GREEN LEVEL PUMPING STATION
Erith
London DA8

London Borough of Bexley

Geoarchaeological Watching Brief Report

September 2010

MUSEUM OF LONDON ARCHAEOLOGY

REGISTERED ORGANISATION IfA

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Geoarchaeological Watching Brief Report

Site Code: GPG08
National Grid Reference: 550900 179600

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Summary (non-technical)

This document reports on the geoarchaeological investigations, watching brief and palaeoenvironmental reconstruction undertaken at Green Level Pumping Station, Erith. Museum of London Archaeology (MOLA) were commissioned by the client, Jacobs Engineering UK Limited, to record and evaluate the alluvial floodplain stratigraphy. Previous work at low tide on the Erith foreshore demonstrates the forested nature and preservation of the Neolithic to Bronze Age floodplain. In the Erith area, Neolithic pottery has been found below peat dating to 4040-3700 BC and is compatible with the recent discovery of a Neolithic structure in the lowest part of a peat deposit, at Belmarsh, dated to Cal BC 3960-3700 (Wk-25054, Hart 2009 and Hart 2010).

The examination of the watching brief sections, the window samples and boreholes from previous phases of the work has enabled the characterisation to be made of the subsurface deposits across the area of the site, and provided a basis for the understanding of the evolution of the landscape from the Late Glacial to the present day. The work illustrates the complex nature of the landscape as a progressively inundated landsurface, with levels of hiatus, as water level rose, as a result of relative sea level change, during the Holocene. The surface of the Pleistocene deposits forms the basic topography for much of the Holocene. An area of high gravel (a gravel island) was found to the east of the site and a low area of gravel, representing the route of an early Holocene channel was recorded in the middle of the site. The gravel island would have remained high dry ground for much of the Mesolithic and early Neolithic and would have been an ideal base for past humans to venture out from and exploit the rich marginal wetland resources.

The broad stratigraphic units found on site were basal sand and gravels; fluvial sands banked around the gravel island; organic clays and silty sands representing sluggish flow and pools of standing water in the area of low lying gravel; peat deposits representing a wooded wetland again concentrated in the central area of low lying gravel; increased sedimentation and the formation of fine grained minerogenic mudflats; overlain once more by wooded peat deposits; and finally alluvial silts and clays.

The spatial variation of the local topography and the changing vegetation environments are likely to have been significant to the Prehistoric inhabitants of the area. The local environmental changes roughly conform to broad region models for the Thames evolution. The variation from the regional model is a result of local topography and hydrology rather than significant human influence.

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1 Introduction

1.1 Site background

This document reports on a watching brief and geoarchaeological investigation at the site of Green Level Pumping Station, Erith, Kent. It has been commissioned from Museum of London Archaeology (hereafter MOL Archaeology) by Jacobs Engineering UK Ltd (Jacobs) on behalf of the client, the Environment Agency.

The site is part of Church Manorway Industrial Estate, in Erith Marsh south of the River Thames, within the London Borough of Bexley (Fig 1). It was previously occupied by BICC and Pirelli Cables and comprised factory storage buildings, above ground and underground storage tanks, car parking and recreational areas. Prior to this the area is listed as a bitumen works. The centre of the site, which is currently derelict, with one former storage building and several areas of hard-standing remaining, lies at National Grid reference 550900 179600.

The proposed development will upgrade the existing Green Level Pumping Station, which forms part of the Marsh Dykes drainage network and is the discharge point for an area of low-lying land behind the Thames tidal defences at Erith. It will involve the construction of a new pumping station, culvert and rising main, as well as a discharge point and environmental enhancements.

A desk top archaeological risk study was previously prepared by Jacobs Engineering, which covers the whole area of the site (Jacobs April 2009). This document should be referred to for information on the natural geology, archaeological and historical background of the site, and the initial assessment of its archaeological potential.

As mitigation to part of the watching brief window samples were taken by MOLA between August 2009 and February 2010 and a window sample evaluation report written on the results (MOLA, 2010). This window sample evaluation report (MOLA, 2010) and the desk top archaeological risk study (Jacobs April 2009) informed the design (*Method Statement*) for the watching brief which was eventually carried out (MOLA, 2009).

1.2 The planning and legislative framework

The legislative and planning framework in which the archaeological exercise took place was summarised in the *Method Statement* which formed the project design for the watching brief (see Section 2, MOLA, 2009)

1.2.1 Planning background

The planning background was discussed and on assessment of the construction impact on the deposits of archaeological and palaeoenvironmental interest was made in the Specification for Archaeological Watching Brief (Jacobs January 2009, 1.6).

The following impacts and strategies for monitoring were proposed:

- Culvert
    - trench excavation by machine (sheet piled sides);
    - works will extend into the top of the peat (to –2.20m OD in the culvert and to –3.0m OD in the control structure);

    - access to trench unlikely – watching brief will focus on examination of upcast and collection of grab samples from machine excavated (toothless bucket) spits through the peat (c 150mm thick).
- Pumping Station sump
    - No operative access to the sump during excavation (caisson construction methods – pre-cast concrete segments sunk though the deposits);
    - works will extend below the base of the peat (10m depth);
    - initial borehole probing to be undertaken (five terrier rig holes, with cores taken for off-site analysis from the 'best' location, to provide a context for any samples and finds recovered from the subsequent watching brief;
    - watching brief will focus on examination of upcast and collection of grab samples from machine excavated (toothless bucket) spits through the peat (c 150mm thick).
    - The identification and retrieval of components of any structures that may have existed in the lower levels of the peat will be made from ground level;
- Rising Main
    - trench excavation by machine (battered or sheet piled sides);
    - works will extend only into the top of the peat (base between –1.8 to –2m OD and –2.8m OD under Church Manorway);
    - access to trench unlikely – watching brief will focus on examination of upcast and collection of grab samples from machine excavated (toothless bucket) spits through the peat (c 150mm thick).
- Outfall Structure (initial works)
    - Discharge chamber 2.4m x 2.4m (base at –2m OD) constructed of precast rings sunk onto river bed;
      Initial works to be monitored.

1.2.2 Origin and scope of the report

This report has been commissioned by Jacobs Engineering UK Ltd (Jacobs) on behalf of the client, the Environment Agency and produced by Museum of London Archaeology (MOLA). The report has been prepared within the terms of the relevant Standard specified by the Institute for Archaeologists (IFA, 2001).

The purpose of the watching brief was to determine whether archaeological remains or features were present on the site and, if so, to record the nature and extent of such remains. A number of more site-specific research aims and objectives were established in the preceding *Method Statement* (MOLA 2009), and are outlined in the following section.

1.3 Aims and objectives

The objectives of the watching brief, as set out in the Specification (Jacobs January 2009) are:

- To record any archaeological remains present;
- To place them in the context of the archaeological background, as currently known for the site;
- To collect any information and recover any artefacts surviving in the areas of disturbance; and

- To obtain a series of samples, which upon analysis will provide secure and dateable information about the geoarchaeological sequences in the peat (and associated deposits);
- To record the stratigraphy of the sub-surface deposits;
- To chronicle the development of the environment, in particular related to the period of peat deposition; and to
- Interpret the palaeoecological history and succession of the site.

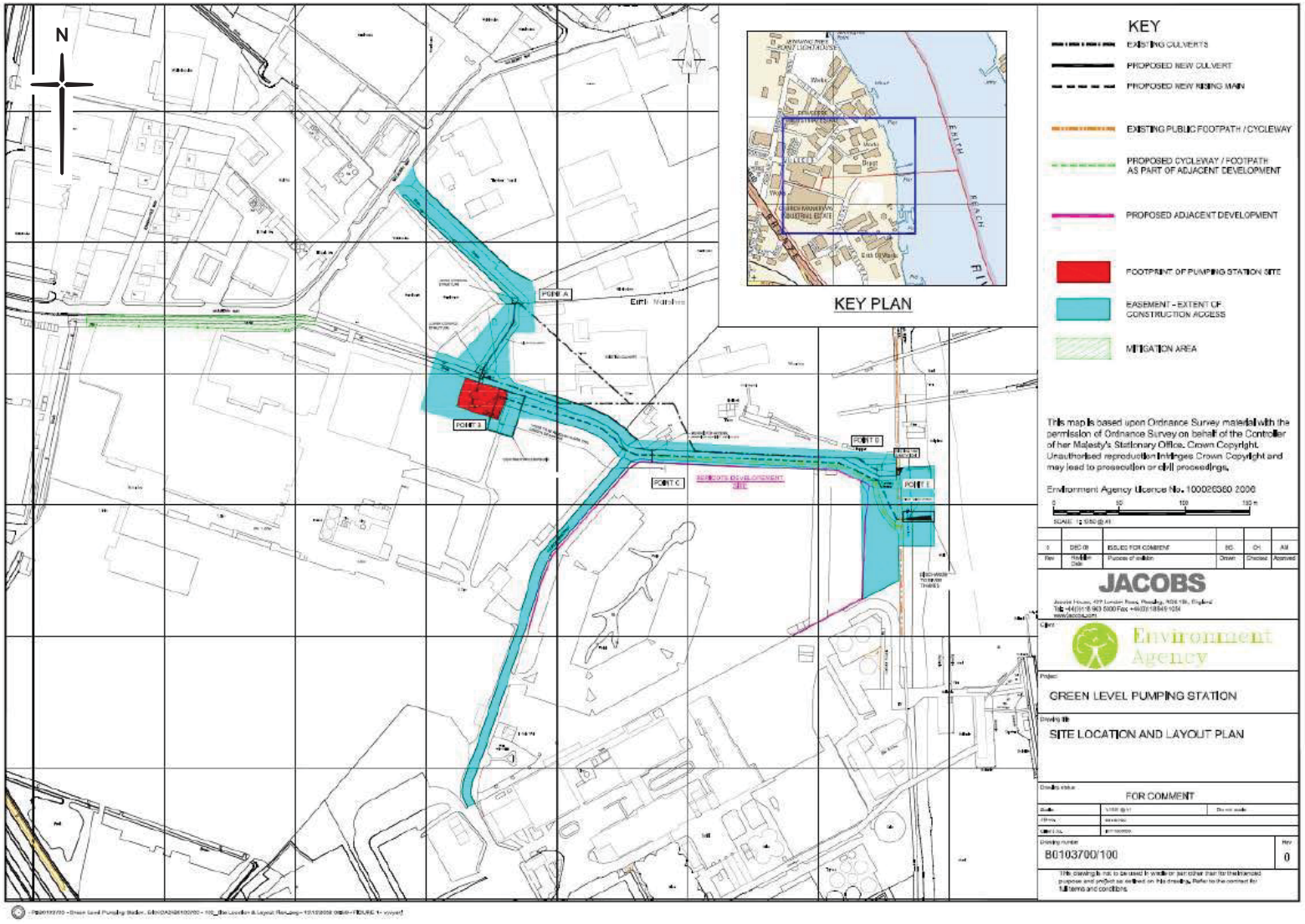

Fig 1 Site location

2 Palaeoenvironmental and Archaeological background

The known archaeological evidence for the site and its surrounding area is summarised in the Specification for Archaeological Watching Brief (Jacobs January 2009) and outlined below.

Limited archaeological investigations have previously taken place on the site, as part of the evaluation work for the proposed pumping station upgrade. This included a ground penetrating radar survey (Fugro/Utsi Electronics) and a geoarchaeological watching brief on the geotechnical site investigation works (MOL Archaeology, no report requested). The logs for the monitored SI work are included in the Appendix (Section 8). The geotechnical works revealed a sequence of sandy clay, peat, silty clay and made ground above the floodplain gravels, but the thickness of the various units and their characteristics varied across the site. A borehole was drilled at the location of the longest and best preserved alluvial sequence, as recorded in the geotechnical investigation and the cores retained and recorded by MOL Archaeology.

The previous work on the site and its surrounding area suggests this sediment sequence in the locality is varied. Although a Mesolithic landsurface might be associated with the interface of the floodplain gravels and sands and overlying alluvium, this horizon is likely to undulate and lie at depth. The overlying alluvium comprises peat and clay deposited in a range of wetland, fluvial and estuarine environments, most of which were suitable for human exploitation but not occupation. Depending on the topography of the underlying gravels and sands (and thus the elevation of the earlier prehistoric landsurface), the overlying alluvium might date from the Mesolithic, Neolithic or later.

Tree stumps exposed on parts of the Erith foreshore at low tide demonstrate the forested nature of the Neolithic floodplain, with dry deciduous woodland replaced by wet alder carr as river levels rose. In the Erith area, Neolithic pottery has been found below peat dating to 4040-3700 BC. The peat is likely to represent the waterlogging of a former landsurface and the subsequent development of a wetland environment. This is compatible with the recent discovery of a Neolithic structure in the lowest part of a peat deposit, at Belmarsh, dated to Cal BC 3960-3700 (Wk-25054, Hart 2009 and Hart 2010) and with a contemporary peat deposit recorded at Corinthian Quay (Morley, 2003) and radiocarbon dated to 5475-5290 Cal BC. Deposits were found in a similar stratagraphic sequence, but as yet undated, at the adjacent Pirelli site (Halsey 2007)

By the Bronze Age the area was probably fully wetland, peripheral to the dryland (to the south and west) and estuary (to the north and east). Timber trackways linking the different parts of this 'ecotonal' landscape demonstrate the value of the varied resources available and include one found at Bronze age Way, Erith. Typically Bronze Age structures, such as trackways, are associated with the upper levels of the peat.

The clay deposits that typically seal the peat generally date to the Iron Age and historic period. This clay might represent intertidal mudflats and salt marsh and can also represent much drier environments, only subject to episodic flooding.

The deposits of archaeological interest (the potential archaeological resource) are likely to extend from the base of the modern made ground down to the top of the

floodplain gravels and comprise the entire alluvial sequence. There is potential for geoarchaeological and palaeo-environmental information to be obtained from the entire sequence. However, the lower and upper levels of the peat are considered to be of particular importance for archaeology, as these levels represent changing environments that might have been targeted by people in the past. Finds might include timber artefacts and structures such as trackways. A log boat of uncertain age was found in 1885 in peat deposits during ditch digging in the western area of the site. Although peat was present in all the geotechnical interventions previously examined on the site, its depth and thickness varied. Its surface differed between –0.9m and –2.3m OD and its thickness ranged from 0.20m to 4.3m. The deepest peat was recorded at –7.05m OD.

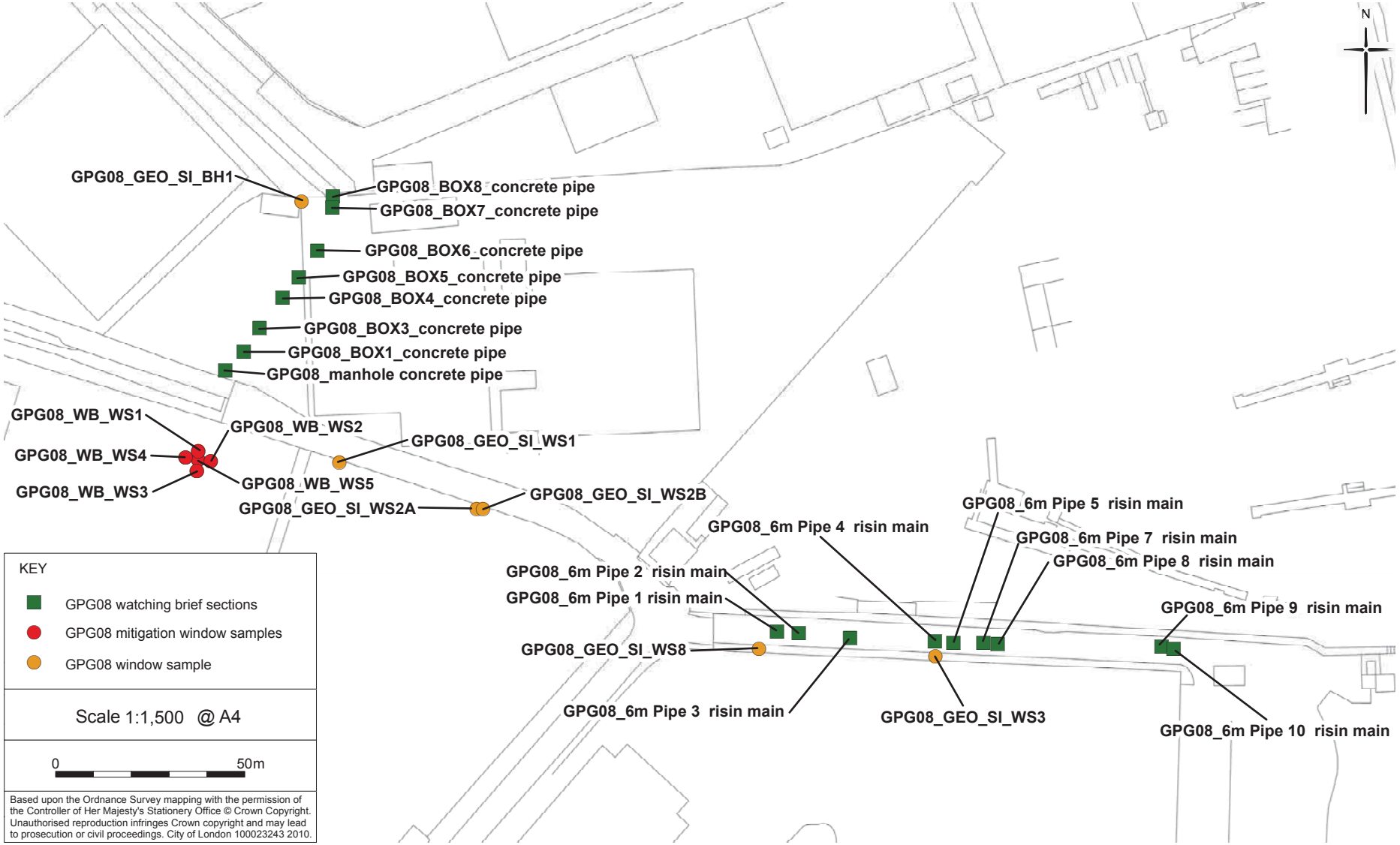

Fig 2 Location of Interventions

3 Methodology

3.1 Onsite

All archaeological excavation and recording during the watching brief was done in accordance with the *Method Statement* (MOLA, 2009) and the *Archaeological Site Manual* (MoLAS, 1994).

The slab/ground was broken out and cleared by contractors under MOLA geoarchaeology supervision. The contractors excavated a length of trench to a maximum depth of 4 to 6m (the formation level for the concrete pipe and rising main) by machine, monitored by a MOLA geoarchaeologist. All the sections were described and recorded from the side of the trench, using 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. Box supports were then inserted into the trench to support the sides and in the process the sides were obscured.

