolithic. However, this date should be treated with caution. The alder wood fragment may be derived from an older peat bed, eroded and redeposited by fluvial action.

The diatom evidence from this deposit consisted of a mixed assemblage of mesohalbous, oligohalbous and polyhalbous taxa all indicative of brackish environments. A freshwater component was also present, although these were of a type that could tolerate low salinities.

The ostracod and foram evidence correlates with the diatom interpretation. The lower samples produced an abundant assemblage of brackish ostracods and forams, with some marine species capable of penetrating outer estuaries. Evidence of potential storm and tidal surges was also indicated by a number of 'exotic' shelf living species of ostracod, and other species diagnostic of southern temperate waters. The presence of two 'cold climate species, *Candona candida*, and *Cytherissa lacustris* probably indicate reworking of the earlier Lateglacial channel sediments thought to be infilling the low lying gravels towards the southern boundary of the site. In general the ostracod and foram evidence indicates a tidal creek/mudflat environment with fringing low-mid to mid-high salt marsh.

This palaeoenvironmental evidence when coupled with the sedimentological evidence suggests that the lower massively structured sediments probably accumulated within the active part of a tidal creek that was probably beneath the water column at both low and high tides, albeit in a low energy marginal part of the channel adjacent to fringing mudflats and low to mid salt marsh.

The plant macro fossils from within these sediments consisted of typical wetland taxa indicative of floodplain woodland, including alder, crowfoot, mosses and sedges. This data contradicts the ostracod and foram evidence, suggesting that the majority of these plant macro fossils are allochthonous. These plant remains may have been washed off the surface of the alder carr woodland into the channel during episodes of high run off, or excessive overbank flooding. The plant remains could also have come from older peat units eroded by fluvial action. However, unlike the eroded peat clasts observed in Facies 3, the plant remains within Facies 5A occurred as inclusions within the sediment matrix itself. This demonstrates that a degree of contemporaneity must exist between the sediment and the plant remains.

The palynological evidence also proves problematic for these lower sediments. The pollen assemblage was dominated by grasses and fen herbs with some alder and willow present. This indicates an onsite environment consisting of floodplain woodland with channel marginal fen environments. However, as with the plant macro fossils the pollen is likely to have been fluvially redeposited, and not indicative of *in situ* vegetational communities.

However, the pollen evidence for the wider terrestrial landscape does point to a much later date for the deposit sequence than that given by the radiocarbon dating. The almost complete absence of lime (Tilia) strongly suggests a Late Bronze Age date for the base of the sequence. Prior to c 3500 BP *Tilia* was widespread and dominant or co-dominant, with oak over much of London. Its decline due to clearance for agriculture, although asynchronous, generally occurred within the Late Neolithic and especially the Middle Bronze Age. This illustrates that the sequence may be *c* 1500 years younger than suggested by the radiocarbon dating.

Facies 5B is very similar in lithology to 5A. However, some subtle differences in the sedimentary characteristics in conjunction with the palaeoenvironmental evidence indicate a distinct difference in depositional environments. The Facies predominately consisted of fine clayey silts with fine sands; however, the laminations became more distinct up through the profile, with clear intervening bands of organic muds and silts. Isolated bands of fine sand and silts were also present, and these were particularly distinctive within context [13]. Within this context, thin discontinuous, wavy and parallel laminations of very fine sand were recorded dipping eastwards at an angle of 30^0. There was no clear boundary between Facies 5A and 5B pointing to a gradual and transitional change in depositional environments. Interestingly, a previous geoarchaeological monitoring exercise across the site (Ainsworth 2002) did make a distinction between the lower massive deposits and the laminated upper part of the sequence (see boreholes SVY02BH30 and SVY02BH28, Fig 9). These occur at roughly the same level as those identified in the archaeological trench.

The distinct laminations of Facies 5A demonstrates cyclic deposition more indicative of regular tidal inundation across fringing mudflats and salt marsh environments. The organic lenses suggest partial vegetation was taking hold across the mudflats. The sand laminations within context [13], may represent the infilling of small runnel channels that dissected these mudflats, draining the retreating tidal waters down through an inclined mudflat bank.

The diatom, ostracod and foram assemblages again point to a brackish environment, with evidence of tidal creeks, mudflats and low–mid, mid–high salt marsh environments. Freshwater ostracods, such as *Limnocythere inopinata,* that can tolerate low salinities are also present. These types prefer weedy, vegetated pools. The organic laminations and inclusions within the sediment may reflect these features, representing isolated vegetated pools of water forming on the surface of the mudflats and salt marsh.

The plant macro fossils assemblage displayed the same characteristics as that for Facies 5A. Again the majority of this plant macro material may have been reworked from the adjacent alder carr wetland peats. The onsite pollen spectra, did however, suggest the presence of *in situ* vegetational communities, more indicative of mudflat and salt marsh environments with isolated freshwater pools. The samples contained spores of bur reed/ reed mace (*Typha angustifolia* type), that can grow in brackish environments. There was also evidence of fresh water pools with the presence of the algae *Pediastrum* and Potamogeton (pond weed).

In summary Facies 5 should be seen as a transitional zone between the in–channel fluvially active parts of a tidal creek, and the partially vegetated mudflats and salt marsh environments that flanked its course. Facies 5A represents the sediment accumulating across the channel bed of this creek, either deposited through suspension or as bedload. It is likely to have been unvegetated and permanently submerged. The pollen and plant macro fossils preserved within this lower sediment are most likely to be ex situ, fluvially transported into the channel from the adjacent floodplain woodland.

Facies 5B marks a transition to channel marginal environments, suggesting migration had occurred. These deposits indicate areas only partially submerged by episodic tidal waters, thus allowing plant communities to take hold. It is representative of tidal mudflats and low–mid salt marsh.

7.6 Facies 6: Late Holocene (Iron Age to post–medieval); mid to high salt masrh (6A), floodplain stabilisation with mature soil formation (6B), overbank flooding (6C)

Facies 6 marks a distinctive change in lithology with a switch from the silts and fine sands of Facies 5 to massive finer grained ‘gleyed’ clays and silts. This part of the deposit sequence was interpreted in the previous evaluation report as indicating the onset of fully estuarine conditions, with the formation of salt marsh and later alluvial accretionary soils. However, the palaeoenvironmental evidence and trench observations have refined this interpretation and identified three sub-facies.

The lowest sub-facies, Facies 6A consisted of massive mid to light grey clays. The top of the sequence contained calcareous inclusions, fine root channels and a blocky ped structure indicative of soil formation. Diatoms were absent throughout this deposit, although a few brackish ostracods and forams were preserved in the lowest sample, indicating a mid to high salt marsh environment. The ostracod samples from the upper part of the sub-facies also produced rhizolith structures (i.e iron and calcareous concretions formed around root channels), earthworm granules, a few very small brackish ostracods and forams, and charophyte oogonia.

This palaeoenvironmental evidence correlates with the observed lithology and suggests there is a gradual transition through the facies from mid to high salt marsh environments, to seasonally flooded semi terrestrial accretionary floodplain soils. Pollen evidence from context [9] of the trench sequence showed an expansion of pollen of Chenopodiacea (goosefoots, oraches and samphire) that may be halophytes from salt marsh and upper mud flat (Salicornia). The succeeding accretionary soils are indicated by the ped structure, pedogenic carbonate concretions, and the presence of earthworm granules with rhizolith structures. The few very small ostracods and forams at the top of the sequence were probably washed in with the overbank flood waters. The charophyte oogonia remains also demonstrate that the floodplain surface contained standing pools of freshwater.

This transition to semi terrestrial floodplain soils was also indicated by the plant macro fossils. Although there was a continuation of the wetland taxa from the underlying facies, there was also an indication of drier, scrubbier grassland environments with the appearance of taxa such as Asteraceae, blackberry (*Rubus fruticosus*) and nightshades (*Solanum nigrum*).

Facies 6B defines a cessation of overbank flooding and the formation of a stable mature soil horizon within the overbank flood sediments. The lower part of the facies, context [6] consisted of a mid greyish brown humic silty clay with a blocky fine ped structure and frequent manganese staining on the ped faces. At the very top of the context was a very thin, *c* 0.01m thick black/yellowish brown organic band. This was excavated partially in plan to reveal a compressed layer of grass stems and other plant litter. This upper band of compressed organics forms an ‘O’ horizon of a soil profile, with the lower humic silty clay forming a possible ‘A’ horizon. A radiocarbon date was obtained from the ‘O’ horizon of this facies. Buttercup seeds were extracted from a bulk sample and submitted for AMS dating. The samples produced a date of 379 +/- 30 BP (Cal AD 1445–1630).

This interpretation of a fully terrerstrial soil was confirmed by the diatom assessment, which identified aerophilous species (*Hantzschia amphioxys, Pinnularia borealis,* and *Navicula perpusilla*) typical of dryland soil within the samples. The drier terrestrial soil also explains the poor pollen preservation, and the absence of ostracods. Even small ostracods that may have been brought in through overbank flooding are absent from this horizon.

The pollen assemblage shows essentially open herbaceous grassland, typical of semi terrestrial floodplain environments. There is a marked increase in cereal pollen, and a notable decline in the tree species (oak and hazel) present within the underlying Facies 5. However, it was noted that the cereal pollen may also be from secondary sources such as anthropogenic material (domestic waste including food and faecal material, offal, floor covering or crop processing waste) that was dumped across the floodplain. An ovum of *Ascaris* (intestinal round worm) was recovered from context [6], supporting this possibility. This does raise questions as to how this dry land soil was utilised by nearby communities and whether cess/manure was dumped across the area as a fertiliser.

Facies 6B is an intriguing part of the overall deposit sequence. This horizon was not identified across any other part of the site. This is almost certainly due to removal by modern truncation. However, within a geotechnical borehole such an ephemeral thin horizon would be very difficult to identify if it survived. Nevertheless this is a rare example of a stabilised mature soil horizon within the upper part of the alluvial sequence. The agency of its formation is difficult to identify with certainty. Given the Medieval date for its burial, this soil may have formed as a result of local land management and extensive drainage that protected the land from flooding, thus allowing a mature soil to develop.

Facies 6C marks a resumption of overbank flood events. This event must have been rapid to seal and preserve the 'O' horizon of Facies 6B. These overlying sediments consist of silty clays, with a blocky ped structure, fine root channels and manganese staining. The sedimentary characteristics are indicative of semi-terrestrial alluvial accretionary soils. Interestingly, small brackish forams and ostracods again appear in the samples, indicating an influx of material and sediment from tidal areas by overbank flooding.

Overall Facies 6 correlates with the uppermost facies of alluvial deposits recorded at WSUV, which again consisted of massive gleyed silts and clays. However, X-radiography carried out on the lower part of these sediments displayed very fine micro laminations indicative of episodic sedimentation associated with regular tidal inundation. These sediments had a sharp interface with the underlying Bronze Age alder carr peats, suggesting a possible phase of erosion and hiatus in the sequence. However, a radiocarbon date from a possible interface unit of organic clays did produce a radiocarbon date of *c* 2430 +/- 50 BP (2725–2345 cal BP; see Fig 9, radiocarbon date no.4), placing the switch to minerogenic sedimentation in the Early Iron Age. Other sites on this stretch of the Thames floodplain, with alder carr peat to minerogenic transitions, have previously been dated to a similar period, indicating a widespread expansion of estuarine environments during the Iron Age.

7.7 Facies 7: Made ground and redeposited alluvium.

Facies 7 remains unchanged from the previous geoarchaeological evaluation report. Within the trench excavation the upper deposits consisted of a mix of rubble, gravel and sand deposits of no archaeological interest. No structures associated with the former industrial use of the dock were identified, apart from the single course of bricks recorded in the watching brief trench. The made ground rested upon redeposited minerogenic alluvium that contained large clods of peat. This material is certainly associated with the dock construction.

8 Potential of the data

This section examines the extent to which the original research questions have been answered by the assessment.

- ***(ORA1)–****Is there any evidence of prehistoric occupation and/or wetland exploitation (i.e. fish traps, boats, jetties and trackways) within the alluvial sequence?*

There was no direct evidence of prehistoric occupation or wetland exploitation within the alluvial sequence

- ***(ORA2)–****Can the results of the excavation refine the understanding of the post-glacial floodplain development of the site gained from the previous geoarchaeological borehole survey, with particular reference to reconstructing the environment of deposition and the evolution and time scale of floodplain formation?*

The excavation has refined the understanding of the deposit sequence on the site, and identified a number of sub-facies within Facies 5 and 6. The chronology of the sequence has also been substantially updated. The palaeoenvironmental evidence and radiocarbon dating now suggest that the area of the site existed as a tidal creek from perhaps the Middle Bronze Age. The channel deposited sands within the main thread of flow, while finer grained deposits accumulated within the distal low energy marginal parts of this channel. The channel was flanked by intertidal mudflats and salt marsh environment.

Although the radiocarbon dating has proved problematic due to the possibility of *ex situ* material eroded and redeposited from older alder carr peat beds, the syntheses of the palaeoenvironmental data does suggest that this estuarine environment was contemporary with the upper part of the alder carr peat formation at WSUV.

The site also recorded the post Bronze Age widespread estuarine inundation recorded across many Thames floodplain sites. These deposits are generally interpreted as forming mid to upper salt marsh environments and later accetionary floodplain soils, with the increased flooding thought to be due to estuarine expansion and rise in river levels.

However, a period of Post-medieval floodplain stability and soil formation, not often observed within these upper alluvial deposits, was also noted. This soil formation may be associated with land management, and drainage schemes. A possible agricultural use of the land is supported by the pollen assemblage that also contained an ovum of an intestinal parasite, indicating the possible dumping of offal and other waste as a form of fertilizer.

- ***(ORA3)–****How does the sites sedimentary sequence compare to present models of the Thames floodplain development and the impacts of vegetational change, rising sea levels and changing fluvial geomorphology?*

There is little information to discern the long term changes to the geomorphology of the river as the majority of the studied sequence is thought to span the Middle Brozne Age to Late Medieval period. The surrounding geotechnical data has been used to plot the underlying early Holocene topography. This identified a low lying area of gravel to the south east of the site, which when compared with data from the WSUV site, infers the possibility of a confined Late Glacial channel in the area. Given the widespread fluvial sands observed at the base of the sequence across the USC site, it is likely that the channel belt expanded in the middle Holocene due to increased river levels and ponding back caused by the upstream migration of the tidal head.

As the majority of the lower sequence accumulated within active channel areas, and waterlogged marginal channel environments the deposits preserve a range of palaeoenvironmental remains not often preserved in contemporary deposits. The majority of the sequence studied across the middle Thames basin consists of a fairly uniform sequence of the basal Pleistocene gravels, overlain by fine grained fluvial deposits, then the ubiquitous Late Neolithic to Late Bronze Age alder carr peats, sealed by the minerogenic estuarine deposits of an Iron Age date or later. The onset of the estuarine inundation is usually attributed to estuarine expansion, and rising river levels occurring during the Early Iron Age, as interpreted from radiocarbon dates for the top of the peat sequence. However, these deposits, which are usually indicative of upper salt marsh or alluvial accretionary soils can be fairly weathered leading to poor preservation of the palaeonvironmental remains.

The USC site is unusual in that it preserves a diverse range of ostracods, forams and diatoms that display an estuarine influence on the channel belt contemporary with the Bronze Age alder carr peats. This estuarine influence continued for some time before the widespread minerogenic alluviation of the Early Iron Age. The sequence therefore has the potential to add important data on understanding the nature and timing of relative sea level rise and its effects on landscape development. It offers an opportunity to reappraise the understanding of the upper part of the Thames alluvial sequence.

Most of the sequence preserved pollen to a relatively high degree. Despite problems with the fluvially dynamic lower part of the sequence that may have reworked pollen from other locations, the upper relatively less disturbed part of the sequence has the potential to reconstruct land development and land use through the Middle Bronze Age to Medieval periods. This is a period of time when pollen is not usually well preserved within the Thames alluvial sequences.

- ***(ORA4)–****How does the reconstructed landscape and topography refine the understanding of the wider prehistoric environment, and how past populations may have settled within, utilised, accessed or traversed this past landscape?*

The spread of geotechnical data has allowed the early Holocene topography to be reconstructed. This has highlighted areas of high gravels that formed elevated areas of land within the floodplain. From the Late Neolithic alder carr peats began to develop across the gravel surface. The lower lying gravels and overlying channel deposits across the USC site have defined the borders between these active channel and stable wetland areas. This channel almost certainly formed a major route of access across the prehistoric landscape. This landscape information could prove fundamental in understanding the location of future prehistoric sites identified within the surrounding area.

- ***(ORA5)–****Are there any local remnants of Post-Medieval to mid 19th century agricultural activities and can the reason(s) for the pre-existing surface formations no longer being present be identified?*

There was no evidence for post–medieval to 19th century agricultural activities or land surfaces directly below the made ground and upcast of the dock constructin. The surface of these deposits was most likely truncated during the dock construction. However, an earlier late medieval to Post-medieval soil was identified within the upper alluvial sequence. The palaeoenvironmental evidence suggested that the dumping of cess and offal material may have taken place across the land surface, which could be related to the spreading of fertiliser for agricultural use of the floodplain.