For each profile, every distinct unit was given a separate number (e.g. for BH1: 4.1, 4.2 etc from the top down) and the depth and nature of the contacts between adjacent distinct units was noted. The sections were given the prefix GPG08 (the site code), and WB (Watching Brief) i.e. GPG08_WB_ Box6 of concrete pipe etc. Linking deposits between sections produced a series of site-wide deposits (facies), which are representative of certain environments. Thus a sequence of environments both laterally and through time has been reconstructed for the site. The results of this part of the watching brief are presented in section 4.1.

No monitoring of excavations between the pumping station and Church Manor way was carried out because of work programming and access problems.

As mitigation to part of the watching brief five windows samples were taken at the site of the pumping station where a 9m deep caisson was to be excavated. This was carried out instead of the watching brief as the excavation method would make monitoring impossible. The mitigation cores are labelled on Fig 2. An evaluation report was previously prepared on the potential of the mitigation cores for palaeoenvironmental reconstruction as part of the watching brief (MOLA 2010). As a result this report and preliminary work on the watching brief data one of the mitigation window samples or one of the site investigation window samples was to be selected for palaeoenvironmental sub sampling.

The locations of the areas of excavation were provided by Mackley Construction.
This information was then plotted onto the OS grid. The site has produced 27 window sample or section logs. The site records can be found under the site code GPG08 in the MOLA archive.

3.2 Offsite

It was previously decided that the findings of the watching brief as a whole should be combined with the data from the window samples taken as part of the site investigation and mitigation phases to provide a site wide section of the sub-surface deposits. This has enabled MoLA geoarchaeologists to model the past landscape and place more detailed palaeoenvironmental data within a broad site-wide setting, which was particularly useful as the trench excavations for the concrete pipe and rising main did not extend below the base of the prehistoric deposits. The evaluation report (MOLA 2010) recommended that 12 pollen, 12 diatoms, and eight ostracod samples were examined from WS5 to assess the potential of the deposits. WS5 was later substituted with WS2B, from the site investigation phase. WS2B was chosen because it contained a longer sequence at a more central position within the site and would better obtain palaeoenvironmental data that would be relevant for the whole site. In addition, a series of radiocarbon dates were taken in order to place the deposits within a chronological framework and enable it to be assessed against the data from nearby sites.

The mitigation logs and site investigation logs are presented in the Appendix (Section 8) and a discussion on the deposit units across the site as a whole is given in Section 4.6.

4 Results

4.1 Watching brief lithostratigraphy

In total, 17 separate interventions were monitored for the purposes of the watching brief, nine from the construction of the rising main and eight from the construction of the concrete pipe. These have been numbered consecutively according to the sections of the respective works. There follows a brief description of the archaeological deposits as recorded.

For all intervention locations see Fig 1

GPG08_Manhole at chain 50 of concrete pipe			**Location:** 550544.09 179706.3	
Unit	**Depth of unit m bgl (Height of unit m OD)**	**Description**	**Interpretation**	**Facies**
	0.10 m OD	**Ground level adjacent to section**		
1.1	0.00 - 0.60	Concrete and made ground	Made ground	Facies 9
	-0.50 m OD			
1.2	0.60 - 2.20	Blue grey silty clay, soft slightly blocky to top, stained yellow 30-40% (contamination) on surface, occasional pocket of organics on surface, historic to very modern intrusions, at 0.8m bgl wooden stakes, squared just below made ground.	Alluvial overbank flood deposits	Facies 7

	-2.10 m OD			
1.3	2.20 - 3.20	Reddish brown peat, frequent fragments of wood, piece of red wood in palaeochannel, fibrous peat, lots of water only one large timber (less than in other areas).	Wooded wetland. Possible fen and Alder Carr	Facies 6
1.4	3.20 - 3.40	Blue grey silty clay layer, frequent fragments of wood, light grey (gleyed), not visible across whole.		
1.5	3.40 - 3.70	Brown fibrous peat.		
1.6	3.70 - 3.80	Light blue grey silty clay (gleyed) less ephemeral than above, occasional wood remains, 30-40cm in size.		
	-3.7 m OD	**Base of section**		

GPG08_Box1 from chain 50 of concrete pipe			**Location:** 550548.85 179711.28	
Unit	**Depth of unit m bgl (Height of unit m OD)**	**Description**	**Interpretation**	**Facies**
	0.20 m OD	**Ground level adjacent to section**		
1.1	0.00 - 0.50	Tarmac and made ground	Made ground	Facies 9
	-0.30 m OD			
1.2	0.50 - 1.50	Blue grey silty clay some diesel contamination to top, occasional round wood/some Fe mottling.	Alluvial overbank flood deposits	Facies 7
	-1.30 m OD			
1.3	1.50 - 2.30	Firm spongy wood peat large timber (300-400mm wide) over 1m long. Bark present, no evidence of working. Some very red wood (alder).	Wooded wetland. Possible fen and Alder Carr	Facies 6
1.4	2.30 - 2.38	Brownish blue slightly organic clay.		
1.5	2.38 - 2.71	Brown fibrous peat.		
	-2.51 m OD	**Base of section**		

GPG08_Box3 from chain 50 of concrete pipe			**Location:** 550553.26 179717.62	
Unit	**Depth of unit m bgl (Height of unit m OD)**	**Description**	**Interpretation**	**Facies**
0.20 m OD		**Ground level adjacent to section**		
1.1	0.00 - 0.60	Concrete and made ground fill.	Made ground	Facies 9
-0.40 m OD				
1.2	0.60 - 1.20	Blue grey silty clay, some manganese staining, square cut large timber post about 1m bgl.	Alluvial overbank flood deposits	Facies 7
-1.00 m OD				
1.3	1.20 - 2.00	Reddish brown peat very woody, visible tree stump at base.	Wooded wetland. Possible fen and Alder Carr	Facies 6
1.4	2.00 - 2.20	Blue grey silty clay.		
1.5	2.20 - 2.70	Peat, reddish brown, large bits of wood at base of trench.		
-2.5 m OD		**Base of section**		

GPG08_Box4 from chain 50 of concrete pipe			**Location:** 550559.49 179725.54	
Unit	**Depth of unit m bgl (Height of unit m OD)**	**Description**	**Interpretation**	**Facies**
0.20 m OD		**Ground level adjacent to section**		
1.1	0.00 - 0.50	Tarmac, concrete and made ground fill.	Made ground	Facies 9
-0.30 m OD				
1.2	0.50 - 1.50	Blue grey silty clay, modern post to top, corrugated iron sheets at the interface with the above.	Alluvial overbank flood deposits	Facies 7
-1.30 m OD				
1.3	1.50 - 2.50	Reddish brown wood peat, large timber fragments at base.	Wooded wetland. Possible fen and Alder Carr	Facies 6
1.4	2.50 - 2.70	Blue grey slightly brown silty clay, very organic.		
1.5	2.70 - 2.80	Peat, reddish brown, less woody than upper peat.		
-2.6 m OD		**Base of section**		

GPG08_Box5 from chain 50 of concrete pipe			**Location:** 550563.45 179730.86	
Unit	**Depth of unit m bgl (Height of unit m OD)**	**Description**	**Interpretation**	**Facies**
	0.20 m OD	**Ground level adjacent to section**		
1.1	0.00 - 0.50	Tarmac and made ground fill.	Made ground	Facies 9
	-0.30 m OD			
1.2	0.50 - 1.20	Blue grey silty clay, soft.	Alluvial overbank flood deposits	Facies 7
	-1.00 m OD			
1.3	1.20 - 2.00	Reddish dark brown peat. Large natural timbers.	Wooded wetland. Possible fen and Alder Carr	Facies 6
1.4	2.00 - 2.20	Irregular upper surface, pale blue grey silty clay. Patches of brownish grey silty clay, with frequent wood inclusions and rooting.		
1.5	2.20 - 2.30	Surface of reddish brown peat.		
	-2.1 m OD	**Base of section**		

GPG08_Box6 of concrete pipe			**Location:** 550568.32 179737.99	
Unit	**Depth of unit m bgl (Height of unit m OD)**	**Description**	**Interpretation**	**Facies**
	0.30 m OD	**Ground level adjacent to section**		
1.1	0.00 - 0.60	Concrete and made ground fill with drainage pipe running through.	Made ground	Facies 9
	-0.30 m OD			
1.2	0.60 - 1.30	Blue grey silty clay, some disturbance to the top with dark blue mottling. Squared off modern looking timber at 0.8m bgl.	Alluvial overbank flood deposits	Facies 7
	-1.00 m OD			
1.3	1.30 - 2.40	Reddish dark brown peat slightly clayey to top. Three large natural timbers were recorded between 1.8 and 2.0m bgl.	Wooded wetland. Possible fen and Alder Carr	Facies 6
1.4	2.40 - 2.60	Irregular upper surface, light slightly blue grey silty clay. Patches of brownish grey silty clay, with frequent wood inclusions and rooting.		
1.5	2.60 - 2.90	Peat, reddish brown, woody, slightly clayey		
1.6	2.90 - 3.00	Pale blue grey silty clay		
	-2.7 m OD	**Base of section**		

GPG08_Box7 of concrete pipe			**Location:** 550572.28 179749.43	
Unit	**Depth of unit m bgl (Height of unit m OD)**	**Description**	**Interpretation**	**Facies**
	0.35 m OD	**Ground level adjacent to section**		
1.1	0.00 - 0.10	Concrete		
1.2	0.10 - 0.30	Sand and brick		
1.3	0.30 - 0.90	Ash clinker fill, large concrete/brick culvert of land drain.	Made ground	Facies 9
	-0.55 m OD			
1.4	0.90 - 1.40	Soft blue grey silty clay, black and contaminated.	Alluvial overbank flood deposits	Facies 7
	-1.05 m OD			
1.4	1.40 - 2.45	Brown fibrous peat, large timber near to top of peat, woody.	Wooded wetland. Possible fen and Alder Carr	Facies 6
1.5	2.45 - 2.60	Slightly brownish grey clay, visible round wood, humic/organic component.		
1.6	2.60 - 2.70	Peat, reddish brown, surface only		
	-2.35 m OD	**Base of section**		

GPG08_Last 5m of concrete pipe by ditch (Box 8)			**Location:** 550572.59 179752.43	
Unit	**Depth of unit m bgl (Height of unit m OD)**	**Description**	**Interpretation**	**Facies**
	0.35 m OD	**Ground level adjacent to section**		
1.1	0.00 - 1.35	Made ground with knotweed contamination.	Made ground	Facies 9
	-1.00 m OD			
1.2	1.35 - 1.50	Dark mottled blue grey silty clay, soft, disturbed.	Alluvial overbank flood deposits	Facies 7
	-1.15 m OD			
1.3	1.50 - 2.00	Blue grey silty clay, soft, not visibly disturbed.	Wooded wetland. Possible fen and Alder Carr	Facies 6
1.4	2.00 - 2.50	Reddish brown peat, large timbers, spongy.		
	-2.15 m OD	**Base of section**		

GPG08_6m Pipe 1 of rising main			**Location:** 550689.91 179637.49	
Unit	**Depth of unit m bgl (Height of unit m OD)**	**Description**	**Interpretation**	**Facies**
	0.30 m OD	**Ground level adjacent to section**		
1.1	0.00 - 0.70	Made ground, gravel and brick rubble.	Made ground	Facies 9
	-0.40 m OD			
1.2	0.70 - 1.80	Blue grey silty clay, slightly sandy, soft, homogenous, occasional manganese staining.	Alluvial overbank flood deposits	Facies 7
	-1.50 m OD			
1.3	1.80 - 2.60	Dark brown, slightly reddish wood peat, frequent wood, small round wood/wood chips and larger timbers (rare).	Wooded wetland. Possible fen and Alder Carr	Facies 6
	-2.3 m OD	**Base of section**		

GPG08_6m Pipe 3 of rising main			**Location:** 550709.31 179635.84	
Unit	**Depth of unit m bgl (Height of unit m OD)**	**Description**	**Interpretation**	**Facies**
	0.30 m OD	**Ground level adjacent to section**		
1.1	0.00 - 0.40	Made ground	Made ground	Facies 9
	-0.10 m OD			
1.2	0.40 - 1.60	Blue grey silty clay, soft, homogenous.	Alluvial overbank flood deposits	Facies 7
	-1.30 m OD			
1.3	1.60 - 2.60	Peat, Dark reddish brown, occasional large wooden timbers.	Wooded wetland. Possible fen and Alder Carr	Facies 6
	-2.3 m OD	**Base of section**		

GPG08_6m Pipe 4 of rising main			**Location:** 550731.61 179635.01	
Unit	**Depth of unit m bgl (Height of unit m OD)**	**Description**	**Interpretation**	**Facies**
	0.30 m OD	**Ground level adjacent to section**		
1.1	0.00 - 0.60	Made ground, gravel and brick rubble, electrical service trench fill.	Made ground	Facies 9
	-0.30 m OD			
1.2	0.60 - 1.70	Blue grey silty clay soft, homogenous, occasional wood fragments to top of unit, slightly sandy in places.	Alluvial overbank flood deposits	Facies 7
	-1.40 m OD			
1.3	1.70 - 2.50	Dark reddish brown wood peat, frequent round wood <8cm, occasional to rare large timbers.	Wooded wetland. Possible fen and Alder Carr	Facies 6
	-2.2 m OD	**Base of section**		

GPG08_6m Pipe 5 of rising main			**Location:** 550736.56 179634.6	
Unit	**Depth of unit m bgl (Height of unit m OD)**	**Description**	**Interpretation**	**Facies**
	0.30 m OD	**Ground level adjacent to section**		
1.1	0.00 - 0.40	Made ground, gravel and brick rubble in clayey loam.	Made ground	Facies 9
	-0.10 m OD			
1.2	0.40 - 1.60	Blue grey silty clay soft.	Post Medieval soil	Facies 8
	-1.30 m OD			
1.3	1.60 - 2.10	Dark reddish brown wood peat.	Alluvial overbank flood deposits	Facies 7
	-1.80 m OD			
1.5	2.10 - 2.30	Blue grey pale silty clay, very woody, frequent thick (<10cm) round wood/root remains.	Wooded wetland. Possible fen and Alder Carr	Facies 6
	-2.0 m OD	**Base of section**		

GPG08_6m Pipe 7 of rising main			**Location:** 550744.41 179634.6	
Unit	**Depth of unit m bgl (Height of unit m OD)**	**Description**	**Interpretation**	**Facies**
	0.30 m OD	**Ground level adjacent to section**		
1.1	0.00 - 0.40	Made ground, gravel and brick rubble.	Made ground	Facies 9
	-0.10 m OD			
1.2	0.60 - 1.40	Blue grey silty clay soft, no visible wood inclusions.	Post Medieval soil	Facies 8
	-1.10 m OD			
1.3	1.30 - 2.10	Peat, large timber to end, very woody peat, dark reddish brown.	Alluvial overbank flood deposits	Facies 7
	-1.80 m OD			
1.5	2.60 - 2.30	Woody pale blue silty clay.	Wooded wetland. Possible fen and Alder Carr	Facies 6
	-2.0 m OD	**Base of section**		

GPG08_6m Pipe 8 of rising main			**Location:** 550748.12 179634.19	
Unit	**Depth of unit m bgl (Height of unit m OD)**	**Description**	**Interpretation**	**Facies**
	0.30 m OD	**Ground level adjacent to section**		
1.1	0.00 - 0.60	Made ground, gravel and brick rubble in a clayey loam.	Made ground	Facies 9
	-0.30 m OD			
1.2	0.60 - 1.60	Blue grey silty clay, homogenous, no visible inclusion, or upper evidence of soil formation.	Alluvial overbank flood deposits	Facies 7
	-1.30 m OD			
1.3	1.60 - 2.50	Dark reddish brown peat, very fibrous, no visible timbers/wood remains to the top, woody below 2m bgl.	Wooded wetland. Possible fen and Alder Carr	Facies 6
	-2.2 m OD	**Base of section**		

GPG08_6m Pipe 9 of rising main			**Location:** 550695.69 179637.08	
Unit	**Depth of unit m bgl (Height of unit m OD)**	**Description**	**Interpretation**	**Facies**
	0.30 m OD	**Ground level adjacent to section**		
1.1	0.00 - 0.70	Made ground, clay loam with frequent brick and concrete rubble.	Made ground	Facies 9
	-0.40 m OD			
1.2	0.70 - 1.90	Soft blue grey silty clay, top 0.5m disturbed with service cuts.	Alluvial overbank flood deposits	Facies 7
	-1.60 m OD			
1.3	1.90 - 2.20	Peat, dark brown, fibrous and slightly woody.	Wooded wetland. Possible fen and Alder Carr	Facies 6
	-1.9 m OD	**Base of section**		

GPG08_6m Pipe 10 of rising main			**Location:** 550791.47 179633.36	
Unit	**Depth of unit m bgl (Height of unit m OD)**	**Description**	**Interpretation**	**Facies**
	0.30 m OD	**Ground level adjacent to section**		
1.1	0.00 - 0.60	Made ground, clay loam with frequent brick and concrete rubble.	Made ground	Facies 9
	-0.30 m OD			
1.2	0.60 - 1.30	Blue grey silty clay, soft, looks relatively clean and unmixed but ceramic pipe at 1.6m bgl, unknown level of disturbance.	Alluvial overbank flood deposits	Facies 7
	-1.00 m OD			
1.3	1.30 - 2.40	Peat dark reddish brown and fibrous.	Wooded wetland. Possible fen and Alder Carr	Facies 6
	-2.10 m OD	**Base of section**		

4.2 Radiocarbon dating (chronostratigraphy)

Five samples were taken for dating. Three from WS2b, one from the base of the organic deposits to the west of the site (WS4) and one from the top at the east end of the site (Pipe 7 of the rising main). Botanical remains such as seeds were submitted to Beta Analytic, Miami, USA for standard AMS (^{14}C) dating and provide a basis for the chronology of the site.

Table 1 Radiocarbon samples taken from the organic sediments

Location	Sample Depth (m)	Sample Height (m OD)	Lab Number	Material Pre-treatment	Measured Age	13C/12C	Conventional Age	2 Sigma Calibration
Pipe 7 of rising main	1.70 to 1.71	-1.26 to -1.27	BETA 279864	(seeds): acid/alkali/acid	3180 +/- 40 BP	-24.5 o/oo	3190 +/- 40 BP	Cal BC 1520 to 1400 (Cal BP 3470 to 3350)
WS2B	2.02 to 2.07	-1.58 to -1.63	BETA 279865	(charred material): acid/alkali/acid	NA	NA	680 +/- 40 BP	Cal AD 1270 to 1320 (Cal BP 680 to 630),Cal AD 1350 to 1390 (Cal BP 600 to 560)
WS2B	5.95 to 6.00	-5.51 to -5.56	BETA 279866	(seeds): acid/alkali/acid	5470 +/- 40 BP	-27.9 o/oo	5420 +/- 40 BP	Cal BC 4340 to 4230 (Cal BP 6290 to 6180)
WS4	7.00 to 7.05	-6.70 to -6.75	BETA 279868	(seeds): acid/alkali/acid	4790 +/- 40 BP	-26.8 o/oo	4760 +/- 40 BP	Cal BC 3640 to 3500 (Cal BP 5590 to 5450),Cal BC 3430 to 3380 (Cal BP 5380 to 5330)
WS2B	8.24 to 8.30	-7.80 to -7.86	BETA 279867	(seeds): acid/alkali/acid	6450 +/- 40 BP	-28.1 o/oo	6400 +/- 40 BP	Cal BC 5470 to 5310 (Cal BP 7420 to 7260)

4.3 Pollen

(Dr Rob Scaife)

4.3.1 Introduction

Pollen analysis has been carried out on this 6.5m peat and mineral sediment profile. Although, the substantial thickness of the sequence has necessitated a broad pollen-sampling interval, a useful record of the on-site and off-site vegetation has been obtained. The study appears to show a predominately wooded environment both on the floodplain and on adjacent interfluves. Possible phases of brackish water incursion have been identified which relate to changes in sedimentological and vegetational environment. It is suggested that the sequence probably dates back to the middle Holocene and spans the Neolithic Elm Decline at *ca*. 5,500-5000 BP.

4.3.2 Method

Site Code	WS	Sample Depth (m)			Sample Height (m OD)			Sample Number
GPG08	2B	1.70	to	1.71	-1.26	to	-1.27	P12
GPG08	2B	1.96	to	1.97	-1.52	to	-1.53	P11
GPG08	2B	2.48	to	2.49	-2.04	to	-2.05	P10
GPG08	2B	3.44	to	3.45	-3.00	to	-3.01	P9
GPG08	2B	3.96	to	3.97	-3.52	to	-3.53	P8
GPG08	2B	4.46	to	4.47	-4.02	to	-4.03	P7
GPG08	2B	4.94	to	4.95	-4.50	to	-4.51	P6
GPG08	2B	6.01	to	6.02	-5.57	to	-5.58	P5
GPG08	2B	6.96	to	6.97	-6.52	to	-6.53	P4
GPG08	2B	7.40	to	7.41	-6.96	to	-6.97	P3
GPG08	2B	7.96	to	7.97	-7.52	to	-7.53	P2
GPG08	2B	8.20	to	8.21	-7.76	to	-7.77	P1

Table 2 Pollen sub sample locations

Samples of 2ml were processed using standard techniques for the extraction of the sub-fossil pollen and spores (Moore and Webb 1978; Moore *et al.* 1992). Micromesh sieving (10u) was also used to aid with removal of the clay fraction in these sediments. Pollen was extracted from all of the 12 samples prepared. The sub-fossil pollen and spores were identified and counted using an Olympus biological research microscope. A pollen sum of 400 grains of dry land taxa was counted for each level. Where numbers of *Alnus* were high, these were counted (and calculated) outside of this sum taking total pollen counts to as high as 1,300 grains in these levels. Additionally, all extant spores and pollen of marsh taxa (largely Cyperaceae), fern spores and miscellaneous pre-Quaternary palynomorphs were also counted for each of the samples analysed. A pollen diagram has been plotted using Tilia and Tilia Graph (Fig 3 and Fig 4). Percentages have been calculated in a standard way but with *Alnus* calculated as a percentage of the pollen sum + *Alnus* and *Salix* as discussed by Janssen (1969). This gives a more realistic representation of the dry land/interfluve taxa.

Sum **=** % total dry land pollen (tdlp)
Marsh/aquatic = % tdlp + sum of marsh/aquatics
Spores = % tdlp + sum of spores
Carr % tdlp + *Alnus* and *Salix*
Misc. = % tdlp + sum of misc. taxa. (pre-Quaternary)

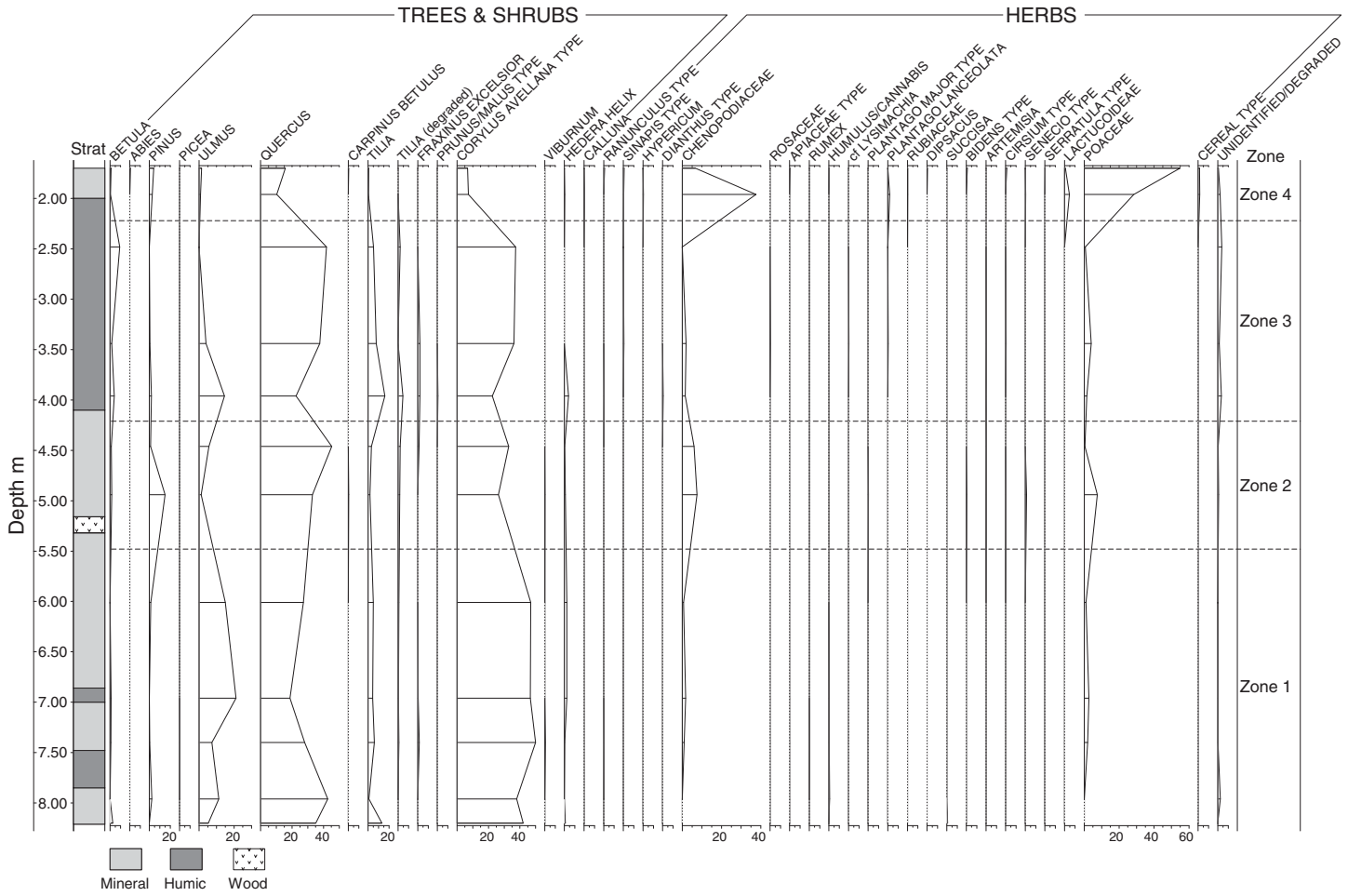

Fig 3 Pollen diagram (Author Dr R Scaife)

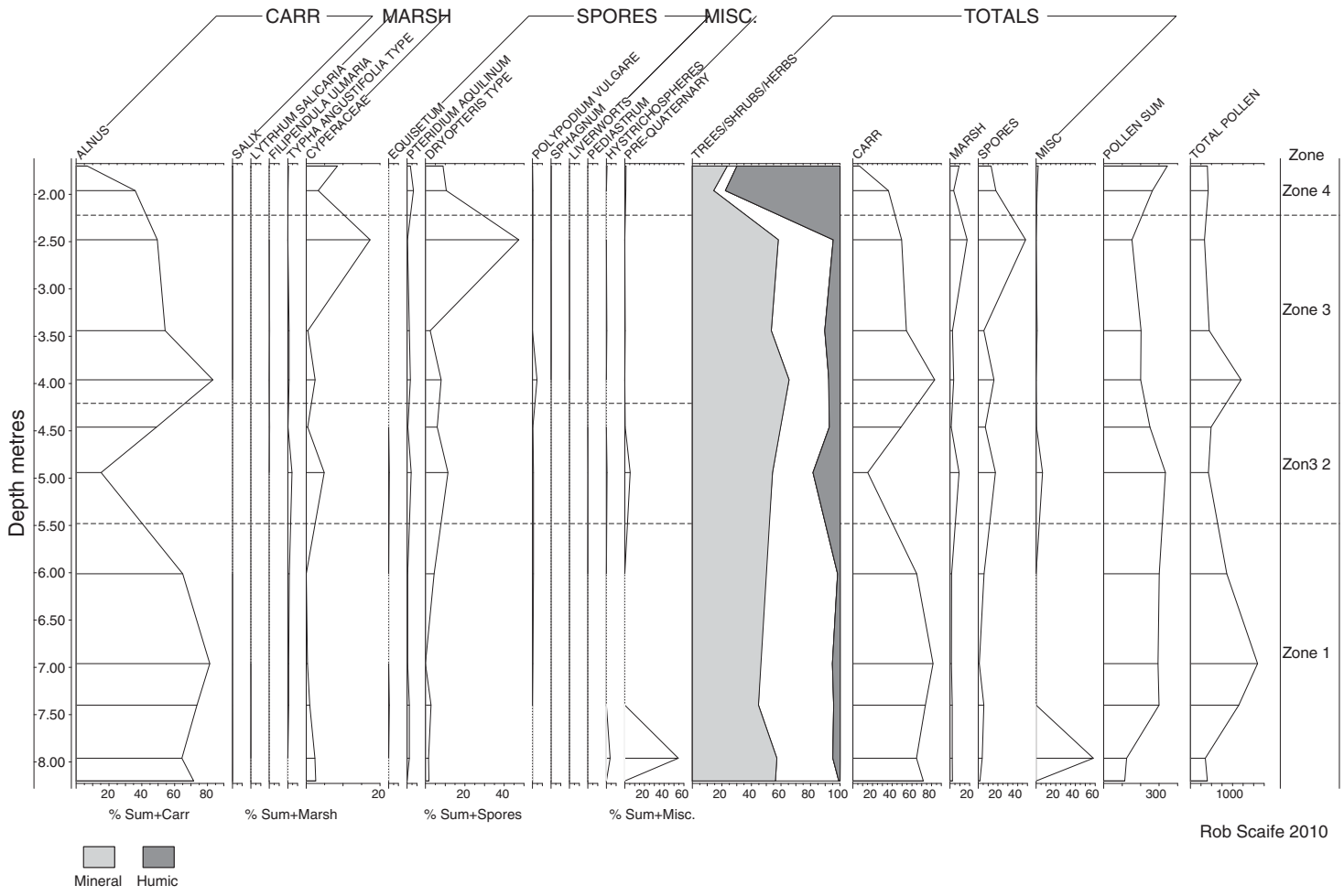

Fig 4 Pollen diagram (continued, Author Dr R Scaife)

Taxonomy, in general, follows that of Moore and Webb (1978) modified according to Bennett *et al.* (1994) for pollen types and Stace (1992) for plant descriptions. These procedures were carried out in the Palaeoecology Laboratory of the Department of Geography, University of Southampton.

4.3.3 Results

Overall, the pollen assemblages are dominated by trees and shrubs with few herbs except in the upper levels. Except in the upper levels, *Alnus* (alder) is dominant (on-site floodplain carr woodland) with *Ulmus* (elm), *Quercus* (oak), *Tilia* (lime) and *Corylus avellana* type (hazel) and *Hedera helix* (ivy). The most important herbs are Chenopodiaceae (goosefoots, oraches and glassworts), Poaceae (grasses) and Cyperaceae (sedges) with fluctuating values. Greater numbers of these occur in the more minerogenic sediments, especially the upper in the upper alluvium.

To aid description of this long pollen sequence, four local pollen assemblage zones have been recognised. Details of these are given in Table 3.

l.p.a.z. 4 2.22m – 1.70m Chenopodiaceae-Poaceae	Change from peat to upper alluvial minerogenic sediments. There is a reduction of trees and shrubs and an expansion of herbs. The former including *Quercus* (to 12%), *Corylus avellana* type (6%), *Tilia* (to absence) and *Alnus* (to 5%). Sporadic *Abies, Ulmus,* and Carpinus. Poaceae (to 55%) and Chenopodiaceae (peak to 40%) are dominant. Cyperaceae remains important (15%). There is some increase of *Plantago lanceolata* (1-2) and sporadic cereal pollen and *Humulus/Cannabis* type.
l.p.a.z. 3 4.21m – 2.22m *Quercus-Tilia Corylus avellana* type-*Alnus*-Cyperaceae	*Tilia* increases (peak to 20%) with *Ulmus* (peak to 26%). *Quercus, Corylus avellana* type (45%) and *Alnus* (peak to max. values; 88% sum + carr) are dominant. *Fraxinus* is more consistent (1-2%). Herbs numbers and diversity remain low with Poaceae (2-3%), Chenopodiaceae (1-2%), most important. *Plantago lanceolata* is incoming but at low levels. Cyperaceae (19%) and spores of *Dryopteris* type (to 46%) have high peaks at 2.50m.
l.p.a.z. 2 5.50m – 4.21m *Quercus-Tilia-Corylus avellana* type-Chenopodiaceae	Delimited by a reduction of *Ulmus* (to low levels (followed by an expansion), an increase in Chenopodiaceae (peak to 9%) and expansion of Cyperaceae. *Quercus* (peak to 49%), *Corylus avellana* type (30-40%) and *Alnus* remain important. Aln*u*s declines to low values at 4.94m followed by recovery, corresponding with the expansion of Cyperaceae. Other trees and shrubs include *Tilia, Carpinus* (<1%) and a peak

	of *Pinus* (19%). Monolete spores (*Dryopteris* type) become more important. There are occasional *Pediastrum* cysts.
l.p.a.z. 1 8.20m – 5.50m *Ulmus-Quercus-Corylus avellana type-Alnus.*	Dominated by *Ulmus* (peak to 26%), *Quercus* with highest values (to 44%), *Corylus avellana* type (49%) and *Alnus* (to 85% sum + carr). *Tilia* (12% at base) is also present. There are few herbs with Poaceae (1-2%), Chenopodiaceae (1-2%) and *Humulus/Cannabis* type (1%). Fen carr and fen taxa include *Alnus* (noted), *Salix* (<1%), Cyperaceae (1-3%) and *Typha angustifolia* type (<1%). There is a substantial peak of derived pre-Quaternary palynomorphs in the basal minerogenic sediment.

Table 3 Details of the local pollen assemblage zones.

4.3.4 Discussion

It is suggested that this sediment profile is of late prehistoric age, probably dating back to the Neolithic (MOLA 2010). The pollen data obtained are commensurate with this and compare with the now substantial palaeo-vegetation database which exists for London. However, it is possible that the sequence extends back into the middle Holocene. Whilst the peats and intercalated minerogenic sediments are of late-prehistoric age, the overlying alluvial, minerogenic sediments of l.p.a.z. 4 may be of historic age with a hiatus between l.p.a.z. 3 and l.p.a.z.4.

The changes in pollen within this long profile relate to both the changing, on site habitat/environment and, to the drier land of the interfluves/better drained soils. Changes in the former are intricately linked to the changing fluvial regime which was being affected by changes of sea level.

The on-site vegetation and environment
Because the sediment sequence is long and the pollen-sampling interval is very broad, only broad patterns of change can be delimited. It is clear that the site was largely dominated by on-site floodplain alder carr woodland except in its very uppermost alluvial levels. This was, however, subject to possible phases of increasing wetness which resulted in a wetter fen habitat (grass-sedge-reed) and possible brackish water influence as indicated by halophytes (largely Chenopodiaceae; goosefoots and oraches). These phases are seen in the basal levels of the profile (l.p.a.z.1; 5.48m to 4.21m) and the upper mineral sediment (l.p.a.z 4; 2.22m to 1.70m). The former, lowest phase was probably a response to regional rising (relative) sea-level causing inception of sedimentation. Once established, fen carr woodland was able to develop. The suggested habitat changes are given in Table 4 below.

l.p.a.z. 4	Change to minerogenic/alluvial sediments. Alder carr woodland is much reduced at this site but was probably a moving fringe to the floodplain wetland as it expanded in area. Carr woodland was replaced by grass/sedge fen with probable marine/brackish water influence (Chenopodiaceae).
l.p.a.z. 3	There was a return to fen carr woodland (alder and willow). This was followed (upper part of the zone) by increasing wetness which caused progressive reduction of the alder carr to sedge fen. This was probably a response to the late-prehistoric rising sea level which culminated in disruption of the local river systems and widespread alluviation of the Thames floodplain (Devoy Thames Stage 4).
l.p.a.z. 2	A possible phase of marine sedimentation indicated by higher values of Chenopodiaceae pollen. Mineral sedimentation also resulted in deposition of reworked geological palynomorphs and dinoflaggellates (as seen at base of l.p.a.z.1). Alder becomes less important and was replaced by grasses, sedges and bur reed and/or reed mace. Along with algal Pediastrum this indicates a phase of increased ground water table/wetter conditions and probable brackish water ingress.
l.p.a.z. 1	Basal minerogenic sediment containing reworked geological pollen, spores and dinoflaggellates. Overbank alluviation? Alder dominated floodplain carr woodland with willow became dominant on or very close to the sample site. Ground flora of grasses and sedges and other fen herb taxa. Incoming Chenopodiaceae (oraches etc) from the middle of the zone may be evidence of ephemeral saline/brackish incursions.

Table 4 The changing wetland habitats.

The dry-land vegetation

The on site habitat was one of, probably dense, floodplain carr woodland. This may have restricted the pollen input from the surrounding interfluves (Tauber 1963, 1967). This may have been responsible for the paucity of herb pollen recovered. There is, however, clear representation of arboreal types and throughout most of the time-span represented by the sediments, woodland was clearly dominant in the adjacent region.

From the base of the profile, oak, elm lime and hazel woodland was dominant. This is the typical woodland flora of the region prior to prehistoric clearance. The apparently small numbers of lime (*Tilia*) belie its real importance as a major woodland constituent as this taxon is insect (entomophilous) pollinated and is usually under represented in pollen assemblages compared with wind pollinated (anemophilous) oak, elm and hazel. This similarly applies to ash (*Fraxinus*) which may also have been present in small numbers. Pine (*Pinus*) peaks in l.p.a.z. 2 and l.p.a.z. 3 are not regarded as significant because pine produces substantial quantities of wind blown pollen, which may be dispersed, over great distances. It is also typically over represented in fluvial and especially marine/brackish sediments due to its ability to float long distances. A further possibility is that it may have been eroded from older sediments. It was not a local taxon of this region during the late Holocene.