- ***(ORA6)–****Can the mid 19th century site preparation processes, related to dock construction be identified and understood and placed in context of the tidal basin of Royal Victoria Dock.*

There was little evidence of 19th century site preparation processes, related to dock construction. However, the lower part of the anthropogenic deposits did consist of redeposited alluvium containing clods of disturbed peat. This material is probably derived from the upcast of the dock construction

- ***(ORA7)–****Is there any evidence for occupation and informal activities on the eastern third of the site between tipping of dock spoil and the construction of the first phase of dock side buildings?*

There was no evidence for occupation and informal activities on the eastern third of the site.

- ***(ORA8)–****How was the site first developed, related to servicing the business requirements of the London Midland Railway company*

There was no data regarding the business requirements of the London Midland Railway company.

- ***(ORA9)–****What remains on site of the mid to late 19th century to mid 20th century dock side facilities (including three or more phases of substantial sheds) and internal/external railway infrastructure?*

A single course of bricks that may be associated with a dock side structure was identified in the watching brief.

- ***(ORA10)–****How does the archaeology of this site confirm or change our perception of the archaeological resource of this part of Newham?*

Although the investigations did not reveal any significant archaeological remains, a rich palaeoenvironmental resource was revealed alongside important topographical data on the prehistoric landscape

- ***(ORA11)–****Are there structures and artefacts that if retained on site would support and celebrate the objectives of the development and cultural activities of Newham?*

There were no structures or artefacts that if retained on site would support and celebrate the objectives of the development and cultural activities of Newham

8.1 Summary of potential

The key points on the potential of the data are summarised below

- The samples taken from the site have good preservation of a range of microfossils of a Late Bronze Age to post-medieval age not usually preserved in typical sequences of the East Thames floodplain.
- There is evidence for the incursion of estuarine environments in the Middle Bronze Age. This evidence does not concur with the present models developed for the formation of the East London Thames floodplain and could lead to a revised understanding of the nature and timing of tidal influence in this area.
- The data has refined the topographic plot of the Early Holocene surface for this part of the Thames, placing the channel feature within the wider floodplain landscape
- There is unusual evidence of a post-medieval soil horizon within the upper intertidal and overbank flood deposits

9 Significance of the data

The palaeoenvironmental work carried out on the core and trench samples, together with the topographical data provides a record of landscape change from the Middle Bronze Age to post-medieval periods. Due to the environment of deposition the palaeoenvironmental remains are generally better preserved than on other floodplain sequences of a contemporary date. The deposits therefore provide the opportunity to study a period of landscape development not usually encountered on other floodplain sites.

This data is certainly of local and possibly of regional significance, especially when considering the onset of intertidal flooding/estuarine expansion, and the landuse of the medieval floodplain. It also provides an important comparison and reappraisal of the record of Holocene floodplain evolution already published (from WSUV and other sites). The WSUV site did not preserve assemblages of ostracods, diatoms and forams, and therefore the nature and timing of intertidal conditions was inferred on sedimentological grounds alone. The good preservation of microfossils in the samples from USC provides the opportunity to investigate this further, and enhance the understanding of these upper floodplain deposits.

The nature and timing of the estuarine conditions recorded on the site is of particular interest and importance. The information from the assessment has suggested the site was under the influence of tidal conditions from perhaps the Late Neolithic (*c* 4400 BP). This is much earlier than stated in the published models for the mid to late Holocene evolution of the east Thames floodplain (i.e. Long et al 1995, 2000; Sidell et al 2000). The USC site is significant in that it provides new information to refine these previous interpretations. Interestingly only one other published piece of work has inferred a Neolithic date for tidal incursion (Woodbridge 1998). Diatom evidence and radiocarbon dating undertaken on a series of boreholes drilled through the Bermondsey foreshore demonstrated that by 5400 BP the Thames tidal head was probably upstream of Bermondsey. The evidence from USC could support this claim.

10 Publication project: aims and objectives

10.1 Revised research aims

The assessment has answered the original research questions and identified a number of revised research aims (RRA) where further analysis has potential to provide new information to enrich our current understanding of the evolution of the East London Thames floodplain and river regime. These are listed below.

RRA 1*: How do the deposits recorded across the site relate to current models of the Thames floodplain evolution, and update the understanding of the sedimentary sequence published from WSUV?*

Further correlation of the deposits recorded at WSUV can be made with those recorded at USC. The deposits can be examined with reference to current models of floodplain evolution to update the understanding of allogenic and autogenic forcing in determining floodplain sedimentation and development.

RRA 2*: Can further work on the pollen refine the understanding of Middle Bronze Age to post-medieval vegetation succession and land use?*

To address this question, further pollen work is required on the sedimentary sequence within the trench section. This would involve sampling at smaller intervals to identity subtle changes in vegetation up through the sequence. Late Bronze Age to medieval pollen assemblages are not usually well preserved on the middle Thames floodplain sequence. The deposits at USC provide an opportunity to enhance the understanding of landscape development and use during these periods.

RRA 3: *To what extent do the ostracod, diatom and foram assemblages revise our understanding of the onset of estuarine conditions and the development of intertidal environments?*

The assemblages have potential to reconstruct the intertidal and saltmarsh environments for the Middle/Late Bronze Age through to the post-medieval periods. The initial assessment work has demonstrated a tidal influence from at least as early as the Middle Bronze Age, which is not normally recorded in the floodplain deposits. The information from USC when compared with other floodplain sequences will be able to refine the understanding of estuarine expansion, and the transition from alder carr wetlands to minerogenic intertidal/ salt marsh environments. A closer sampling interval is required for the diatoms, ostracods and forams to identify subtle changes up through the sequence.

RRA 4: *Can the* d*eposit sequence be accurately dated, and the chronology refined?*

Although a rough chronology for the sequence has been determined, the palaeoenvironmental data would suggest a degree of secondary reworking, especially in lower part of the sequence. This may have affected the reliability of the dating. The chronology could be refined by undertaking dating on a number of different materials at the same stratigraphic level to arrive at a reasonably inferred date. Ostracods can be dated, along with radiometric dates on the total bulk humin fraction from organic bulk samples. Identifiable organic remains can also be dated if they are determined to be *in situ* remains, and not fluvially reworked. The good dating is essential for understanding the chronological context of the ecofact assemblages.

RRA 5: *Are the deposits across USC time transgressive, and do they represent the migration of a former channel of the Lea in a westwards direction?*

The dating of the basal sands within USCMoLBH3, demonstrates that the sands were accumulating in an active part of the channel while the intertidal muds were accumulating in the vicinity of the archaeological trench. This would suggest possible migration of the channel towards the west. However, further dating is required on the deposits, and especially the intertidal deposits within USCMoLBH3 to confirm this hypothesises.

RRA 6: *Can the plant macrofossils provide additional information on landscape change and development?*

Although a degree of reworking has taken place on the plant macrofossils within the lower part of the sequence, their analysis would verify the onsite environments inferred from other strands of palaeoenvironmental evidence. These samples could also potentially provide plant macrofossils suitable for radiocarbon dating.

RRA7: *Was the soil horizon within the upper part of the alluvial sequence exploited for agricultural activity during the medieval period, and how did it form?*

The preliminary results suggests that Facies 6B represents a buried soil with the development of an 'O' and 'A' horizons. The formation and uses of this soil could be further investigated by soil micromorphology, which could identify whether the soil developed in a grassland or agricultural environment.

10.2 Preliminary publication synopsis

The results obtained within this report, in conjunction with the results of the previous evalaution report and the results of further analysis are of great enough significance to warrant dissemination to the wider archaeological audience and should be published in an appropriate archaeological (eg Surrey Archaeological Collections) or Quaternary Science (eg Proceeding of the Geologist Society) journal.

It is envisaged that the publication will comprise an article which incorporates the lithological evidence with the palaeoenvironmental specialist work integrated, to reconstruct the depositional history of the site. Depending on the results of analysis, the article is likely to be in the order of 5 – 10,000 words.

At this stage a brief publication synopsis can be presented. The general layout of the publication will follow the format outlined below:

- ***Introduction***

Stating the site location, circumstances and dates of the fieldwork, background to the project

- ***Palaeoenvironmental and Archaeological background***

Brief summary of previous archaeological fieldwork within the vicinity, and examination of past models of Thames floodplain development

- ***Methodology***

Method of excavation, boreholes survey and palaeoenvironmental sampling strategy

- ***Palaeoenvironmental data***

One or more sub-sections illustrating the results of the various biostratigraphical sedimentological, and dating techniques; to include ostracods/forams, diatoms, pollen, soil micromorphology. Illustrated with tables summarising the results, and sections showing the sampling locations

- ***Lithostratigraphy***

A synthesis of the palaeoenvironmental results with the sedimentology to produce a facies model for the site. This will be placed into a wider landscape context, with an illustration of the landscape topography. Illustrated with sections, borehole transects and surface plots of the gravel topography

- ***Discussion and conclusion***

A discussion on the results, with a comparison with previous models of Thames floodplain evolution.

11 Publication Project: Task Sequence

The various tasks to complete the publication are outlined below.

11.1 Ostracod and forams

1. Examination of an additional 7 ostracod/foram samples to improve resolution. Taken from bulk samples <51>, <49>, <45>, <37>, <34>, <25>, and one from monolith <41>. Includes report writing.

11.2 Diatoms

2. Analysis on 10 diatoms samples to improve resolution, and refine interpretation of Facies 5A/B with report writing.

11.3 Pollen

3. Analysis on 40 additional pollen samples, with closer resolution of *c* 0.04m within Facies 5B, 6A, 6B, and 6C, with publication text.

11.4 Plant macro fossils

4. Analysis of 7 samples from context [15], Facies 5B, with tabulation and report text.

11.5 Soil micromorphology

5. Soil micromorphology analysis on monoliths <6> and <5>, with report text.

11.6 Radiocarbon dating

6. The following dates are proposed either through radiometric on total humin fraction of organic sediment, or AMS on identifiable plant macro fossil.

- Organic sediment from monolith <41> to obtain date for the very base of the trench sequence Facies 5A.
- Material from bulk sample <46> to date base of Facies 5B.
- Material form bulk sample <38> to date top of Facies 5B.
- Material from bulk samples <37> to date base of Facies 6A and the switch to minerogenic sedimentation
- Material from borehole 3, units 3.3 and 3.2. To investigate the time transgressive nature of the deposits, and possible evidence of channel migration. Dating the top and base of Facies 5.

11.7 Geoarchaeology

7. Sample monoliths, and prep sub-samples for specialists.
8. Research past work in the vicinity of the site.
9. Integrate specialist analysis (palaeoenvironmental, sedimentological and radiocarbon dating) with lithology to revise the understanding of the deposit sequence, and create facies model.
10. Correlation of deposit sequence with the previously published WSUV sequence, and other current models of Thames floodplain evolution.
11. Prepare figures, to include borehole transects, surface plots of the topography, trench sequence illustrating sampling locations.

11.8 Publication text

12. Prepare draft text *c* 10,000 words.
13. Edit specialist contributions and integrate into publication text.
14. Technical edit.
15. Corrections to text.

11.9 Graphics

16. Drawing office input to production of site location plans, topographic plots, transects, sections and sample location data, with corrections.

11.10 Project Management

17. Project management, quality control, submission of article

11.11 Publication project: tabulated resources

Financial resources sufficient to cover the work proposed in this document, if deemed appropriate by GLAAS/EH would need to be agreed before any analysis work took place. The scale and scope of the work proposed is set out in the table below:

Discipline	Task No.	Task description	Personnel	days/units
Ostracod/foram analysis	1	Examination of an additional 7 ostracod/foram samples to improve resolution. Taken from bulk samples <51>, <49>, <45>, <37>, <34>, <25>, and one from monolith <41>	External specialist	7
Diatom analysis	2	Analysis on 10 diatoms samples to improve resolution, and refine interpretation of Facies 5A/B	External specialist	10
Pollen	3	Analysis on 40 additional pollen samples, with closer resolution of *c* 0.04m within Facies 5B, 6A, 6B, and 6C	External specialist	40
Plant macro fossils	4	Analysis of 7 samples from context [15]. Facies 5B	Archaeobotanist	5.25
Soil micromorpholgy	5	Soil micromorphology analysis on monoliths <6> and <5>	External	
Radiocarbon dating	6	The following dates are proposed either through radiometric on total humin fraction of organic sediment, or AMS on identifiable plant macro fossil.	External	6
		Organic sediment from monolith <41> to obtain date very base of trench sequence Facies 5A		
		Material from bulk sample <46> to date base of Facies 5B		
		Material form bulk sample <38> to date top of Facies 5B		
		Material from bulk samples <37> to date base of Facies 6A and switch to minerogenic sedimentation		
		Material from borehole 3, units 3.3 and 3.2. To investigate the time transgressive nature for the deposits, and possible evidence of channel migration		

Discipline	Task No.	Task description	Personnel	days/units
		Archaeobotanist to sort and retrieve plant macro fossils suitable for radiocarbon dating	Archaeobotanist	1
		Submission of radiocarbon dates	Geoarchaeologist	1
Geoarchaeology	7	Sample, and prep samples for specialists	Geoarchaeologist	4
	8	Research past work in the vicinity of the site		3
	9	Integrate specialist analysis (palaeoenvironmental, sedimentological and radiocarbon dating) with lithology to revise the understanding of the deposit sequence, and create facies model		5
	10	Correlation of deposit sequence with the WSUV sequence, and the present models of Thames floodplain evolution		2
	11	Prepare figures, to include borehole transects, surface plots of the topography, trench sequence illustrating sampling locations		2
Publication text	12	Prepare draft text *c* 10,000 words	Geoarchaeologist	10
	13	Edit specialist contributions and integrate into publication text		2
	14	Technical edit		2
	15	Corrections to text		2
Graphics	16	Drawing office input to production of site location plans, topographic plots, transects, sections and sample location data, with corrections	Drawing office	8
Project management	17	Project management, quality control, submission of article	Geoarchaeology Project Manager	3
Archive	18	Costs associated with associated with preparation and deposition of archive	tbc	tbc
Publication	19	Costs associated with publication	tbc	tbc

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13 Geoarchaeological Glossary

Alluvium: a broad term referring to material deposited in a river channel or floodplain. Alluvial sediments are usually fine-grained and well-sorted although there is no diagnostic particle size as deposition depends on the energy of the water transport (i.e. from sands and gravels deposited by fast flowing water to clays that settle out of suspension during overbank flooding). Alluvium is frequently laminated or exhibits bedding structures, will often oxidise and change colour following exposure and may be rich in environmental remains such as molluscs or pollen. Impeded drainage leads to peat development and can also be considered to be alluvium, while tufa accumulates where calcium carbonate-saturated water issues from springs.

Braided channel: river channel pattern with multiple channels separated by shoals, bars and unstable islands that migrate and change frequently. Braided channels have high sediment loads and are typical of arctic regions today.

Carr: a north European wetland, a fen overgrown with trees

Devensian: the last glacial complex in Britain (MIS4-2) equivalent to the northern European Weichselian and the Alpine Wurmian (c 120–10 000 BP).

Diatoms: microscopic siliceous algae sensitive to environmental conditions (such as salinity and temperature) used in palaeoenviromental reconstruction.

Facies: Reading's (1996) definition follows 'A *facies* is a body of rock with specified characteristics... A facies should ideally be a distinctive rock that forms under certain conditions of sedimentation, reflecting a particular process or environment.' In sedimentology, lithofacies are defined, based on characters such as grain size and mineralogy that reflect depositional processes.

Fen: a type of wetland often marshy and low-lying, deriving most of their water from groundwater rich in calcium and magnesium, and characterized by a distinctive flora. Fens will ultimately become a terrestrial community such as woodland through the process of ecological succession. Fens are often confused with bogs, which are fed primarily by rainwater and often inhabited by sphagnum moss, making them acidic.

Gley: greenish grey and bluish waterlogged soil or sediment. The greenish colour indicates the presence of iron phosphates or secondary iron alumino-silicates, and bluish tints are caused by the formation of vivianite (ferrous phosphate). Groundwater gleys are influenced from underneath by groundwater, surface water gleys are water-saturated from above, often with water ponding on the surface.

Holocene: or 'Postglacial' is the most recent epoch (part) of the Quaternary, covering the past 10,000 years, characterised by an interglacial climate. The Holocene in Britain is often referred to as the 'Flandrian'.

Kempton Park Terrace: (previously 'Upper Floodplain Terrace') comprises river gravels mapped at approximately +5m OD. Kempton Park gravels are thought to have been deposited during the Devensian and incorporate Ipswichinan Interglacial (MIS5e).

Lateglacial: or Devensian Lateglacial, the period following the Last Glacial Maximum lasting until the start of the Holocene. This period is subdivided into a warm interstadial episode (called the Windermere Interstadial in Britain), followed by a cold snap (the Loch Lomond Stadial/**Younger Dryas**) in which local ice re-advance occurred.

Last Glacial Maximum: the peak of the most recent glaciation (Devensian), from between approximately 22,000 to 18,000 years ago. In Britain this is referred to as the Dimlington Stadial.

Lateglacial Interstadial: an episode of climatic improvement, called the Windemere interstadial in Britain, that occurred during the Devensian from *c* 13 500 to 11 000 yrs BP (equivalent to the European Bølling/Allerød)

OSL: optically stimulated luminescence. A dating technique allowing age determination of sediments deposited within the last glacial-interglacial cycle. The OSL signal builds up over time in quartz and feldspar minerals through naturally occurring ionizing radiation. This signal is 'reset' by exposure to light. If the signal can be measured, the time since sediment burial can be determined.