The values of elm (*Ulmus*) pollen recorded here (to *ca*. 20%) are diagnostic of the middle Holocene (Atlantic; Flandrian Chronozone II) prior to the Neolithic Elm Decline which occurred at *ca*. 5,500-5,000BP (Smith and Pilcher 1973; Smith 1970; Parker *et al.* 2002; Peglar 1993; Peglar and Birks 1993).

If the pollen assemblages of l.p.a.z. 1 and l.p.a.z. 2 are, as indicated by the dominant woodland flora are of middle Holocene age, the decline of elm in l.p.a.z. 3 may be the much discussed Neolithic Elm Decline (e.g. Smith 1970, 1977; Girling 1988; Scaife 1988) caused by spread of fungal disease through elm bark beetle. This important phenomenon is frequently associated with the first appearance of cereals and weeds of agriculture associated with the introduction and establishment of agriculture by the Neolithic. Here, cereal pollen is absent until the top of the profile. However, it is noted that ribwort plantain (*Plantago lanceolata*) is diagnostic as an indicator of human disturbance and occurs here from the point of elm decline from *ca*. 3.70m. This also adds to the possibility that this is the Elm Decline at *ca*. 5,500-5,000 BP. Absence of cereals and other herbs in general may, as noted, be due to the filtering effect of what would have been dense on site alder woodland. With reduction in elm and the possible first indications of human activity (albeit small), ash (*Fraxinus* excelsior) becomes more important. This is also diagnostic of the immediate post Elm Decline with ash colonising areas previously occupied by elm. The taphonomy of pollen in such a changing environment may be complex and with opening of the woodland, lime pollen becomes more evident in the post Elm Decline assemblages with less hindrance to dispersal. The taphonomy here is further complicated by the changing sedimentary regime from mineral sediment (l.p.a.z.2) to peaty clay silt (in l.p.a.z.3).

After the demise of elm, woodland comprising lime, oak and hazel with some ash (l.p.a.z. 3) existed (middle-late Neolithic and early Bronze Age?). This pertained until a major stratigraphical/environmental change occurred with deposition of alluvium overlying the peaty clay silt of l.p.a.z.3. This alluviation of the River Thames floodplain has been described at other sites in London (Sidell *et al*. 2000) and occurred in response to rising sea level and ponding back of river systems and overbank deposition during the late Bronze Age and Iron Age periods. Palynologically, this is often manifested by change from floodplain alder carr woodland which became wetter grass-sedge fen and subsequent mineral alluviation (Scaife 2000). This occurred here with a resulting change in pollen taphonomy which increased the size of the pollen catchment. It is only in the upper zone (l.p.a.z. 4) that cereal pollen is found and this may have been fluvially transported from elsewhere in the river catchment. *Cannabis* type pollen in this upper zone is possibly of hemp (*Cannabis* cultivated for fibre) rather than hop (*Humulus*) which is typical of fen woodland and recorded in the lower zones of this sequence.

4.3.5 Conclusion

The following principal points have been made in this study.

- This long pollen profile demonstrates dominance of woodland throughout most of the time-span represented by the sediments.
- The on-site environment was largely dominated by flood plain alder carr woodland with ephemeral wetter phases.
- There are phases of possible brackish water ingress at the base of the profile, between 4.21m and 3.70m and in the upper mineral sediments (2.22m to 1.70m).
- There are indications that the lower sediments pre-date the Elm Decline by virtue of the woodland dominance including high elm pollen percentages (i.e. greater than normally encountered after *ca*. 5,000 BP.
- A decline of elm pollen at *ca*. 3.70m may be the Neolithic Elm Decline at *ca*. 5,500 to 5,000BP caused by insect spread of elm bark disease.
- The Elm Decline is associated with first occurrence here of ribwort plantain (*Plantago lanceolata*) and expansion of ash (*Fraxinus*). These are diagnostic phenomena often associated with the Elm Decline.
- Subsequently, oak, lime, ash and hazel woodland were dominant on the better soils of the interfluves.
- On site alder carr woodland was ousted by increasing wetness caused by late Holocene regionally rising sea level (relative to land). This caused a change to a grass-sedge fen.
- Changes in the fluvial regime culminated in the deposition of alluvium over floodplain.
- Pollen is not a means of dating and inferences made are based on existing knowledge of London's palaeoecology.

4.4 Diatoms

(Nigel Cameron)

4.4.1 Introduction

Twelve samples from a single sequence were prepared for diatom analysis. The purpose of carrying out diatom analysis for these samples is: firstly to indicate the presence or absence of diatoms within the sequences; secondly, where diatoms are present, to provide information on salinity and the local aquatic environment.

4.4.2 Method

Site Code	WS	Sample Depth (m)			Sample Height (m OD)			Sample Number
GPG08	2B	1.70	to	1.71	-1.26	to	-1.27	D12
GPG08	2B	1.96	to	1.97	-1.52	to	-1.53	D11
GPG08	2B	2.48	to	2.49	-2.04	to	-2.05	D10
GPG08	2B	3.44	to	3.45	-3.00	to	-3.01	D9
GPG08	2B	3.96	to	3.97	-3.52	to	-3.53	D8
GPG08	2B	4.46	to	4.47	-4.02	to	-4.03	D7
GPG08	2B	4.94	to	4.95	-4.50	to	-4.51	D6
GPG08	2B	6.01	to	6.02	-5.57	to	-5.58	D5
GPG08	2B	6.96	to	6.97	-6.52	to	-6.53	D4
GPG08	2B	7.40	to	7.41	-6.96	to	-6.97	D3
GPG08	2B	7.96	to	7.97	-7.52	to	-7.53	D2
GPG08	2B	8.20	to	8.21	-7.76	to	-7.77	D1

Table 5 Diatom sub sample locations

Diatom preparation and analysis followed standard techniques (Battarbee *et al.* 2001). 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:

1. Polyhalobian: >30 g l^{-1}

2. Mesohalobian: 0.2-30 g l^{-1}

3. Oligohalobian - Halophilous: optimum in slightly brackish water

4. Oligohalobian - Indifferent: optimum in freshwater but tolerant of slightly brackish water

5. Halophobous: exclusively freshwater

6. Unknown: taxa of unknown salinity preference.

4.4.3 Results and Interpretation

The samples assessed and analysed for diatoms are shown in Table 6 below. Table 6 shows a summary of the diatom assemblages in the WS2B sequence (although no further analysis will be carried out, the potential for percentage counting is shown in the right hand column to further indicate the quality of the diatom assemblages). Table 3 (Excel table) shows the semi-quantitative analysis of diatom species abundances, based on low sum counts of diatoms in the WS2B sequence.

Where possible a low sum count of diatoms was made to make a semi-quantitative evaluation of diatom abundances. However, in three samples diatoms were absent (samples D2, D8, D10) and in the majority of samples the assemblages were poorly preserved; the only well preserved assemblage was present in sample D11. A semi-quantitative analysis of diatom abundances was determined as the most appropriate method to compare diatom assemblages through the sequence because overall the counting sums possible were necessarily low and it was difficult to obtain a high enough total of diatoms to plot a continuous percentage diagram.

Sample	Diatoms	*Diatom numbers*	Quality of preservation	Diversity	Assemblage type	Potential for % count
D1	+	ex low	ex poor	ex low	bk	none
D2	-	-	-	-	-	none
D3	+	ex low	poor	mod	bk mar	low
D4	+	low	poor to mod	mod	bk mar fw	low
D5	+	low to mod	mod to poor	mod	mar bk fw	low/some
D6	+	low	mod to poor	mod	mar bk fw	low/some
D7	+	low to mod	poor	mod	mar bk	low/some
D8	-	-	-	-	-	none
D9	+	low	poor	low	mar bk fw	low
D10	-	-	-	-	-	none
D11	+	mod	mod	mod	bk mar fw	mod
D12	+	low	poor	mod	bk mar fw	low

Table 6 Borehole GPG08_SI_WS2B, Green Level Pumping Station, Erith

Summary of diatom evaluation results (+ present, - absent, mod – moderately high, ex low- extremely low, fw – freshwater, aero- aerophilous, bk – brackish, mar – marine, hal – halophilous).

It can be seen from Table 5 and Table 6 that the diatom assemblages occurring between 8.20 and 1.70 m depth in WS2B all contain marine-brackish or marine-brackish and marine diatoms (polyhalobous, polyhalobous to mesohalobous and mesohalobous groups). Therefore tidal conditions are reflected by the diatom assemblages throughout the sequence. Freshwater, oligohalobous indifferent, taxa were recorded in all the diatomaceous samples, except for the bottom sample (D1). With the exception of *Aulacoseira granulata* (samples D6 and D9), which is a planktonic species, these freshwater taxa are attached or benthic diatoms, such as the epiphyte *Cocconeis placentula* or epipelic species *Navicula rhyncocephala*. Although the *Fragilaria* taxa: *F. construens, F. lapponica* and *F. pinnata* have optimal growth in freshwater, they do have wide salinity tolerances. Oligohalobous indifferent diatoms are not, however, common in any sample.

In the diatomaceous samples D3 to D9 and D12 the assemblages are dominated by marine plankton (including *Paralia sulcata, Rhaphoneis* spp. and *Cymatosira belgica*), estuarine plankton such as *Cyclotella striata* and benthic, mesohalobous diatoms such as *Nitzschia navicularis, Nitzschia granulata* and *Diploneis didyma*. Exceptionally the best preserved and most diverse sample (D11), from sediments at the top of the borehole sequence, has a higher proportion of mesohalobous and halophilous taxa. These brackish water diatoms appear to reflect a change in the source diatom communities and an increased number of brackish water species are represented. Although the salinity of the sedimentary environment remains high and it is a tidal environment, the component of allochthonous marine plankton is reduced (though *Paralia sulcata* remains common). The common mesohalobous taxa in D11 include *Synedra pulchella, Synedra fasciculata, Nitzschia hungarica, Navicula gregaria, Lyrella pygmaea, Caloneis amphisbaena* fo. *subsalina* and a brackish water diatom associated specifically with tidal environments, *Bacillaria paradoxa*. In addition halophilous diatoms such as *Actinocyclus normanii* (planktonic) and *Nitzchia levidensis* (benthic) are present, whilst the planktonic halophile *Cyclotella meneghiniana* displaces the mesohalobous estuarine species *Cyclotella striata*. In the top sample (D12) there is a return to the dominance of the *Cyclotella striata*, mesohalobous benthos such as *Nitzschia navicularis, Navicula peregrina* and the marine taxa *Paralia sulcata, Rhaphoneis minutissima* and *Rhaphoneis amphiceros*.

4.4.4 Conclusions

- Diatoms are present in nine of the twelve samples prepared for diatom analysis.
- The majority of the diatom assemblages are poorly preserved, however, it has been possible to make low sum counts for the sequence and to produce a semi-quantitative analysis of diatom abundances (*Table 6*).
- The tidal nature of the sedimentary environments is reflected in the dominance of marine and marine-brackish diatoms through the WS2B sequence. Freshwater diatoms form only a small component of the assemblages and some of these are oligohalobous indifferent taxa with wide salinity tolerances.
- In the upper part of the sequence, the diatom assemblage from an exceptionally well-preserved sample (D11) indicates a change in the source communities with a higher proportion of mesohalobous and halophilous diatoms and a reduced component of allochthonous marine plankton. However, tidal conditions continue to dominate and there is a return to the dominance of mesohalobous and polyhalobous plankton at the top of the sequence.

4.5 Foraminifera and Ostracods

(John E. Whittaker)

4.5.1 Introduction

Eight samples for microfossil analysis were submitted by Museum of London Archaeology (MoLA) on May 15th 2010. They are from Window Sample 2B, at the Green Level Pumping Station, Erith (London Borough of Bexley). The samples (O1-O8) represent over 8.5m of sediment within a borehole penetrating alluvial sands and organic clays of the Thames Holocene sequence. Samples O8-O5 (interval 4.06-7.43m below ground level) are placed in Facies 4 and 5, initially interpreted (V.

Yendell, pers. comm.) as “wetland peat with periods of inundation and overbank flood deposition”. Below that, samples O4-O2 (interval 7.85-8.31m below ground level) – Facies 3 – are considered to represent a “quiet shallow, still water environment”. Finally, sample O1 (8.60/8.61m below ground level; Facies 2) is said to belong to “early Holocene sands and silts”. The purpose of the microfossil assessment was to test this palaeoenvironmental interpretation and expand on it where possible.

4.5.2 Method

Sample	Depth (bgl)	Depth (O.D.)	Weight processed
O8	4.06-4.07m	-3.62/-3.63m	10g
O7	4.96-4.97m	-4.52/-4.53m	5g
O6	6.46-6.47m	-6.02/-6.03m	5g
O5	7.42-7.43m	-6.98/-6,99m	5g
O4	7.85-7.86m	-7.41/-7.42m	5g
O3	7.98-7.99m	-7.54/-7.55m	10g
O2	8.30-8.31m	-7.86/-7.87m	10g
O1	8.60-8.61m	-8.16/-8.17m	15g

Table 7 Ostracod sub sample locations

After weighing, each sample was put in a ceramic bowl. The sediment was first broken by hand into very small pieces and then thoroughly dried in the oven. Boiling water was then poured on the sample and a little sodium carbonate added to help remove the clay fraction on washing. It was then left to soak overnight. The sample was then washed with hot water through a 75 micron sieve. In spite of some of them being rather organic a satisfactory breakdown was achieved. The resulting residue was finally decanted back into the bowl for drying in the oven. When dry the sample was stored in a labelled plastic bag. Examination of the residue was undertaken under a binocular microscope. First the residue was put through a nest of dry sieves (>500, >250 and >150 microns) and then sprinkled out a fraction and a little at a time onto a tray. Any organic remains or items of interest were noted and the data incorporated, on a presence (x)/absence basis, into Figure 1, accompanying this report. The ostracods were picked out and placed on 3x1” faunal slides for archive purposes, the species being listed in this case also on a presence/absence basis, and colour-coded for their ecological preferences, also in *Table 8*.

4.5.3 Results and Interpretation

Although the samples provided were exceedingly small (between only 5 and 15g each) some organic remains, potentially useful for a palaeoenvironmental reconstruction, were found. These are listed in the uppermost part of Table 8. Plant debris and seeds are found in 6 of the 8 samples, not surprisingly, as most of them were organic clays.

ORGANIC REMAINS

Sample no.	O8	O7	O6	O5	O4	O3	O2	O1
Depth below ground level	4.06/4.07 m	4.96/4.97 m	6.46/6.47 m	7.42/7.43 m	7.85/7.86 m	7.98/7.99 m	8.30/8.31 m	8.60/8.51 m
plant debris + seeds	x	x	x	x	x		x	
insect remains	x		x					
molluscs			x	x			x	
Bithynia opercula			x					
freshwater ostracods			x	x			x	
brackish ostracods			x					
						silty sand		*silty sand*

FRESHWATER OSTRACODS

Sample no.	O8	O7	O6	O5	O4	O3	O2	O1
Depth below ground level	4.06/4.07 m	4.96/4.97 m	6.46/6.47 m	7.42/7.43 m	7.85/7.86 m	7.98/7.99 m	8.30/8.31 m	8.60/8.51 m
Candona neglecta			xx	x			x	
Darwinula stevensoni			x					
Cyclocypris sp.			x				x	
Ilyocypris sp. (juvs)			x					
Cypria ophtalmica			x					
Pseudocandona sp.			o					

BRACKISH OSTRACODS

Sample no.	O8	O7	O6	O5	O4	O3	O2	O1
Depth below ground level	4.06/4.07 m	4.96/4.97 m	6.46/6.47 m	7.42/7.43 m	7.85/7.86 m	7.98/7.99 m	8.30/8.31 m	8.60/8.51 m
Leptocythere porcellanea			xx					
Cytheromorpha fuscata			x					
Cyprideis torosa (juvs)			x					

Organic remains are recorded on a presence (x)/absence basis

Ostracods are recorded: o - one specimen; x - several specimens; xx - common

Table 8 Ostracod results

Only two samples (the silty sands O3 and O1) were completely barren of anything, although O3 contained reworked microfossils from the Chalk (which may indicate their provenance). Insect remains were found in two samples within Facies 4 and 5, and molluscs in three, but two of these (O2 and O5) contained only fragments. O6, from Facies 5 (6.46-6.47m below ground level), however, contained a good molluscan fauna as well as *Bithynia* opercula. No diatoms (at least larger than 75 microns, the sieve size) observed. Ostracods were only found in three of the eight samples examined (*Table 8*): two contained a small fauna of freshwater ostracods, however the third (O6; from Facies 5; 6.46/6.47m below ground level) proved much more interesting. O6 contains six species of freshwater ostracods and three species of brackish ostracods (the only one in the Erith sequence to do so). The former component (colour-coded light blue in Table 8), it is true, can live in low salinities in estuarine environments and in coastal pools, whereas the latter (colour-coded lime green) occur in tidal rivers, mudflats and creeks, invariably in brackish conditions. Both components, moreover, are represented by carapaces (especially the brackish component) which should signify *in situ* populations or at least very little transport. So what has happened here? A estuarine mudflat into which the freshwater component, living in the adjacent marshes and pools, has been introduced possibly after a

rainstorm or a local pool or wetland adjacent to the river into which a storm surge and subsequent overbank flooding has introduced the brackish component from a nearby tidal flat? It would appear to be the latter and significant evidence of an actual catastrophic event at that, as there is no other evidence of tidal access or a general sea-level rise in any of the other samples from Facies 5. It would also support the initial interpretation by MoLA (see Introduction, above). The occurrence of *Cytheromorpha fuscata* is also worthy of comment. This species, once common in East Coast estuaries and tidal rivers, especially from the early Holocene and apparently right up to the 19th Century, is now virtually extinct and would not been found at all in the Thames today; no-one knows why.

Facies 3 only contains a few freshwater ostracods, but their ecological signal is not good enough to elaborate on the initial interpretation by MoLA of shallow, quiet [fresh]water. Facies 2 is completely barren.

4.6 Integrated Palaeoenivironmental Discussion

The tabulated sedimentary units from the watching brief sections and the previous site investigation and mitigation window samples and boreholes (section 4.1 and 8, and shown in Fig 2) have been grouped into sediment packages or facies with key markers in the sequence, which denote major events and used as points of correlation. These principally comprise the change from clast supported gravels to Early Holocene sands (between -6.74 to -8.38m OD); backwater deposits (between -6.89 to -8.1m OD); a wooded wetland environment (between -6.54 and -7.06m OD); inundation and the formation of a sedge fen (between -5.44m and -6.5m OD); a return to a wooded wetland (between -1.93m and -3.9m OD,); alluvial floodplain (between -1.0m and -2.93m OD) and modern made ground (between -0.1m to -1.3m OD).

The deposits represent a progressively inundated landscape with various chronological and spatial environmental changes. The transitions between the facies and the broad environments they represent would have occurred at different times at different points across the site. In order to illustrate this two transects are provided (see Fig 5 for their locations), one running west to east (Fig 6) and one north to south (*Fig 7*). In addition the locations of the sub samples used for palaeoenvironmental reconstruction are depicted in Fig 8 along with a summary of the findings (Table 9).

4.6.1 Facies 1: Pleistocene Gravels

The basal sediment located on site was orange to greenish grey coarse sand and gravel deposit. These gravels belong to the Shepperton floodplain gravels, and were deposited in a cold climate fast flowing braided river environment at the end of the last glacial period (c 15000 to 10000 BP).

The deposit was not recorded in any of the watching brief sections and was only encountered in the window samples and boreholes. The surface of the gravels lies between -6.74 and -8.38m OD. It is lowest towards the west end of the line of the rising main and rises up towards the east end of the site. This area of high gravel probably formed as a channel bar within the braided river system, accumulating in slow moving water on the inside of a bend in the river. As the Late Pleistocene glacial floodwaters began to subside, this area of high gravel would have emerged as an island of high dry ground. This area of high gravel has been highlighted in previous

Fig 5 Distribution of data and transect location

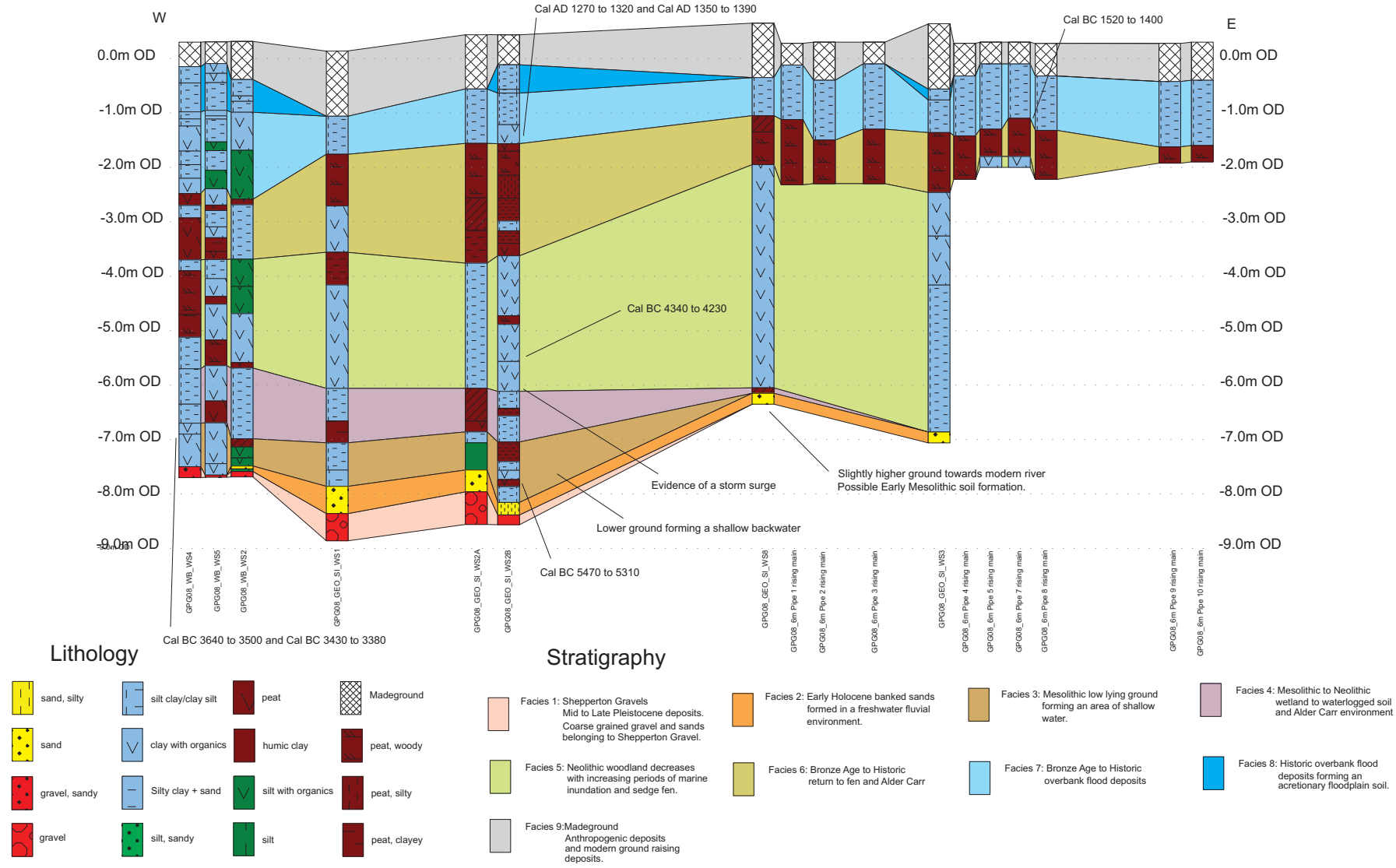

Fig 6 West east transect

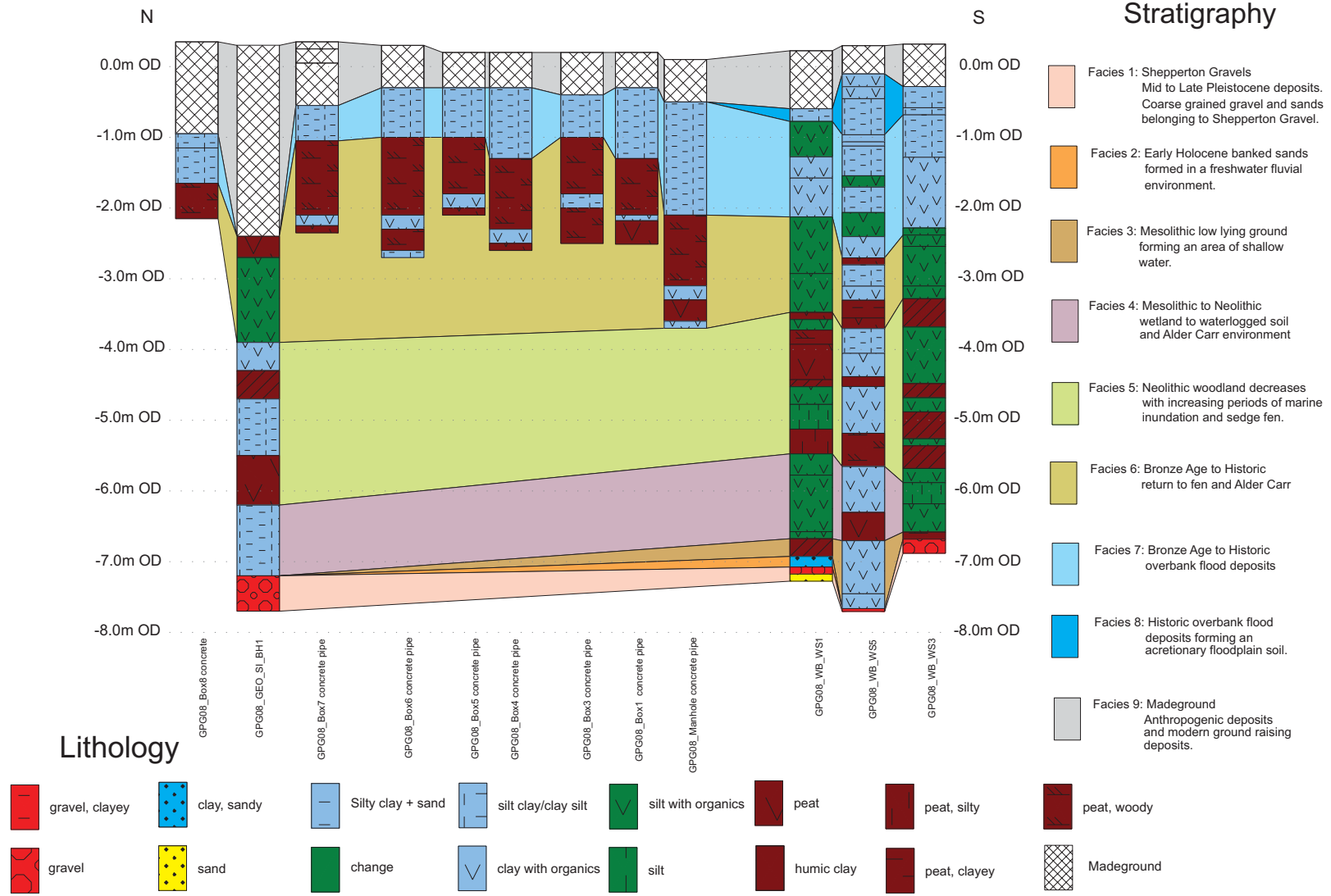

Fig 7 North South transect

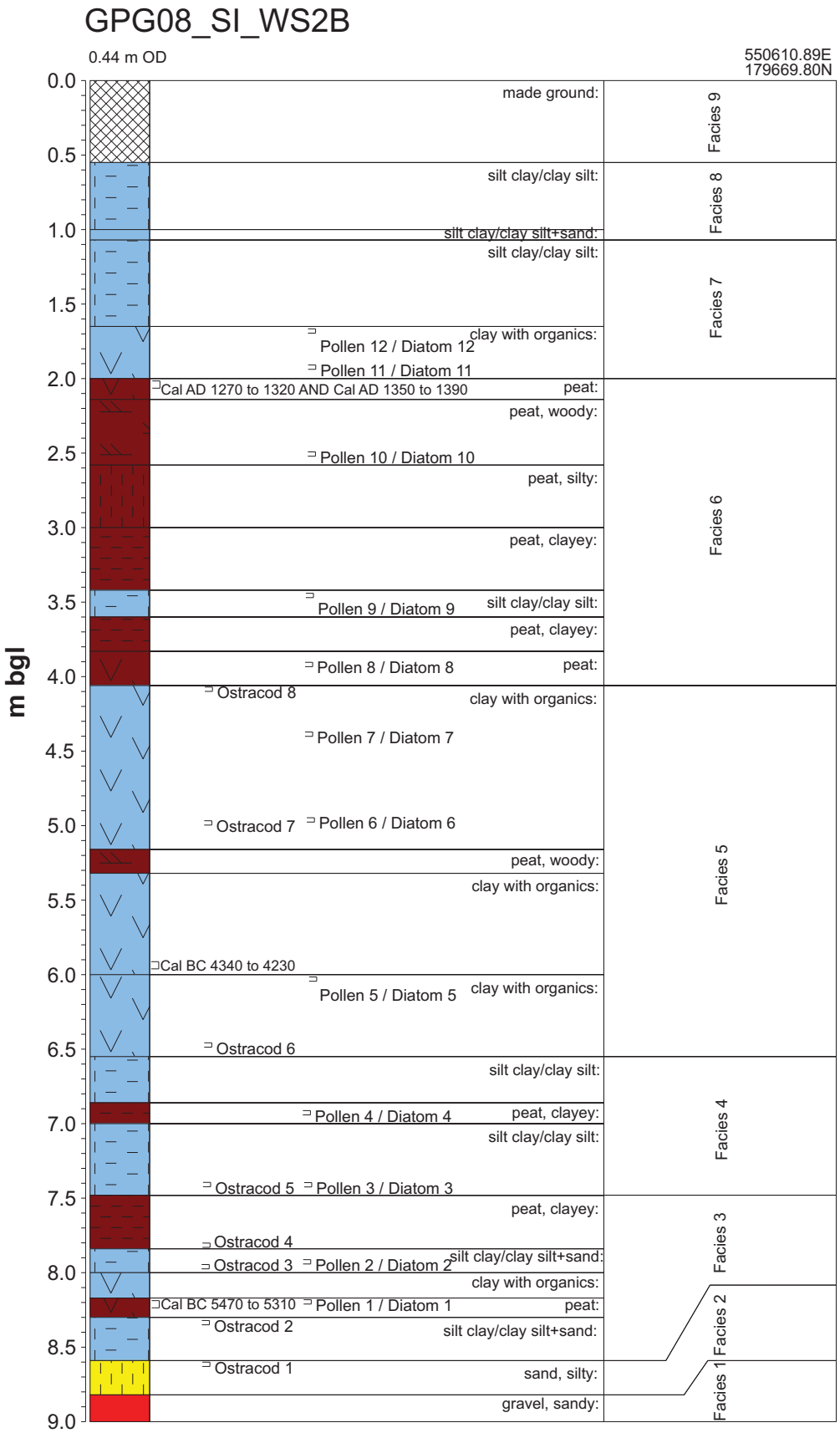

Fig 8 Sub sample locations

Work at the adjacent Pirelli site (MOLA 2007). The surface of the gravels forms the basic topography for early Holocene landscape and is shown in Fig 9. A schematic drawing separating the area into landscape zones is presented in Fig 10 where the gravel island to the east is represented by landscape zone 1 (LZ1). The western limit of the island is evident in Fig 9 and data from the Pirelli site provides some of the southern extent. However, despite the data from the present work and that of the previous Pirelli site the southern, eastern and northern limits of the island are still unknown.

4.6.2 Facies 2: Early Holocene fluvial sands

The gravels are variably overlain by orange to green sands occasionally grading upwards into silty sands. The surface of the sands lies between -6.89 to -8.1m OD and they are between 0.1m and 0.8m in thickness. No sand deposits were recorded to north of the site (see *Fig 7*). The thickest sand deposits are found within the low lying area to the west end of the rising main and thin out slightly as they rise over the high area of gravel.

At the beginning of the Holocene as higher energy waters of the braided river system subsided, these sands and finer minerogenic sediments were deposited. The fining up sequence represented by the sands and silts characterize the gradual reduction and stabilization of the flow rate. Thick deposits of sand have been previously recorded banked up against the gravel island (MOLA 2007). The thicker sands to the middle of the site and the west east transect (Fig 8) have accumulated in an area of low lying gravel and may represent a Late Glacial or even early Holocene channel flowing around the island (LZ2, Fig 10). The thick sands and the sands overlying the gravel high would have formed areas of high dry ground as Late Glacial flood waters abated and ephemeral soils may have formed in these during the Mesolithic. This area of high gravel would have remained high dry ground for much of the Mesolithic and early Neolithic and would have been attractive to past humans roaming the landscape and attempting to exploit the rich marginal wetland resources.

4.6.3 Facies 3: Late Mesolithic backwater

Facies 3 consists of organic silts and clays to sandy silts. The surface of these deposits lie between -6.54 and -7.06m OD and they are from 0.25m to 1.10m in thickness. This facies represents a slightly varied landscape of potentially sluggish water flow, the sandy silts to in WS2A, pools of standing water, the organic silty clays, and areas of waterlogged soil represented by the clayey peats. This backwater environment is focused upon the low lying area of gravel and may represent the silting up of the potential Late Pleistocene to Early Holocene channel or poor drainage with this low lying area. These deposits contain a small amount of freshwater ostracods and some marine brackish diatoms suggesting a mixed freshwater backwater and marginal estuarine environment. However, from the numbers of surviving ostracods and diatoms there is seemingly little input from either environment. The pollen evidence suggests some alluvial processes in a landscape of oak, elm lime and hazel dominated woodland with Alder Carr developing as salinity increases to a brackish environment.