Ostracods: bivalve crustacea common to almost all fresh and marine aquatic environments including semi-terrestrial settings living within the water column on and in the substrate

Periglacial: characteristic of a region close to an ice sheet but not covered in ice. In such a region, the ground may be frozen all year, thawing and waterlogging the surface in summer because it cannot drain away through the sub-surface ice. Geomorphological and sedimentological features characteristic of periglacial environments include tors, patterned ground and involutions.

Pleistocene: referring to the part of the Quaternary pre-dating the climatic amelioration at the start of the Holocene (approximately 2.6 million years ago to 10,000 BP).

Quaternary: the most recent major sub-division (series) of the geological record, extending from around 2.6 million years ago to the present day and characterised by climatic oscillations from full glacial to warm episodes (interglacial), when the climate was as warm as if not warmer than today. The observed pattern is of long glacial stages with cold and warm perturbations (stadials and interstadials) and short interglacials (usually less than 10,000 years). Human evolution has largely taken place within the Quaternary period.

Shepperton Gravel: or 'buried channel' infill (previously 'Lower Floodplain Terrace') on the floodplain of the Thames deposited during glacial outwash following the last Glacial Maximum (approximately 18–15 ka BP)

Soliflucted sediment: In periglacial environments, surface thawing results in a saturated surface layer overlying a frozen substrate. Where this occurs on valley sides it can result in the surface layers sludging down-slope over the frozen subsoil.

Younger Dryas: an end Pleistocene cold climate period (named after the alpine / tundra wildflower *Dryas octopetala*) at approximately 12,800 to 11,500 years Before Present. The Younger Dryas followed the Bölling/Allerød interstadial and preceded the Preboreal of the early Holocene.

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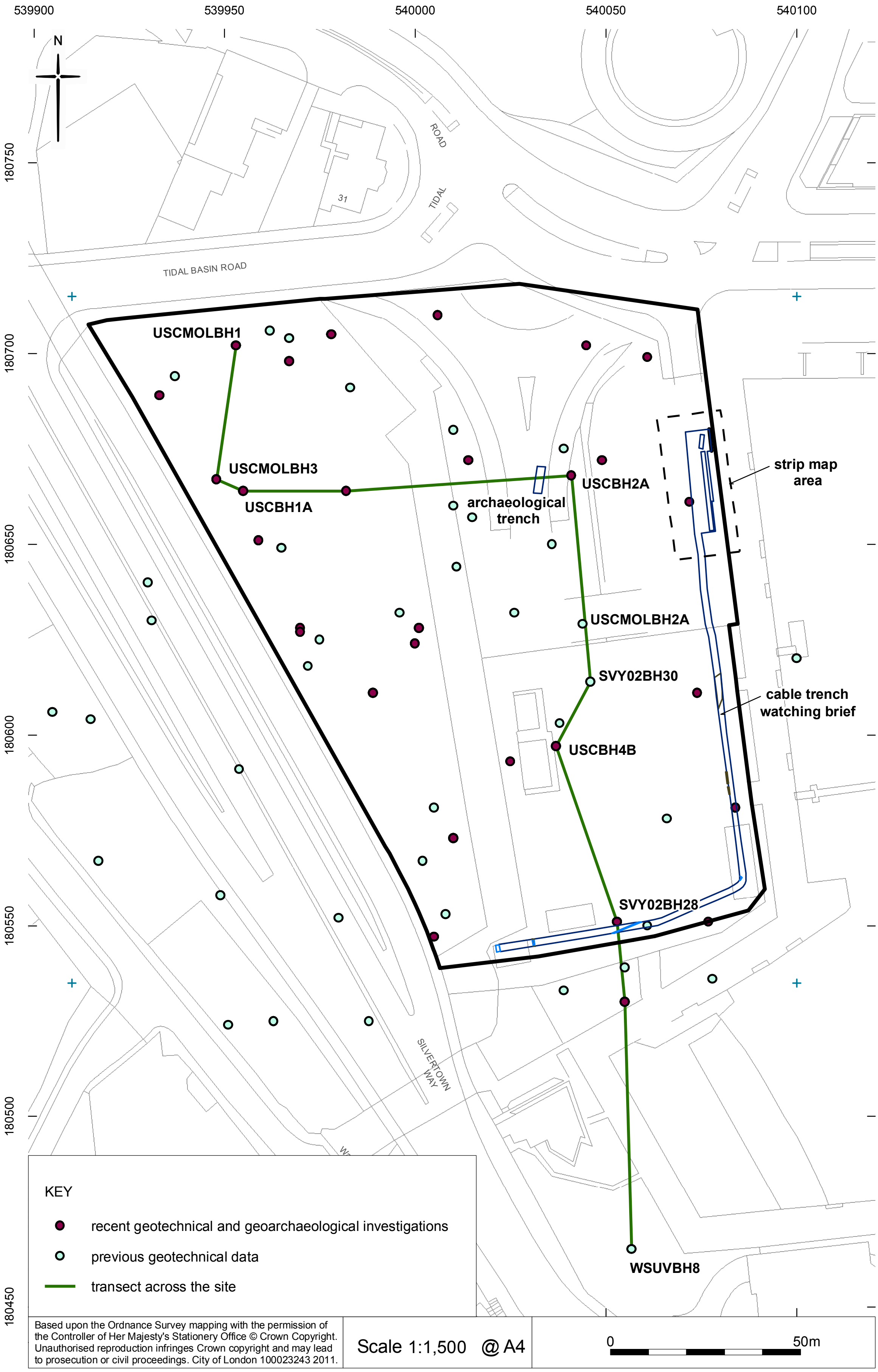
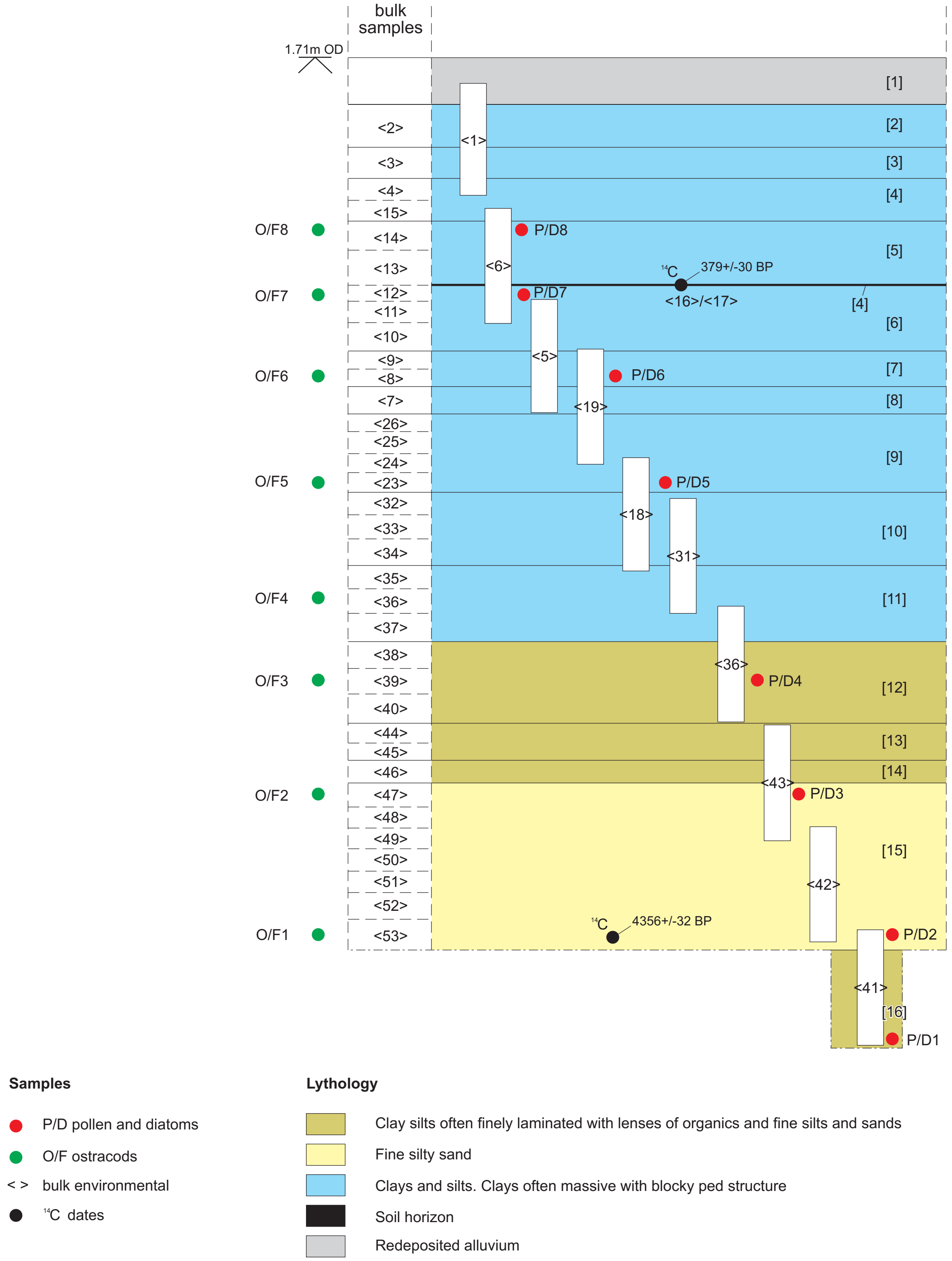