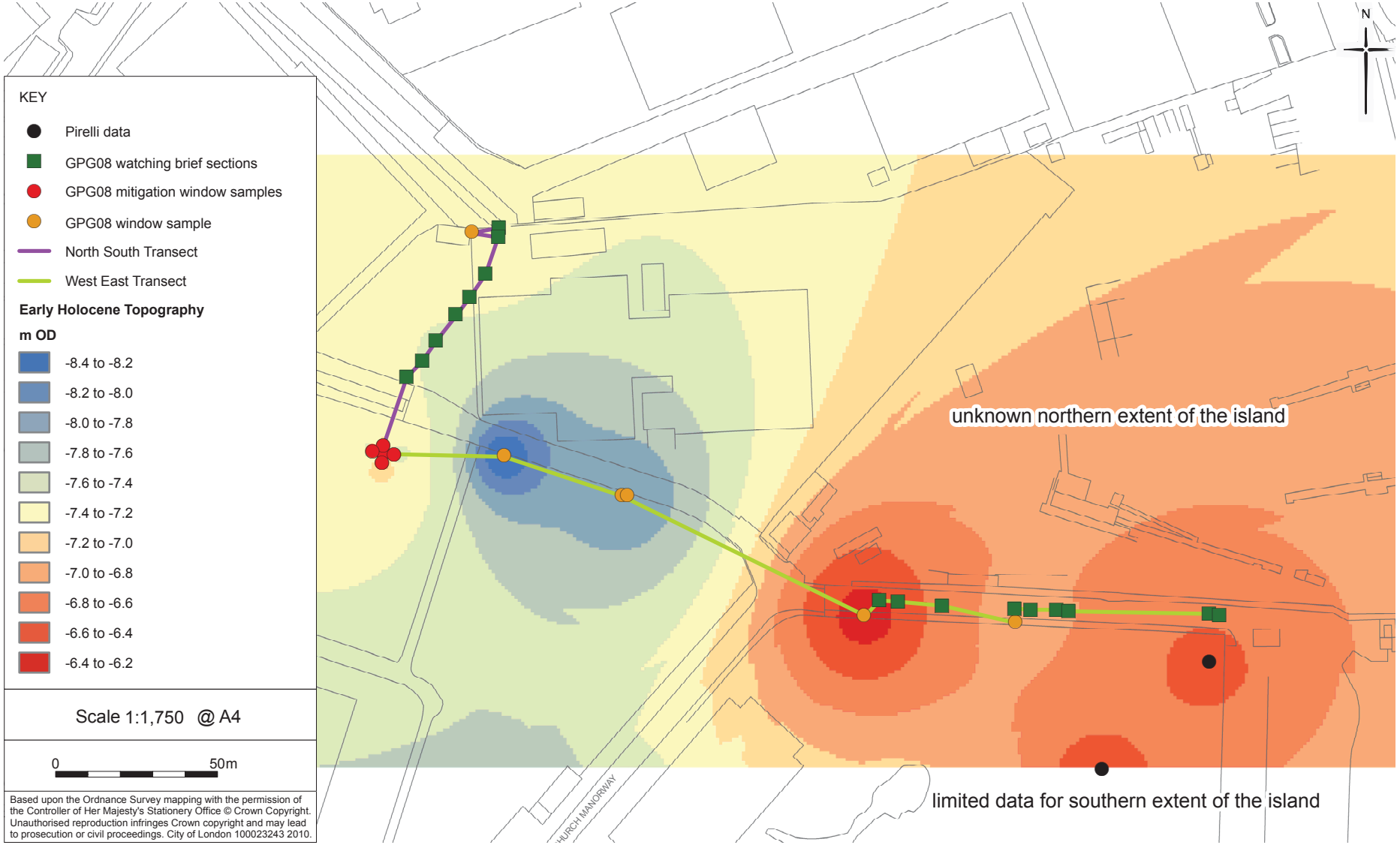

Fig 9 Early Holocene topography

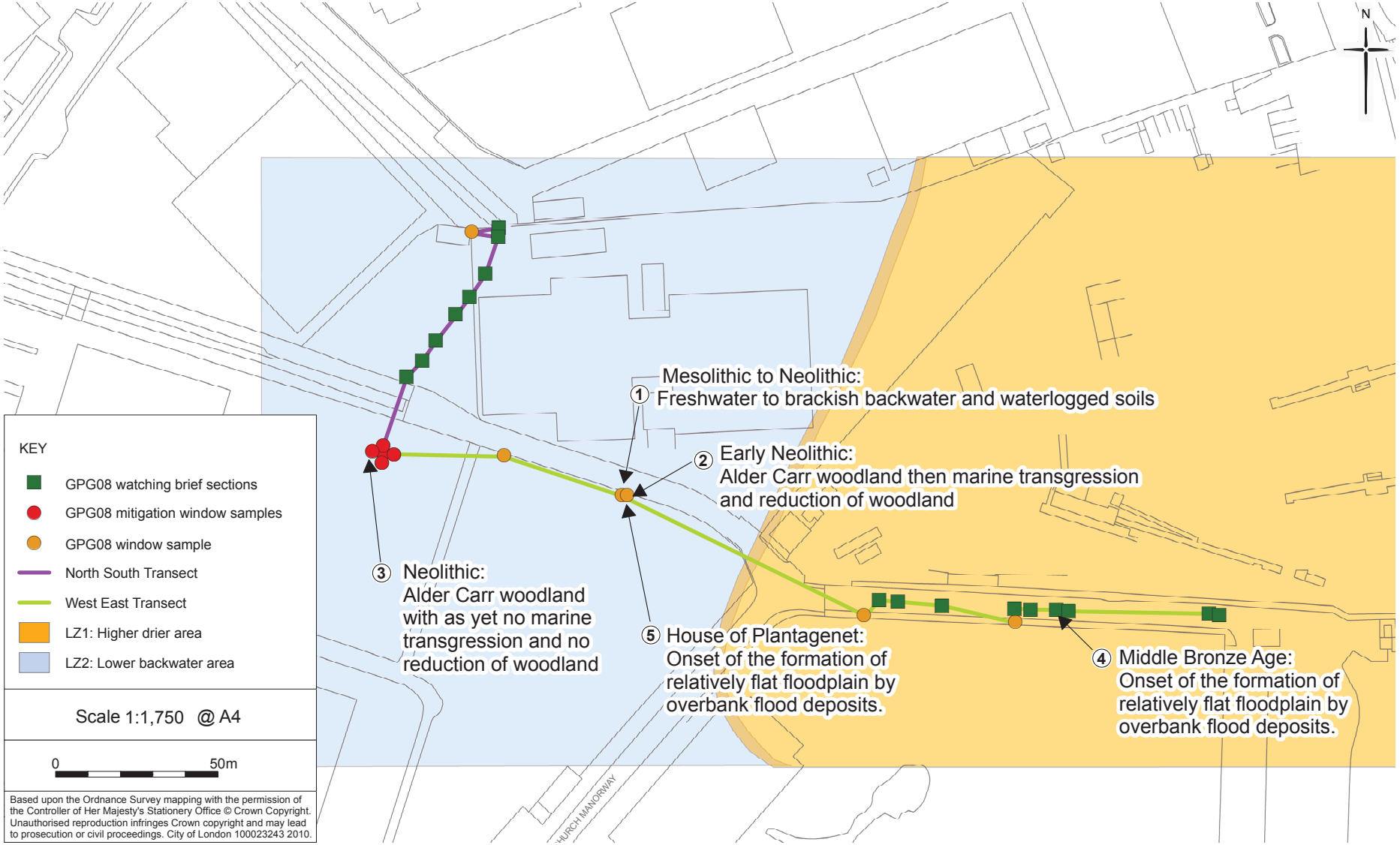

Fig 10 Landscape zones and dated phases of landscape change

Table 9 Summary of palaeoenvironmental sub sample results from WS 2B

Sample Number	Sample Height from/to (m OD)		Sediment description		Diatom Results	Ostracod Results	Pollen Results	Period
P12/D12	-1.26	-1.27	Soft bluish grey silty clay, frequent small organics flecks throughout, occasional to rare Fe mottling.	Facies 7	Marine brackish and freshwater then return to below		Zone 4: Change to minerogenic/alluvial sediments. Alder carr woodland is much reduced at this site but was probably a moving fringe to the floodplain wetland as it expanded in area. Carr woodland was replaced by grass/sedge fen with probable marine/brackish water influence (Chenopodiaceae).	
P11/D11	-1.52	-1.53			Marine brackish and freshwater, change in source increased salinity reduced plankfonic, small signs of tidal/estuarine			
C14	-1.58	-1.63	Black, soft, spongy peaty topsoil visible rooting and small fibrous organic remains. Irregular lower boundary.	Facies 6				Middle Ages, House of Plantagenet
P10/D10	-2.04	-2.05	Dark reddish brown, firm but spongy wood peat, frequent round wood remains to top and base. Irregular lower boundary.		Absent		Zone 3: There was a return to fen carr woodland (alder and willow). This was followed (upper part of the zone) by increasing wetness which caused progressive reduction of the alder carr to sedge fen. This was probably a response to the late-prehistoric rising sea level which culminated in disruption of the local river systems and widespread alluviation of the Thames floodplain (Devoy Thames Stage 4).	
P9D9	-3.00	-3.01	Mid grey brownish grey soft, frequent reed remains, grades into unit below, silty clay.		Marine brackish and freshwater			
	-3.02	-3.03				Absent		
P8/D8	-3.52	-3.53	Black firm to spongy, fibrous peat, frequent wood remains. Diffuse lower boundary.		Absent			
O8	-3.62	-3.63	Soft blue grey silty clay, darker colour in top 0.2m, grades into a light blue grey, freq to abundant org flecks <0.5cm throughout. 4.34 to 4.35m thin band of dark grey silt no inclusions (crack or root infill). 4.91 to 4.95m large wood piece.	Facies 5		Absent		
P7/D7	-4.02	-4.03			Marine brackish and freshwater		Zone 2: A possible phase of marine sedimentation indicated by higher values of Chenopodiaceae pollen. Mineral sedimentation also resulted in deposition of reworked geological palynomorphs and dinoflaggellates (as seen at base of l.p.a.z.1). Alder becomes less important and was replaced by grasses, sedges and bur reed and/or reed mace. Along with algal Pediastrum this indicates a phase of increased ground water table/wetter conditions and probable brackish water ingress.	
P6/D6	-4.50	-4.51			Marine brackish and freshwater			
O7	-4.52	-4.53				Absent		
C14	-5.51	-5.56	Blue grey to olive grey silty clay, soft frequent organic flecks throughout, <1cm occasionally <3cm.					Early Neolithic
P5/D5	-5.57	-5.58	Dark blue grey silty clay, soft. Large hard wood frags at 6.09 to 6.13m and 6.51 to 6.54m, occasional light Fe mottling, occasional rare org. flecks, mollusc frags in last 5cm. Irregular and diffuse lower boundary.		Marine brackish and freshwater			
O6	-6.02	-6.03				Freshwater ostracods, brackish species (only ones present), in situ, estuarine mudflat into which freshwater component from adjacent marshes and pools had been introduced by rain storm OR local pool or wetland where storm surge and subsequent overbank flooding introduced brackish component from nearby mudflat.	Zone 1: Basal minerogenic sediment containing reworked geological pollen, spores and dinoflaggellates. Overbank alluviation? Alder dominated floodplain carr woodland with willow becoming dominant on or very close to the sample site. Ground flora of grasses and sedges and other fen herb taxa. Incoming Chenopodiaceae (oraches etc) from the middle of the zone may be evidence of ephemeral saline/brackish incursions.	
P4/D4	-6.52	-6.53	Slightly clayey peat, black, occasonalsand, occasional wood frags.	Facies 4	Marine brackish			
P3/D3	-6.96	-6.97	Mid to dark blue grey silty clay, soft, occ to rare org flecks, occ mollusc frags throughout, seed at 7.28m. Diffuse lower boundary.		Marine brackish and freshwater			
O5	-6.98	-6.99				A couple of freshwater		
O4	-7.41	-7.42	Blue grey to yellow sandy silty clay, very soft.	Facies 3		Absent		
P2/D2	-7.52	-7.53			Absent			
O3	-7.54	-7.55				Absent		
P1/D1	-7.76	-7.77	Peat fibrous, black, spongy, also slightly, mixed.		Marine brackish			
C14	-7.80	-7.86						Meso/Neo transition
O2	-7.86	-7.87	Very soft light grey silty clay, slightly sandy, fine and increasing with depth.			A couple of freshwater		
O1	-8.16	-8.17	Slightly silty fine to medium sand, firm, yellow grey to blue grey.	Facies 2		Absent		

These deposits have been dated to the Late Mesolithic (Cal BC 5470 to 5310 (Cal BP 7420 to 7260) BETA 279867) in WS2B. During this period it is likely that dry land soils were forming within the sand deposits on the gravel island to the east. Peat deposits at a depth of c -8.7m OD from the nearby Corinthian Quay site (Morley 2003) were previously dated to Cal BC 5475-5290 (Cal BP 7425 to 7240) and support a roughly Late Mesolithic date for the formation of the earliest peats and wet soil environments as yet recorded for the vicinity. The date of these deposits relates to Devoy's (1979) Tilbury II regression event. There is a reduction of energy flow as indicated by the finer particle size but on the whole the central area of the site is still one of sluggish flow and stand pools of water. The low elevation of the underlying gravels in this central area indicates the presence a past river channel, albeit one now silting up. As such the effects the Tilbury II regressive event would have been lessened or somewhat delayed.

In the central part of the site and in the vicinity of WS2B, the environment represented by facies 3 changes significantly some time prior to the early Neolithic. Such a date is indicated by the Cal BC 4340 to 4230 (Cal BP 6290 to 6180, BETA 279866) date obtained from the overlying facies 5. However, to the west end of the site the top of the facies 3 deposits are dated to the mid Neolithic (Cal BC 3640 to 3500 (Cal BP 5590 to 5450) and Cal BC 3430 to 3380 (Cal BP 5380 to 5330), BETA 279868). These dates suggest that there is roughly 1000 yrs between the cessation of facies 3 at the centre and the western end of the site (see *Fig 6*). Fig 10, as well as depicting the broad landscape zones, also attempts to map the various temporal and spatial environmental changes recorded across the site. Facies 3 is represented by label number 1 and the end of facies 3 by labels 2 and 3 on Fig 10.

4.6.4 Facies 4: Mesolithic to Neolithic wooded wetland

Sealing the localized deposits of facies 3 and spreading over a larger area are the peats and dark organic clays of facies 4. The surface of these deposits was encountered between -5.44m and -6.5m OD, and the deposits are 0.1m to 1.3m in thickness. The unit is a relatively uniform thickness across the northern and western ends of the works, thinning out eastwards as it rises over the gravel island. Again only small numbers of freshwater ostracods and brackish and freshwater diatoms are present. The Pollen evidence indicates an Alder Carr dominated floodplain with some Willow possibly encroaching from the higher drier soils over the gravel island. To the west of the site the formation of this wooded wetland begins during the mid Neolithic (Cal BC 3640 to 3500 (Cal BP 5590 to 5450) and Cal BC 3430 to 3380 (Cal BP 5380 to 5330), BETA 279868) and corresponds to label 3 on Fig 10. It is likely that this waterlogged soil formed at an earlier date, possibly the late Mesolithic to early Neolithic, in the low lying central areas of the site. This soil horizon would have developed during a short phase of landscape stability and may relate to a period after Devoy's (1979) Tilbury II regression event. It is slightly later than would be expected for Tilbury II but the low lying ground and complex hydrology around the nearby gravel island may have impeded the effects of the marine regression and also the development of the waterlogged soil. The nature of these works makes it difficult to ascertain but some wood remains were noted within the window samples and boreholes and no evidence of working was obvious.

4.6.5 Facies 5: Neolithic inundation and sedge fen

Sealing the lower deposits and in a thick band across the whole of the site is a unit of blue grey silty clay with organic inclusions. The surface of the unit lies between -

1.93m and -3.9m OD, and is from 0.9m to 4.1m in thickness. The thickest deposits overlie the gravel island to the east of the site. The pollen record indicates a change from the Alder Carr or willow dominated woodland of facies 4 to grass and sedge fen environment with significant marine inundation and sedimentation. The diatom data supports the interpretation of a marine brackish to freshwater environment. The ostracod findings could also suggest a brackish to freshwater environment but could also be indicative of a storm surge. A storm surge cannot be discounted but the lack of coarser grained material or evidence of erosion indicates that the area of the site did not suffer the full effects of a storm surge but may have been exposed to it as it ebbed.

As a whole this facies probably relates to Devoy's (1979) Late Mesolithic Thames II estuarine expansion during a period of relative sea level rise. This phase of inundation and fine grained minerogenic sedimentation would have arrested the growth of woodland vegetation and formed tidal mudflats and sedge fens. The deposits are thinner towards the west end of the site and this may relate to a channel previously highlighted in this area (MOLA 2007).

A radiocarbon date for the lower portion of facies 4, towards the centre of the site (WS2B), indicates the Early Neolithic (Cal BC 4340 to 4230 (Cal BP 6290 to 6180), BETA 279866) and following the discussion of the dating of facies 3 (see section 4.6.3) the date of facies 5 can be assumed to be latter than early Neolithic as the rising water levels and marine inundation moves westward.

4.6.6 Facies 6: Bronze Age to historic wooded wetland

Overlying the previous facies is a unit of woody peats and very organic clays. The surface of this facies lies between -1.0m and -2.93m OD. It is from 0.9m to 2.2m in thickness. The facies is relatively uniform in thickness but thins out towards the east of the site over the thick sediments of facies 5 and the gravel island. No ostracod remains survive in this or any overlying sediments. The diatom evidence continues to suggest a mixed freshwater and brackish environment. Generally the pollen evidence suggests a return to a fen carr woodland of alder and willow. The off site pollen record shows a decline of elm pollen within this facies. This change may represent the Neolithic Elm Decline, caused by the insect spread of elm bark disease, but the sample is high in the sequence and an Early Neolithic radiocarbon date (Cal BC 4340 to 4230 (Cal BP 6290 to 6180), BETA 279866) exists at a significant depth (c 2m) below this point in the same sequence. The presence of ribwort plantain is also noted in the pollen record and indicates that the decreasing levels of Elm could also relate to a later (*ca*. 5,500 to 5,000BP) human induced Elm decline. A late Neolithic to Early Bronze Age human induced Elm decline appears more likely considering the chronology of the sequence provided by the radiocarbon dates.

Large wood timbers were consistently seen during the watching brief. None of the wood remains appeared worked or placed on the surface of the peat as part of a trackway, platform or similar structure. All of the wood remains appeared to be part of the woodland and had naturally been incorporated within the deposits.

The re colonization of the alder and willow woodland followed a reduction of the relative sea level. No deposits were dated from the base of this facies but at the nearby Corinthian Quay site (Morley 2003) the base of a similar deposit in a comparable sequence was previously dated to Cal BC 4350 to 4050 (Cal BP 6300 to 6000). However this date is similar to the date obtained for facies 5. In addition the dated base of the deposit was at -4.9m OD, at least a 1m deeper than the base of

the facies in question here. It is reasonable to infer that the onset of peat formation and alder fen development occurred at a later date, potentially Bronze Age, in this area. Two dates were obtained from the top of this facies. To the east end of the site the cessation of peat development was dated to the middle Bronze Age (Cal BC 1520 to 1400 (Cal BP 3470 to 3350) BETA 279864) and in the centre of the site it was dated to the middle ages (Cal AD 1270 to 1320 (Cal BP 680 to 630), Cal AD 1350 to 1390 (Cal BP 600 to 560) BETA 279865).

Facies 3 maybe related to Devoy's (1979) Tilbury IV regression. This phase was characterised by increasingly wet conditions and the development of an alder and willow woodland. There is little evidence in the pollen record for the onsite of conditions relating to the earlier Tilbury III phase of dry land woodland that should have preceded the Tilbury IV phase. Oak, lime, ash and hazel woodland were dominant offsite but there is little pollen evidence for their existence on site. Evidence of the Tilbury III phase was recorded to the south and west of the site at the Pirelli Works (MOLA 2007). The sequences recorded at the Pirelli Works are lower in elevation than those recorded at the present site. Therefore the presence of dry land woodland at the lower site would suggest dry land woodland should be evident at this site. However, the Tilbury III stage was only indicated by lithology and no pollen samples were taken. As a result it may be inferred that, due to poor drainage or the proximity to past channels the area of the site and potentially the area around it as well did not experience the effects of the broader marine regression to the degree that would have enabled the formation of a dry soils suitable for the oak, lime, ash and hazel woodland of the Tilbury III stage.

4.6.7 Facies 7 and 8: Overbank flood deposits and floodplain soil

Facies 7 is a blue grey silty clay sealing the underlying deposits. The surface of facies 7 lies from -0.1m to -1.3m OD and is between 0.5m and 1.95m in thickness. The unit is relatively uniform across the site but thickens to the south west and is totally truncated to the north of the site in BH1. The diatom results show fluctuations between freshwater and brackish conditions whilst the pollen data indicates increased sedimentation reducing the alder carr woodland, forcing it to the fringes or an expanding mudflat environment with vegetated areas of grass and sedge fen.

This facies is associated with Devoy's Thames IV transgressive event. During this time increasing relative sea level led to low energy waters depositing fine grained sediments. As these minerogenic alluvial sediments filled in the undulations of the landscape a broad flat floodplain was created. The alluviation and forcing back of the Alder Carr woodland would have occurred progressively across the landscape over a long period. The effects of relative sea level rise and the onset of this period of alluviation is significantly different across the site. To the east the alluviation began during the middle Bronze Age (Cal BC 1520 to 1400 (Cal BP 3470 to 3350) BETA 279864). This is represented by label 4 on Fig 10. However, to the centre of the site c. 150m away the formation of the alluvial floodplain doesn't begin until the middle ages, specifically during the House of Plantagenet (Cal AD 1270 to 1320 (Cal BP 680 to 630), Cal AD 1350 to 1390 (Cal BP 600 to 560) BETA 279865). This change is shown on Fig 10 by label 5.

Facies 8 is a similar deposit to Facies 7 and forms the upper part of the alluvial sequence where not truncated. It is a brownish blue grey fine grained minerogenic deposit characterised by heavy oxidation. This weathered layer of alluvium indicates a reduction of sedimentation and water logging allowing for dry land soil development to begin. Despite evidence of dying out and soil formation the area

would have still been prone to seasonal flooding, making it an unlikely location for permanent occupation but suitable for agriculture or animal grazing. Facies 8 only exists in localised areas across the site, predominantly to the south west. This may be indicative of the drier areas of the site where soil formation could occur or may be due to modern disturbances or truncation. Without exposed sections this cannot be ascertained either way.

4.6.8 Facies 9: Made ground

Made ground deposits sealed all of the underlying deposits and formed the uppermost unit across the site. This facies was composed of demolition rubble and re-deposited alluvium. The material most likely formed attempts to raise the ground level in association with nearby building works. The made ground is between 0.4 and 2.7m in thickness and has no archaeological potential.

5 Potential of archaeology

5.1 Original research aims

- *To record any archaeological remains present;*

No archaeological remains were recorded.

- *To place them in the context of the archaeological background, as currently known for the site;*

No archaeological remains were recorded.

- *To collect any information and recover any artefacts surviving in the areas of disturbance;*

No artefacts were found.

- *To obtain a series of samples, which upon analysis will provide secure and dateable information about the geoarchaeological sequences in the peat (and associated deposits);*

Five samples were taken for dating. Botanical remains such as seeds were submitted for AMS (^{14}C) dating. The majority of the samples were taken from the longest sequence (WS2B) where the palaeoecological sub samples were taken. These samples were taken from the basal organic deposits (facies 3) in order to get the earliest date for peat or soil formation on site; and taken towards the base of facies 5 in order to date the transition between the wooded wetland (facies 4) and the earliest period of inundation induced by relative sea level rise (facies 5); and taken from the top of the uppermost organic or peat deposits (facies 6) in order to date their cessation and the onset of the formation of the alluvial floodplain (facies 7). Additional samples were taken from the base of the organic deposits to the west of the site (WS4) and one from the top at the east end of the site (Pipe 7 of the rising main). These were taken in order to relate the site wide stratigraphic sequence chronologically as well as spatially and to illustrate the chronology of a progressively transgressive or regressive wetland environment. The dated chronology of the site ranges from the Late Mesolithic (Cal BC 5470 to 5310 (Cal BP 7420 to 7260) BETA 279867) to the middle ages, specifically during the House of Plantagenet (Cal AD 1270 to 1320 (Cal BP 680 to 630), Cal AD 1350 to 1390 (Cal BP 600 to 560) BETA 279865).

- *To record the stratigraphy of the sub-surface deposits;*

The examination of the watching brief sections and the window samples and boreholes from previous phases of the work has enabled the characterisation of the subsurface deposits across the area of the site, and provided a basis for the understanding of the evolution of the landscape from the Late Glacial to the present day. Even though he deposits across the site are laterally similar localised variations have been highlighted. The surface of the Pleistocene deposits forms the basic topography for much of the Holocene. Highlighted in this early Holocene topography is a high area of high gravel (a gravel island) to the east of the site (LZ1, Fig 10), which had been highlighted previously (MOLA 2007) and the limits of which have been further refined. Additionally a low area of gravel is recorded to the centre of the line of the rising main and may represent the route of an early Holocene channel. Both of these landscape zones shape the evolution of the overlying deposits and the environments they represent. The gravel island would have remained high dry ground for much of the Mesolithic and early Neolithic and would have been an ideal base for past humans to venture out from and exploit the rich marginal wetland resources.

The broad stratigraphic units highlighted consist of the basal sand and gravels (facies 1); fluvial sands banked around the gravel island (facies 2); organic clays and silty sands representing sluggish flow and pools of standing water in the area of low lying gravel (facies 3); peat deposits representing a wooded wetland again concentrated in the central area of low lying gravel (facies 4); increased sedimentation and the formation of fine grained minerogenic mudflats (facies 5); overlain once more by wooded peat deposits (facies 6); and finally alluvial silts and clays (facies 7).

- *To chronicle the development of the environment, in particular related to the period of peat deposition;*

The site forms a progressively inundated landscape with periods of hiatus and marine regression. The basal sediments are part of the Shepperton floodplain gravels (facies 1), and were laid down within a fast flowing, cold climate, braided river environment at the end of the last Glacial period (c 15000 to 10000 BP). The inherited gravel surface topography of low and high elevations represents a Late Pleistocene to Early Holocene channel to the west and a gravel island to the east. Within the low lying area and banked atop and around the gravel high are Late Pleistocene to Early Holocene fluvial sands (facies 2), formed as channel bars. During the Late Mesolithic (Cal BC 5470 to 5310 (Cal BP 7420 to 7260) BETA 279867) this channel silted up and became an area of standing water and sluggish water flow (facies 3). During this time the gravel island to the north would still have been high dry ground. During the mid Neolithic (Cal BC 3640 to 3500 (Cal BP 5590 to 5450) and Cal BC 3430 to 3380 (Cal BP 5380 to 5330), BETA 279868) to the west of the site, and possibly during the late Mesolithic to early Neolithic to the middle of the site a wooded wetland begins to form (facies 4). Throughout this time the gravel island to the east would still have formed a relatively dry surface.

Dated to the Early Neolithic (Cal BC 4340 to 4230 (Cal BP 6290 to 6180), BETA 279866) in the central part of the site, but in a thick band across the whole site (including the gravel island) are thick deposits indicating mudflat development and marine inundation (facies 5). This period is followed by a return to a wooded wetland last roughly from the Bronze Age to the Historic period (facies 6). To the east end of

the site the cessation this woodland was dated to the middle Bronze Age (BETA 279864 and BETA 279865). From this period onwards the site is progressively inundated from the east to the west (facies 7). In the increasing wet conditions a mudflat environment develops and the previous wooded environment is pushed back to the fringes of the landscape. To the east this began during the middle Bronze Age (Cal BC 1520 to 1400 (Cal BP 3470 to 3350) BETA 279864) but does not reach the centre of the site until the Middle Ages, specifically during the House of Plantagenet (Cal AD 1270 to 1320 (Cal BP 680 to 630), Cal AD 1350 to 1390 (Cal BP 600 to 560) BETA 279865). Variably across site the upper portion of the floodplain deposits dry and form an acretionary floodplain soil (facies 8).

- *Interpret the palaeoecological history and succession of the site.*

Various palaeoenvironmental remains were sampled for in order to expand on the palaeoecology of the site and its landscape evolution as represented by the above facies. These facies have also been related to Devoy's model for the development of the Thames in order to place the landscape changes within a wider, more regional context.

The wider landscape of the Early Holocene would have consisted of a growing oak, elm lime and hazel woodland typical for this area prior to prehistoric clearance. Onsite a freshwater channel slackened and deposited sand banks around the gravel island (facies 2). The Late Mesolithic backwater, which formed to the west of the island, became slightly brackish and some alder carr begins to colonise. This phase relates to Devoy's (1979) Tilbury II regression event. As waterlogged conditions continued to lessen during the Tilbury II regression event alder carr began to dominate the low lying areas of the site and brackish conditions are evident (facies 4). During the Early Neolithic a period of relative sea level increase gave rise to Devoy's (1979) Thames II estuarine expansion. The increasingly wet brackish conditions forced the alder carr to retreat to higher elevations as sedge fen and grass mudflats developed and there is some evidence for storm surges in the region (facies 5). The Tilbury IV regression event occured roughly from the Neolithic to Bronze Age in the central eastern parts of the site; this event is characterised on site by a mixed freshwater and brackish fen carr woodland (facies 6), and the off-site pollen record may document a late Neolithic to Early Bronze Age human induced Elm decline. The wide spread inundation by alluvial sediments of facies 7 is indicative of the Thames IV transgressive event. The increasing relative sea level, and subsequent sedimentation, led to the formation of a broad flat floodplain. With fluctuating freshwater and brackish conditions and as a result of the increased alluvial deposition the alder carr woodland was once again forced back to the fringes of the wetland landscape and grassy water meadows and sedge fen dominated. To the east the Thames IV stage began during the Middle Bronze Age but it did not encroach on the central area of the site until the middle ages.

5.2 General discussion of potential

5.2.1 Facies 1

The basal sands and gravels are in-channel fluvial deposition dating from the Late Devensian through to the Late Glacial period (i.e. 18 000–10 000 BP). The distinctive sedimentary structures within these deposits can indicate a wide range of fluvial

bedforms and styles which may have evolved in response to the climatic oscillations occurring during the transition from the Pleistocene to Holocene epochs.

Coarse grained sediments such as these are unlikely to provide any palaeoenvironmental information as any biological remains present within them are likely to be highly abraided by the fluvial action of the sand and gravel bedload. The gravel island would have emerged as an area of high dry ground and would have been attractive to human groups during later periods of landscape development. From this work the western limit of the island is now well known. However, the southern, eastern and northern limits of the island are still relatively unknown and could be a focus for future work in the vicinity.

5.2.2 Facies 2 to 3

The sands and channel fills immediately overlying the surface of the Shepperton gravel were likely laid down as the meltwater flux of the Late Pleistocene abated during the very early stages of the Holocene.

The sand units present in facies 2 are represent fluvial bar deposits infilling the low lying area to the centre of the site and banked against the gravel island to the east. The sand accumulations and the associated gravel high formed small islands on the floodplain, which would have been attractive to early Mesolithic settlers roaming the landscape along channel margins in search of resources. The sand sediments were most likely deposited over long periods of time. Occasional hiatuses in deposition would have enabled pedogenesis (soil formation) to occur predominantly this would be expected over the gravel island.

There is potential for finds of Mesolithic age within these deposits, especially where associated with Early Holocene landsurfaces. However, the environmental potential of the facies 2 sands is low. In contrast the overlying organic deposits of the facies 3 have preserved good assemblages of palaeo-environmental remains as well as being particularly suitable for dating using radiocarbon methods.

5.2.3 Facies 4 to 6

From the Late Mesolithic and Bronze Age the floodplain in this area was dominated by alder-carr with a mixed woodland off site, which was typical of a dryland environment. A previous study of the Neolithic woodland of the submerged forest at Erith (Seel 2000) shows that the composition and distribution across the floodplain of tree species can vary markedly. As such this palaeoenvironmental reconstruction should not be taken as the full interpretation of the environments and vegetation that existed in the wider area.

The alder carr woodland is likely to have proved too thick for carrying out subsistence activities. However, channels have been previously highlighted to the south west (MOLA 2007) and such channels flowing across this forested landscape would have formed open corridors aiding movement across the floodplain. As a result, the potential for recovery of archaeological remains is thought to be higher in these channel proximal areas. No direct evidence for such past human activity was recovered from the core samples. Although, no cereal pollen was recovered from these facies some indirect evidence of cultivation is recorded and a possible human induced Elm decline is noted during the late Neolithic to early Bronze Age.

The modelling of the subsurface deposits has highlighted two landscape zones (a low lying early Holocene channel area and an Early Holocene gravel island). These

represent environments that could have been appealing for exploitation by Late Mesolithic to Bronze Age people. Within the peaty wetland deposits timber trackways and dug out canoes have been found, of both Neolithic and Bronze Age origin, associated with the exploitation of gravel 'highs' and channel networks in this area (Corcoran 2009). There is good potential for future findings adding more data to reconstructions of the evolution of the landscape.

The organic nature of these facies preserved good assemblages of palaeo-environmental remains (most notably pollen) as well as being particularly suitable for dating using radiocarbon methods. The on-site environment is recorded as an alternating mix of alder carr and sedge fen. A closer interval of palaeenvironmental sub-sampling at future sites may provide better understanding of the heterogeneous mix of different woodland types that existed at this time and the impact of rising (and fluctuating) river levels at a scale likely to have been recognised by contemporary prehistoric communities. The opportunity provided by this work, however, has enabled detailed palaeoenvironmental analysis of the deep sub surface deposits to be combined with a wider stratagraphic and topographic profile and environmental context as provided by the watching brief sections.

5.2.4 Facies 7 to 8

The effects of a regional rise in relative sea level can be seen on the site from the Mid Bronze Age to the middle ages. During this time the floodplain landscape changed considerably becoming more waterlogged as it was inundated by the rising river levels. This period of alluviation is associated with Devoy's (1979) Thames IV estuarine expansion event, which he identified just downstream from about 2600 BC. As water-logging and sedimentation increased, woodland became waterlogged and died off and the landscape became more open. As a result of the sedimentation the topography of the landscape began to level out and former undulations in the floodplain silted up. At the edge of the meandering River Thames, sedge fen and grassy water meadows formed and would have been prone to episodic overbank flooding. This seasonal flooding deposited fine-grained sediment that gradually built up as an accretionary floodplain soil. During the medieval period, this land may have been used as pasture, and was occasionally reclaimed by increasing the elevation of the ground level with domestic and industrial waste. Any potential for archaeology is low, and is restricted to chance finds of items discarded on the floodplain or within deposits dumped on the foreshore. The palaeoenvironmental survival was good and provided a valuable insight into the Mid Bronze Age to middle ages evolution of the historic floodplain. No evidence of local cultivation or pastoral activity was found although this does not rule it out for nearby areas.

5.3 Significance of the data

Whilst the archaeological remains are undoubtedly of local significance there is nothing to suggest that they are of regional or national importance.

6 Publication and archiving

Information on the results of the watching brief will be made publicly available by means of a database in digital form and submitted to LAARC with the site archive, to permit inclusion of the site data in any future academic researches into the development of London.

The site archive containing original records and finds will be stored in accordance with the terms of the *Method Statement* (Corcoran 2009) with the Museum of London within 12 months of the end of the excavation.

In view of the limited further potential of the material (Sections 5) and the relatively limited significance of the data (Section 5.3) it is suggested that a short note on the results of the watching brief should appear in the annual round up of the *London Archaeologist.*

7 Acknowledgements

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8 Appendix: Monitored SI Logs

GPG08_WB_WS1			**Location:** 550537.064/179685.726	
Unit	**Depth of unit m bgl (Height of unit m OD)**	**Description**	**Interpretation**	**Facies**
	0.26 m OD	**Ground level adjacent to section**		
1.1	0.00 - 0.82	Made ground	Made ground	Facies 9
	-0.56 m OD			
1.2	0.82 - 0.90	Mid blue clayey silt, moderately firm.	Historic overbank flood deposits forming an accretionary floodplain soil.	Facies 8
1.3	0.90 - 1.30	Void		
	-1.04 m OD			
1.4	1.30 - 1.50	Mid blue green silts with organic rich banding. Diffuse lower contact.	Alluvial overbank flood deposits	Facies 7
1.5	1.50 - 1.80	Moderately firm, mid blue occasionally oxidised, silty clay, organic at top, diffuse lower boundary.		
1.6	1.80 - 2.00	Dark grey very soft clay silts with organic flecks.		
1.7	2.00 - 2.75	Void		
	-2.49 m OD			
1.8	2.75 - 3.00	Very soft dark grey silts with frequent wood fragments.	Wooded wetland. Possible fen and Alder Carr	Facies 6
1.9	3.00 - 3.30	Void		
1.10	3.30 - 3.70	Very soft dark grey silts with frequent wood fragments. Clear undulated lower contact (eroded).		
	-3.44 m OD			
1.11	3.70 - 3.80	Dark brown fibrous peat.	Wooded wetland with increasing periods of inundation and overbank flood deposition.	Facies 5
1.12	3.80 - 3.95	Soft medium brown organic silts with occasional peat fragments and root from above, possible laminations.		

1.13	3.95 - 4.00	Dark brown woody peat.		
1.14	4.00 - 4.30	Void		
1.15	4.30 - 4.65	Soft dark reddish brown fibrous peat, more humfied and dark from 4.5 down. Diffuse lower contact.		
1.16	4.65 - 4.75	Dark brown soft peaty silt.		
1.18	4.75 - 5.00	Soft Mid grey silts with frequent organics (possibly laminated).		
1.19	5.00 - 5.25	Void		
1.20	5.25 - 5.35	Mid grey soft silts (backfill?), undulating but clear contact.		
1.21	5.35 - 5.70	Dark brown silty peats (woody between (5.45-5.5 and5.62-5.7), clear lower boundary.		
	-5.44 m OD			
1.22	5.70 - 6.00	Very soft mid grey silts, occasional organic flecks throughout.	Wetland to waterlogged soil and possible Alder Carr environment	Facies 4
1.23	6.00 - 6.30	Void		
1.24	6.30 - 6.80	Very soft mid to light grey silts, occasional to moderately organic flecks occasional molluscs fragments. Lower boundary diffuse.		
1.25	6.80 - 6.90	Soft Dark grey organic silts with humified black organic material, increasingly woody.		
	-6.64 m OD			
1.26	6.90 - 7.15	Dark grey black peaty silt, humified organics and wood, molluscs at interface.	Low lying ground forming an area of shallow water	Facies 3
	-6.89 m OD			
1.27	7.15 - 7.30	Mid grey sandy clay, firm, chalk clasts at base.	Early Holocene sands and silts	Facies 2
	-7.04 m OD			
1.28	7.30 - 7.40	Fine green gravels.	Pleistocene gravels	Facies 1
1.29	7.40 - 7.50	Coarse sand, green.		
	-7.24 m OD	**Base of borehole**		

GPG08_WB_WS2			**Location:** 550540.6/179682.583	
Unit	**Depth of unit m bgl (Height of unit m OD)**	**Description**	**Interpretation**	**Facies**
	0.338 m OD	**Ground level adjacent to section**		
2.1	0.00 - 0.70	Made ground	Made ground	Facies 9
	-0.362 m OD			
2.2	0.70 - 1.00	Dark grey firm silty clay, some contamination.	Historic overbank flood deposits forming an accretionary floodplain soil.	Facies 8
2.3	1.00 - 1.10	Firm mid brown silty clay, graded lower contact.		
	-0.762 m OD			
2.4	1.10 - 1.30	Firm mid grey silty clay with oxidised mottling and possible laminations, graded lower contact.	Alluvial overbank flood deposits	Facies 7
2.5	1.30 - 1.50	Firm mid brown silty clay, laminated, fine organic fragments throughout.		
2.6	1.50 - 2.40	Void		
	-2.062 m OD			
2.7	2.40 - 2.90	Mid grey very soft clay silt, occasional organics throughout, occasional mollusc fragments, wood, branch, root at base.	Wooded wetland. Possible fen and Alder Carr	Facies 6
2.8	2.90 - 3.00	Wood		
	-2.662 m OD			
2.9	3.00 - 3.80	Void	Wooded wetland with increasing periods of inundation and overbank flood deposition.	Facies 5
2.10	3.80 - 4.00	Very soft greenish grey silt.		
2.11	4.00 - 4.20	Void		
2.12	4.20 - 4.50	Very soft mid grey green silt, occasional organic fragments. Graded lower contact.		
2.13	4.50 - 5.00	Soft mid grey silt becoming more brown and organic with depth, only fragments of organic.		
2.14	5.00 - 5.25	Void		
2.15	5.25 - 5.90	Brownish grey, soft organic clay silt with concentrations of wood and peat, fragments banded throughout the top two thirds.		