Fig 2 Location of archaeological trench, 'strip map and sample' area, cable trench watching brief, geotechnical/geoarchaeological boreholes and transect across the site

Fig 3a Photograph showing the excavation of the cable trench

Fig 3b Photograph showing the single course of brickwork observed in the section

Fig 4 Photograph showing the excavation within the ‘strip map and sample’ area



Palaeoenvironmental evidence				Environment of deposition and Facies numbers
Diatoms	Ostracod and Forams	Plant macro fossil	Pollen	
Diatoms absent	Small brackish forams present. Samples contained earthworm granules	Continuation of wetland alder carr taxa from deposits below, along with evidence of semi-terrestrial environments as indicated by Asteraceae, blackberry and nightshade	Poor preservation, only the more robust taxa surviving such as Brassicaceae (charlocks) and Lactucoideae (dandelion types)	Overbank seasonal flooding and formation of accretionary soils. **Facies 6C**
Aerophilous species indicative of dry soil horizons	Ostracods and forams absent. Samples contained frequent plant remains and rootlets indicating well vegetated surface			Floodplain stability and cessation of tidal flooding. Formation of 'O' and 'A' soil horizons. **Facies 6B**
Diatoms absent	Charophyte oogonia present, suggesting still, freshwater bodies present across the floodplain surface. Occasional brackish ostracods and forams. Rhizolith structures observed within the samples Brackish forams and ostracods indicative of tidal mudflats and creeks. Mid to high saltmarsh ostracods present		Expansion of Chenopodiaceae (goosefoots, oraches and samphire); halophyptes of upper to mid saltmarsh	Upper to mid salt marsh, and accumulation of accretionary soils formed by seasonal overbank flooding. **Facies 6A**
Mixed assemblage of mesohalobous oligohalobous and polyhalobous taxa indicative of brackish environments	Abundant assemblage of brackish forams and ostracods indicative of mudflats saltmarsh (low-mid, mid-high). Small assemblage of freshwater ostracods that can tolerate low salinities and prefer vegetated pools of standing water. Influx of marine and 'exotic' shelf living species suggesting storm and/or tidal surges	Alder carr type plants with crowfoot, mosses and sedges	Pediastrum alga. Increase in sedges, bur reed/reed mace	Channel marginal tidal mudlfats and low to mid saltmarsh. **Facies 5B**
			Grasses dominant, with fen herbs, alder and willow. Pollen likely to be reworked by fluvial action	In-channel low energy distal part of tidal creek. **Facies 5A**

Fig 5 Composite section through the trench sequence illustrating the lithology, sampling locations, and summarising the palaeoenvironmental evidence and inferred environment of deposition

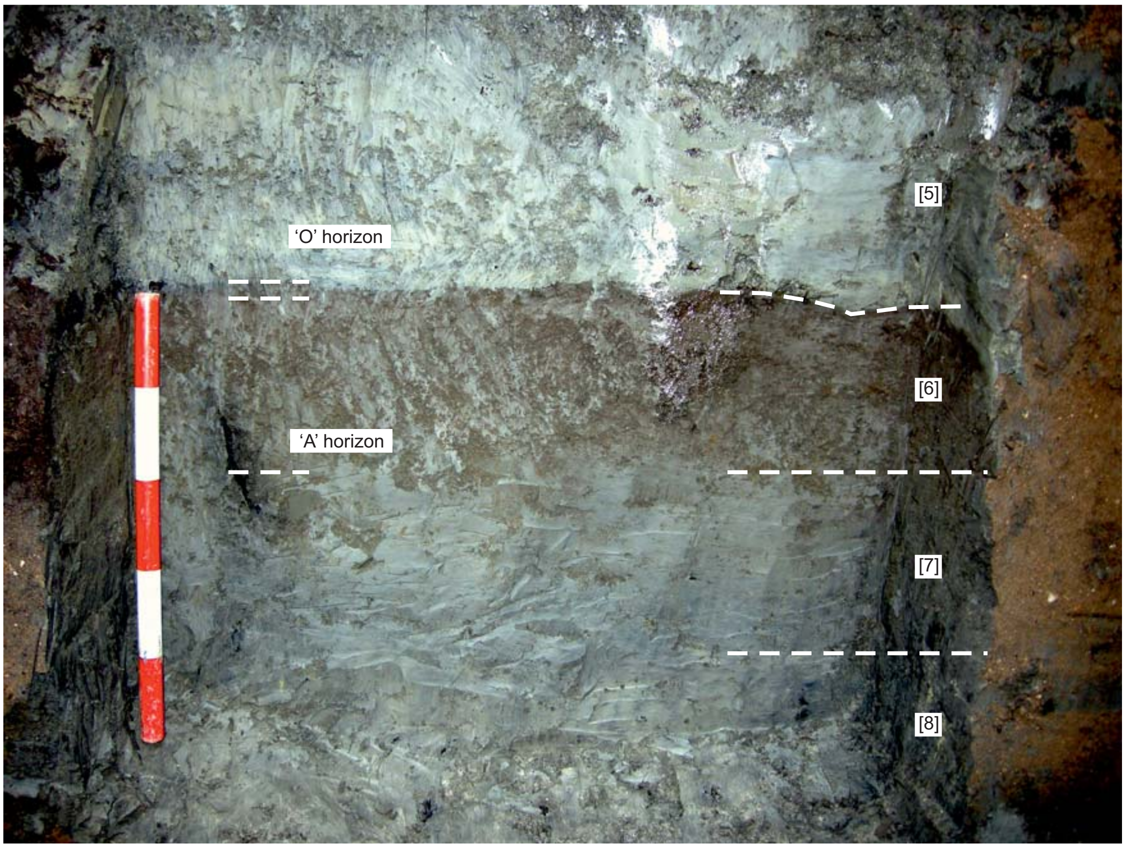


Fig 6 Upper part of the alluvial sequence within the trench excavation illustrating the dry land surface horizon

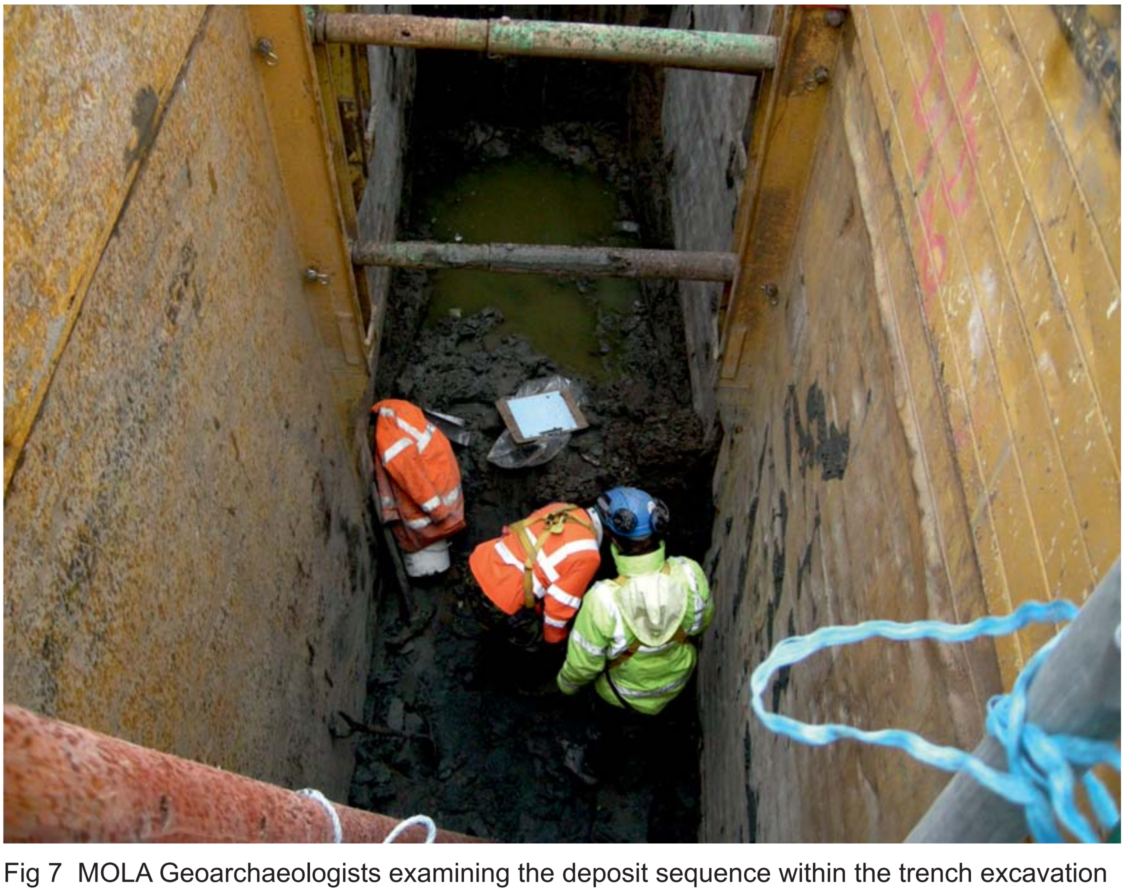


Fig 7 MOLA Geoarchaeologists examining the deposit sequence within the trench excavation

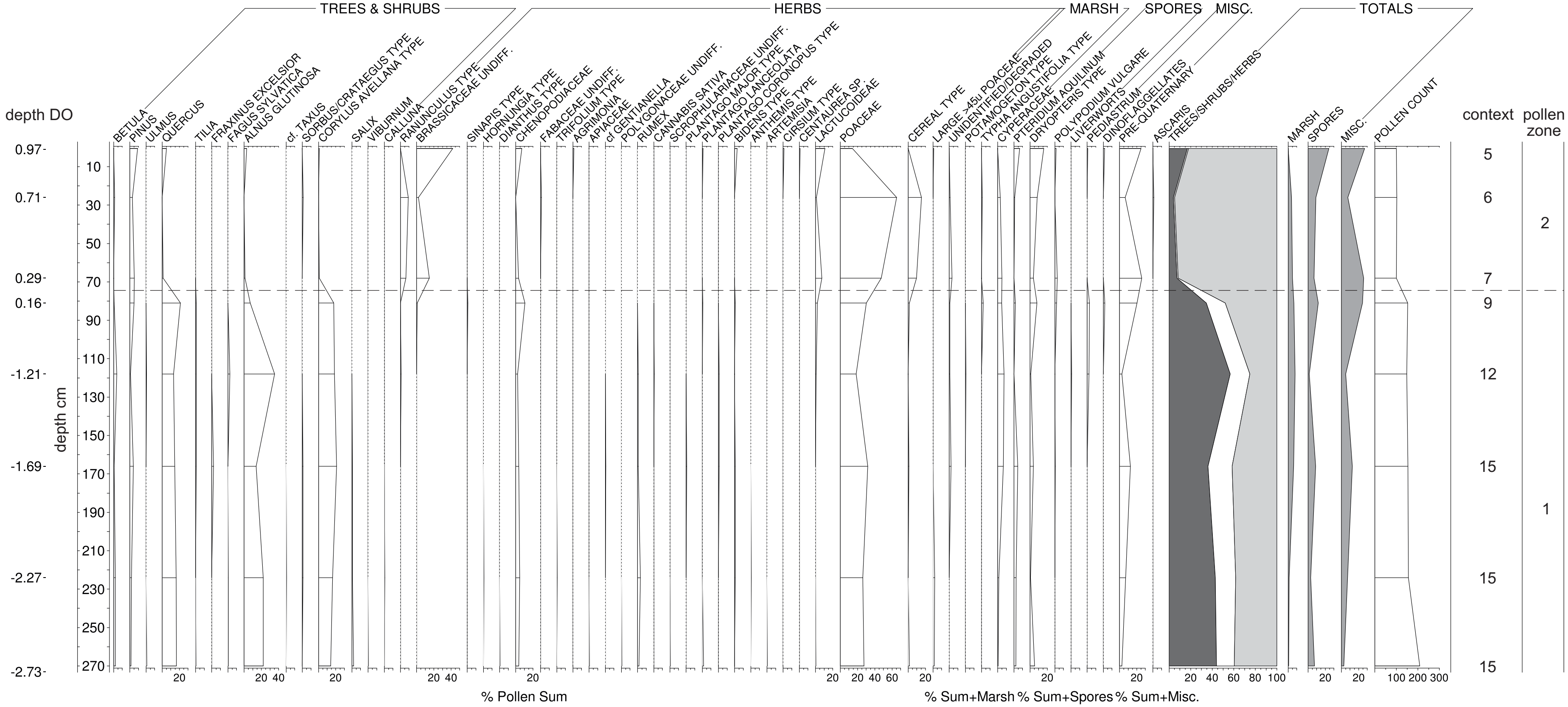
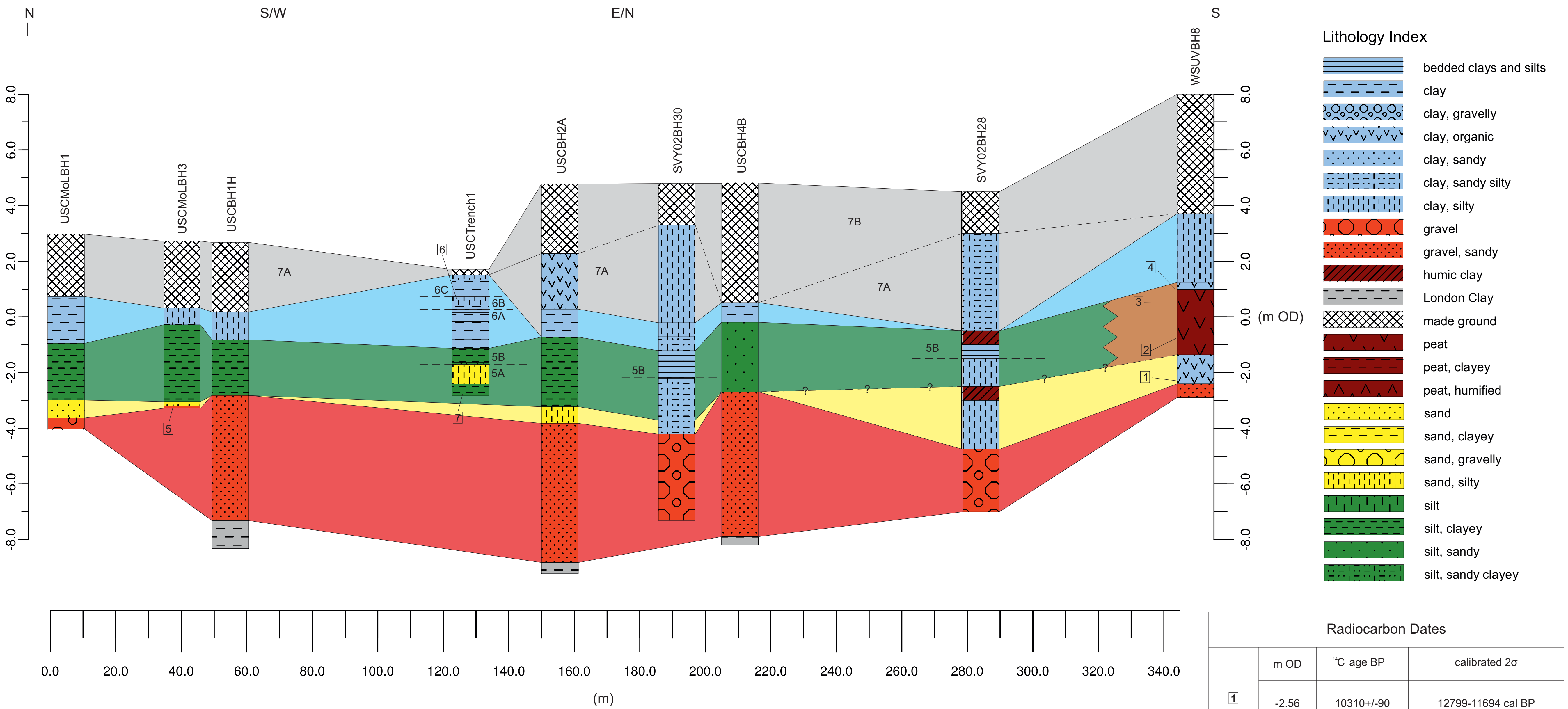


Fig 8 Pollen diagram from the trench deposit sequence



Radiocarbon Dates

	m OD	^{14}C age BP	calibrated 2σ
1	-2.56 -2.40 -2.20	10310+/-90 10010+/-70 9360+/-70	12799-11694 cal BP 12075-11229 cal BP 11035-10290 cal BP
2	-1.00	5010+/-70	5914-5600 cal BP
3	+0.42	3070+/-60	3438-3080 cal BP
4	+0.95	2430+/-50	2726-2345 cal BP
5	-3.10	3680+/-30	4141-3915 cal BP
6	+0.73	379+/-30	505-380 cal BP
7	-2.20	4356+-32	5036-4851 cal BP

Deposits Index

- Facies 1: Late Pleistocene Shepperton floodplain gravels *c* 18000–15000 BP
- Facies 2: Late Glacial/Early Holocene fluvial fine grained deposits with lenses of organic silts and clays, deposited within marginal area of the channel belt *c* 15000–11500 BP
- Facies 3: Late Glacial (?) to Mid Holocene (Late Upper Palaeolithic to Early Bronze Age) fluvial sands and silts, deposited within active, high energy proximal part of the channel belt *c* 15000–4000 BP
- Facies 4: Mid Holocene peat formation, within alder carr wetland environment fringing channel areas (Neolithic to Early Iron Age) *c* 6000–2500 BP
- Facies 5: : Mid Holocene fine grained deposits, accumulating within low energy marginal areas of a tidal creek **(5A)** and across adjacent mudflats, and low to mid salt marsh **(5B)**, *c* 5000 BP
- Facies 6: Late Holocene (Iron Age to Medieval) fine grained deposits accumulating across intertidal mid to high salt marsh **(6A)**, and through later episodic overbank flooding across a semi-terrestrial floodplain **(6C)**. Evidence of intervening floodplain stabilisation and mature soil formation **(6B)**.
- Facies 7: Anthropogenic deposits of a possible Post-medieval to modern date **(7B)**. Lower part consists of redeposited peat and alluvium associated with the construction of the Royal Victoria Docks **(7A)**

Fig 9 Transect across the site illustrating the major facies associations

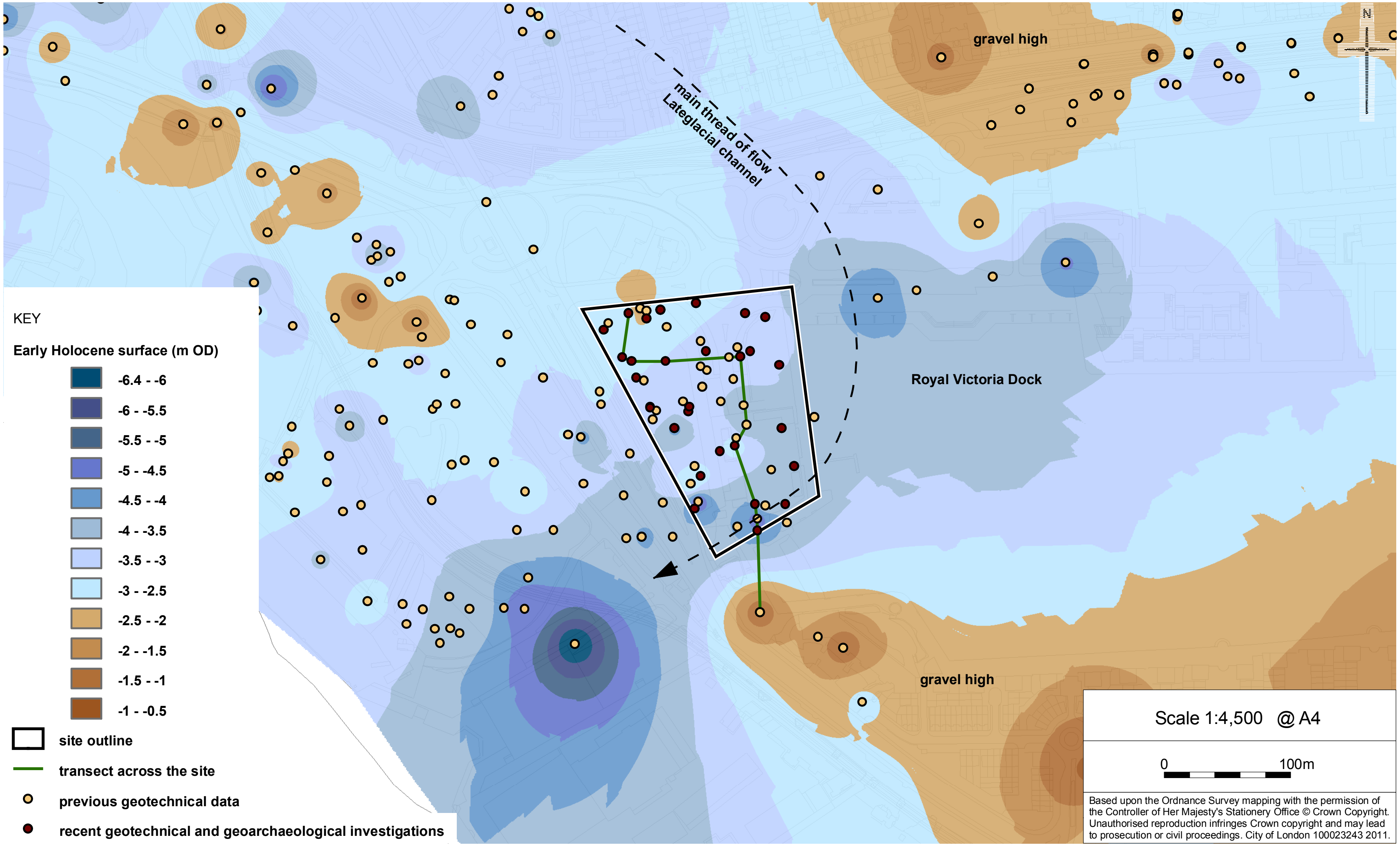


Fig 10 Topography of the Early Holocene (previously illustrated in Halsey 2010a)

15 NMR OASIS archaeological report form

15.1 OASIS ID: molas1-104229

Project details

Project name	Urban Sustainabilty Centre
Short description of the project	A strip map and sample exercise, watching brief and the excavation of an archaeological trench was carried out on the site. The strip map and sample, and watching brief were focused to identify significant structures/industrial heritage associated with the former industrial usage of the Victoria Dock basin. No significant features were identified during these works. The archaeological trench was placed to investigate the deeper alluvial deposits in an area of the site likely to be substantially impacted upon by piling. The trench excavation in conjunction with a multi proxy palaeoenvironmental study (ostracods, diatoms, forams, and pollen) was able to refine the stratigraphy presented in a previous geoarchaeological report. The basal deposits consisted of fine grained silts and sands deposited within low energy distal part of a tidal creek. The base of the sequence was radiocarbon dated to Cal BC 3086-2901. As channel migration occurred towards the west, the site developed into an area of intertidal mudflats and low to mid salt marsh. This gradually transformed in to a drier upper to mid saltmarsh. A period of landscape stability, and mature soil formation was indicated by a thin organic layer indicative of a preserved 'O' soil horizons. This appeared to overly a possible 'A' horizon. The soil was sealed by clays deposited by overbank flooding. The soil may have formed as a result of medieval drainage and land management in an attempt to protect and use the floodplain for agricultural activity. A radiocarbon date from the 'O' horizon produced a date of Cal AD 1445-1632.
Project dates	Start: 27-07-2010 End: 19-01-2011
Previous/future work	Yes / No
Any associated project reference codes	mola1-84951 - OASIS form ID
Type of project	Recording project

Site status	Area of Archaeological Importance (AAI)
Current Land use	Other 13 - Waste ground
Monument type	PALAEOCHANNEL Bronze Age
Monument type	PALAEOCHANNEL Iron Age
Monument type	BURIED SOIL HORIZON Medieval
Significant Finds	NONE None
Investigation type	'Part Excavation','Watching Brief'
Prompt	Direction from Local Planning Authority - PPG16

Project location

Country	England
Site location	GREATER LONDON NEWHAM CANNING TOWN Urban Sustainabilty Centre
Postcode	E16 1AF
Study area	3.00 Hectares
Site coordinates	TQ 540020 180640 50.9408482741 0.192247282381 50 56 27 N 000 11 32 E Point
Height OD / Depth	Min: -3.65m Max: 0.56m

Project creators

Name of Organisation	MOLA
Project brief originator	Arup

Project design originator	Arup
Project director/manager	Jane Corcoran
Project supervisor	Craig Halsey
Type of sponsor/funding body	Siemens plc

Project archives

Physical Archive recipient	LAARC
Physical Contents	'Environmental'
Digital Archive recipient	LAARC
Digital Contents	'Stratigraphic'
Digital Media available	'Database','GIS'
Paper Archive recipient	LAARC
Paper Contents	'Environmental','Stratigraphic'
Paper Media available	'Notebook - Excavation',' Research',' General Notes','Plan','Report'

Project bibliography 1

Publication type	Grey literature (unpublished document/manuscript)

Title	Urban Sustainabilty Center, Royal Victoria Docks, Newham, A geoarchaeological post-excavation assessment
Author(s)/Editor(s)	Halsey, CJ
Date	2010
Issuer or publisher	MOLA
Place of issue or publication	London
Description	A4 bound report with palaeoenvironmental multi proxy assessment, and geoarchaeological synthesis
Entered by	Craig Halsey (chalsey@museumof london.org.uk)
Entered on	28 June 2011