2.16	5.90 - 6.00	Wood		
	-5.662 m OD			
2.18	6.00 - 6.80	Void	Wetland to waterlogged soil and possible Alder Carr environment	Facies 4
2.19	6.80 - 7.30	Grey very soft silt.		
	-6.962 m OD			
2.20	7.30 - 7.45	Dark brown peaty silt.	Low lying ground forming an area of shallow water	Facies 3
2.21	7.45 - 7.65	Very soft dark grey silt, occasional organics, clear lower contact.		
2.22	7.65 - 7.80	Wood in matrix of dark red brown organic silt.		
	-7.462 m OD			
2.23	7.80 - 7.85	Mid green grey sand.	Early Holocene sands and silts	Facies 2
2.24	7.85 - 7.90	Dark red brown, organic silt.		
	-7.562 m OD			
2.25	7.90 - 8.00	Green sands and gravels.	Pleistocene gravels	Facies 1
	-7.66 m OD	**Base of borehole**		

GPG08_WB_WS3			**Location:** 550536.805/179679.998	
Unit	**Depth of unit m bgl (Height of unit m OD)**	**Description**	**Interpretation**	**Facies**
	0.354 m OD	**Ground level adjacent to section**		
3.1	0 - 0.60	Made ground	Made ground	Facies 9
	-0.246 m OD			
3.2	0.60 - 0.90	Firm greenish grey clayey silt, with a band of orange sand and an eroded lower contact.	Historic overbank flood deposits forming an accretionary floodplain soil.	Facies 8
3.3	0.90 - 1.00	Dark grey blocky clay silt		
	-0.646 m OD			
3.4	1.00 - 1.60	Backfill	Alluvial overbank flood deposits	Facies 7
3.5	1.60 - 2.60	Firm mid grey clay silt, frequent organic fragments throughout, laminated.		
3.6	2.60 - 2.70	Soft mid grey fine silt with frequent organic material and occasional mollusc fragments.		
	-2.346 m OD			
3.7	2.70 - 2.86	Wood in soft mid grey silt matrix	Wooded wetland. Possible fen and Alder Carr	Facies 6

3.8	2.86 - 3.42	Soft mid grey fine silt, occasional organics.		
3.9	3.42 - 3.60	Red grey fine silt with frequent organics.		
	-3.246 m OD			
3.10	3.60 - 4.00	Dark reddish brown peaty silt.	Wooded wetland with increasing periods of inundation and overbank flood deposition.	Facies 5
3.11	4.00 - 4.58	Void		
3.12	4.58 - 4.80	Very soft mid grey silt with occasional organics.		
3.13	4.80 - 5.00	Dark reddish brown peaty silt.		
3.14	5.00 - 5.20	Very soft mid grey silt with occasional organics and wood.		
3.15	5.20 - 5.58	Dark reddish brown peaty silt more, silty toward base.		
3.16	5.58 - 5.68	Dark grey soft organic silts		
3.18	5.68 - 6.00	Humified dark brown peaty silt.		
3.19	6.00 - 6.20	Wood (solid) in dark grey soft organic silts.		
	-5.846 m OD			
3.20	6.20 - 6.50	Very soft light grey silt (backfill).	Wetland to waterlogged soil and possible Alder Carr environment	Facies 4
3.21	6.50 - 6.90	Soft dark grey silt with frequent organic fragments increasing with depth.		
	-6.546 m OD			
3.22	6.90 - 7.00	Wood	Low lying ground forming an area of shallow water	Facies 3
3.23	7.00 - 7.10	Void		
	-6.746 m OD			
3.24	7.10 - 7.20	Gravel	Pleistocene gravels	Facies 1
	-7.66 m OD	**Base of borehole**		

GPG08_WB_WS4			**Location:** 550533.580/179683.758	
Unit	**Depth of unit m bgl (Height of unit m OD)**	**Description**	**Interpretation**	**Facies**
	0.30 m OD	**Ground level adjacent to section**		
4.1	0.0 - 0.45	Made ground	Made ground	Facies 9
	-0.15 m OD			

4.2	0.45 - 0.75	Light brown to slightly blue grey silty clay, firm, heavily oxidised, 2 cm thick gravel layer at base.	Historic overbank flood deposits forming an accretionary floodplain soil.	Facies 8
4.3	0.75 - 1.28	Blue grey silty clay, blue grey silty clay, firm, very fine sand/silt to top associated with occasional gravel.		
	-0.98 m OD			
4.4	1.28 - 1.41	Blue grey silty clay, firm occasional localised Fe nodule formation, mottled 80% yellow, diffuse lower boundary.	Alluvial overbank flood deposits	Facies 7
4.5	1.41 - 1.54	Blue grey silty clay, firm, mottled 40-60% green, occasional dark manganese staining.		
4.6	1.54 - 2.0	Dark bluish grey silty clay, frequent organic wood fragments throughout and increasing with depth, possible reed remains.		
4.7	2.0 - 2.25	Mixed disturbance blue grey silty clay, mottled with yellow 40-60%		
4.8	2.25 - 2.5	Similar to 4.6 but very soft and wet.		
4.9	2.5 - 2.78	Mid to dark brownish grey, firm, occasional to frequent wood fragments (tiny to round wood lengths).		
4.1	2.78 - 3.0	Upper boundary irregular spanning 15cm, black to mid brown friable peat, occasional wood frags.		
4.11	3.0 - 3.23	Blue grey silty clay, occasional to rare round wood, very wet and soft.		
	-2.93 m OD			
4.12	3.23 - 4.0	Black to reddish brown peat, very soft and wet to 3.6m bgl, firm to spongy below this.	Wooded wetland. Possible fen and Alder Carr	Facies 6
	-3.7 m OD			
4.13	4.0 - 4.2	Very soft and wet silty clay, occasional organic, yellow mottling, Backfill?	Wooded wetland with increasing periods of inundation and overbank flood	Facies 5

4.14	4.2 - 5.0	Black to dark brown peat, very soft to the top, less soft to the base, frequent larger fragments of wood, small pocket of silty clay (2 cm) at 4.3m bgl	deposition.	
4.15	5.0 - 5.3	Void		
4.16	5.3 - 5.42	Peat very soft, frequent wood fragments.		
4.17	5.42 - 6.0	Blue grey silty clay, laminated occasional organic laminations, occasional mollusc fragments.		
	-5.7 m OD			
4.18	6.0 - 6.65	As above but less visible laminations if any.	Wetland to waterlogged soil and possible Alder Carr environment	Facies 4
4.19	6.65 - 7.0	Sludge blue grey		
	-6.7 m OD			
4.2	7.0 - 7.2	Organic very wet silty clay.	Low lying ground forming an area of shallow water	Facies 3
4.21	7.2 - 7.8	Very soft blue grey silty clay, occasional small organic fragments, occasional mollusc fragments.		
	-7.5 m OD			
4.22	7.8 - 8.0	Orange sands and fine quartz gravel.	Pleistocene gravels	Facies 1
	-7.7 m OD	**Base of borehole**		

GPG08_WB_WS5			**Location:** 550536.913/179682.843	
Unit	**Depth of unit m bgl (Height of unit m OD)**	**Description**	**Interpretation**	**Facies**
	0.332 m OD	**Ground level adjacent to section**		
5.1	0.0 - 0.4	Made ground	Made ground	Facies 9
	-0.068m OD			
5.2	0.4 - 0.58	Slightly brownish grey, mixed with pockets of orange gravel and sand, pea sized gravel.	Historic overbank flood deposits forming an accretionary floodplain soil.	Facies 8
5.3	0.58 - 0.75	Dark brownish grey, silty clay, slightly organic and some horizontal bedding, diffuse lower boundary.		
5.4	0.75 - 1.26	Light brown slightly grey silty clay, slightly sandy with vertical rooting.		

5.5	1.26 - 1.36	Laminations of silty sands and silty clay, mid brown slightly orange.		
	-1.028 m OD			
5.6	1.36 - 1.42	Firm dark blue grey silty clay, frequent manganese staining, occasional Fe mottling.	Alluvial overbank flood deposits	Facies 7
5.7	1.42 - 1.84	Firm brown grey silty clay, occasional Fe mottling and nodules.		
5.8	1.84 - 2.0	Dark grey with frequent small organic remains in horizontal bands, soft to firm.		
5.9	2.0 - 2.36	Disturbed redrilled silty clay sediment.		
	-2.368 m OD			
5.10	2.36 - 2.7	Dark brownish grey silt, occasional organic remains, no banding.	Wooded wetland. Possible fen and Alder Carr	Facies 6
5.11	2.7 - 3.0	Soft to firm blue grey silty clay, and abundant round wood remains, occasional mollusc fragments.		
5.12	3.0 - 3.1	Very soft wet peat, Redrill?		
5.13	3.1 - 3.4	Silty clay soft blue grey mottled yellow slightly, occasional tiny organic remains.		
5.14	3.4 - 3.6	Blue grey silty clay, frequent to abundant organic remains, occasional molluscs.		
5.15	3.6 - 3.85	Red brown soft clayey peat, banded organics.		
5.16	3.85 - 4.0	Black spongy slightly clayey peat, visible organic tissue.		
	-2.768 m OD			
5.17	4.0 - 4.35	Soft blue grey silty clay, occasional very small organics to base, occasional mottled yellow.	Wooded wetland with increasing periods of inundation and overbank flood deposition.	Facies 5
5.18	4.35 - 4.68	Very soft blue grey silty clay, frequent large wood chips and possible reed fragments, occasional mollusc fragments throughout.		
5.19	4.68 - 4.82	Spongy slightly clayey peat, black to dark brown, occasional wood remains.		

5.20	4.82 - 5.48	Firm silty clay, yellow grey to dark grey, frequent tiny organic remains and banded structure.		
	-5.148 m OD			
5.21	5.48 - 5.95	Soft, dark brown, slightly clayey peat frequent wood remains.	Wetland to waterlogged soil and possible Alder Carr environment	Facies 4
5.22	5.95 - 6.4	Mid greenish grey, very soft silty clay, occasional to frequent organic remains.		
	-6.068 m OD			
5.23	6.4 - 6.8	Backfill	Low lying ground forming an area of shallow water	Facies 3
5.24	6.8 - 7.0	Mid to dark reddish brown peat, spongy, occasional wood remains.		
5.25	7.0 - 7.3	Backfill		
5.26	7.3 - 7.75	Soft dark bluish grey, silty clay, frequent organic remains.		
5.27	7.75 - 7.96	Firm dark grey organic clay, frequent wood fragments and larger pieces, graded upper boundary, sharp lower boundary.		
	-7.628 m OD			
5.28	7.96 - 8.0	Yellow sand and gravel slightly clayey.	Pleistocene Gravels	Facies 1
	-7.67 m OD	**Base of borehole**		

GPG08_SI_WS1			**Location:** 550574.04/179681.82	
Unit	**Depth of unit m bgl (Height of unit m OD)**	**Description**	**Interpretation**	**Facies**
	0.14 m OD	**Ground level adjacent to section**		
1.1	0.00 - 1.00	Inspection pit	Made ground	Facies 9
	-0.86 m OD			
1.2	1.00 - 1.20	Brown grey silty clay frequent to abundant organic and wood inclusions.	Historic overbank flood deposits forming an accretionary floodplain soil.	Facies 8
	-1.06 m OD			
1.3	1.20 - 1.90	Grades into firm blue grey silty clay occasional round wood inclusions	Alluvial overbank flood deposits	Facies 7
	-1.76 m OD			
1.4	1.90 - 2.85	Soft spongy red brown peat, woody.	Wooded wetland. Possible fen and Alder Carr	Facies 6

1.5	2.85 - 3.70	Grades over 10cm into blue grey soft silty clay, with occasional to frequent small round wood inclusions.		
-3.56 m OD				
1.6	3.70 - 4.30	Sharp boundary with a dark brown clayey peat frequent round wood inclusions	Wooded wetland with increasing periods of inundation and overbank flood deposition.	Facies 5
1.7	4.30 - 6.20	Grades into laminated blue grey silty clay, frequently organic and wood chips, occasional to rare molluscs more frequent with depth, wood in bands.		
-6.06m OD				
1.8	6.20 - 6.80	Grades into a dark grey silty clay, laminated, occasional organic inclusions and molluscs, more frequent with depth.	Wetland to waterlogged soil and possible Alder Carr environment	Facies 4
1.9	6.80 - 7.20	Dark brown clayey peat occasional wood.		
-7.06 m OD				
1.10	7.20 - 7.70	Greenish grey sandy silty clay grading into a sandy silt, rare organic inclusions, no visible structures, rare mollusc fragments.	Low lying ground forming an area of shallow water	Facies 3
-7.56 m OD				
1.11	7.70 - 8.50	Yellow grey fine sand.	Early Holocene sands and silts	Facies 2
1.12	8.50 - 9.00	Sands and gravels	Pleistocene gravels	Facies 1
-8.86 m OD		**Base of borehole**		

GPG08_SI_WS2A			**Location:** 550610.39/179669.70	
Unit	**Depth of unit m bgl (Height of unit m OD)**	**Description**	**Interpretation**	**Facies**
0.44 m OD		**Ground level adjacent to section**		
1.1	0.00 - 1.00	Inspection pit	Made ground	Facies 9
-0.56 m OD				

1.2	1.00 - 2.00	Blue grey silty clay, occasional manganese associated with roots, soft, Fe staining to top.	Alluvial overbank flood deposits	Facies 7
-1.56 m OD				
1.3	2.00 - 2.90	Red brown, spongy wood peat, long bits of compressed round wood.	Wooded wetland. Possible fen and Alder Carr	Facies 6
1.4	2.90 - 3.60	Slightly brown grey, humic silty clay, frequent to abundant wood chips, soft, rare shell fragments.		
1.5	3.60 - 4.20	Grades into a fibrous peat slightly clayey, brown slightly red, occasional small wood chips.		
-3.76 m OD				
1.6	4.20 - 6.50	Grades back into a blue grey very soft silty clay, slight horizontal structure, occasional wood chips and roots, occasional large wooden timbers, 10 to 20cm in diameter.	Wooded wetland with increasing periods of inundation and overbank flood deposition.	Facies 5
-6.06 m OD				
1.7	6.50 - 7.10	Black organic woody band in top 5cm. Grades into dark grey slightly humic, laminated silty clay, occasional round wood, occasional to frequent molluscs, abundant molluscs around top.	Wetland to waterlogged soil and possible Alder Carr environment	Facies 4
1.8	7.10 - 7.30	Black spongy peat, detrital, sharp lower boundary.		
-6.86 m OD				
1.9	7.30 - 7.50	Very soft blue grey silty clay, rare small organics, rare visible inclusions.	Low lying ground forming an area of shallow water	Facies 3
-7.06 m OD				
1.10	7.50 - 8.00	Grades into a soft turquoise blue sandy silt.	Early Holocene sands and silts	Facies 2
1.11	8.00 - 8.40	Yellow brown fine sands		
-7.96 m OD				
1.12	8.40 - 9.00	Sands and gravels	Pleistocene gravels	Facies 1
-8.56 m OD		**Base of borehole**		

GPG08_SI_WS2B			**Location:** 550610.89/179669.80	
Unit	**Depth of unit m bgl (Height of unit m OD)**	**Description**	**Interpretation**	**Facies**
	0.44 m OD	**Ground level adjacent to section**		
1.1	0.00 - 0.55	Dark grey to yellowish brown sandy gravel, fine to coarse sand, angular to rounded gravel.	Made ground	Facies 9
	-0.11 m OD			
1.2	0.55 - 1.00	Mid brown to bluish brown silty clay, gravel inclusions and heavy disturbance to top, fine cracks and Fe staining to base.	Historic overbank flood deposits forming an accretionary floodplain soil.	Facies 8
1.3	1.00 - 1.07	Dark grey silty clay with coarse sand. Backfill.		
	-0.63 m OD			
1.4	1.07 - 1.65	Firm silty clay, mid to light bluish brown, occasional to rare Fe concretions around root channels, diffuse lower boundary, small pocket of <1cm organics near base.	Alluvial overbank flood deposits	Facies 7
1.5	1.65 - 2.00	Soft bluish grey silty clay, frequent small organics flecks throughout, occasional to rare Fe mottling.		
	-1.56 m OD			
1.6	2.00 - 2.14	Black, soft, spongy peaty topsoil visible rooting and small fibrous organic remains. Irregular lower boundary.	Wooded wetland. Possible fen and Alder Carr	Facies 6
1.7	2.14 - 2.58	Dark reddish brown, firm but spongy wood peat, frequent round wood remains to top and base. Irregular lower boundary.		
1.8	2.58 - 3.00	Black silty peat, patches of dark brown clayey peat and light blue clay between 0.72 and 0.80 m bgl. Occasional wood remains throughout.		

1.9	3.00 - 3.42	Black slightly clayey peat, frequent wood chips/reed remains, spongy.		
1.10	3.42 - 3.60	Mid grey brownish grey soft, frequent reed remains, grades into unit below, silty clay.		
1.11	3.60 - 3.83	Mid brown slightly clayey peat, frequent small wood frags <1cm, occasional medium wood frags <3cm.		
1.12	3.83 - 4.06	Black firm to spongy, fibrous peat, frequent wood remains. Diffuse lower boundary.		
	-3.62 m OD			
1.13	4.06 - 5.16	Soft blue grey silty clay, darker colour in top 0.2m, grades into a light blue grey, freq to abundant org flecks <0.5cm throughout. 4.34 to 4.35m thin band of dark grey silt no inclusions (crack or root infill). 4.91 to 4.95m large wood piece.	Wooded wetland with increasing periods of inundation and overbank flood deposition.	Facies 5
1.14	5.16 - 5.32	Mid brown, compacted wood fibres.		
1.15	5.32 - 6.00	Blue grey to olive grey silty clay, soft frequent organic flecks throughout, <1cm occasionally <3cm.		
1.16	6.00 - 6.55	Dark blue grey silty clay, soft. Large hard wood frags at 6.09 to 6.13m and 6.51 to 6.54m, occasional light Fe mottling, occasional rare org. flecks, mollusc frags in last 5cm. Irregular and diffuse lower boundary.		
	-6.11 m OD			
1.18	6.55 - 6.86	Grey to dark grey, silty clay, soft, frequent mollusc frags in top 10cm.	Wetland to waterlogged soil and possible Alder Carr environment	Facies 4
1.19	6.86 - 7.00	Slightly clayey peat, black, occasonal sand, occasional wood frags.		

1.20	7.00 - 7.48	Mid to dark blue grey silty clay, soft, occ to rare org flecks, occ mollusc frags throughout, seed at 7.28m. Diffuse lower boundary.		
-7.04 m OD				
1.21	7.48 - 7.84	Firm dark to mid brown, slightly clayey fibrous peat, more peaty with depth, occ wood. Irregular lower boundary.	Low lying ground forming an area of shallow water	Facies 3
1.22	7.84 - 8.00	Blue grey to yellow sandy silty clay, very soft.		
1.23	8.00 - 8.17	Mid brown, silty clay, soft, slightly mixed looking, occ small wood chips.		
1.24	8.17 - 8.30	Peat fibrous, black, spongy, also slightly, mixed.		
1.25	8.30 - 8.59	Very soft light grey silty clay, slightly sandy, fine and increasing with depth.		
-8.15 m OD				
1.26	8.59 - 8.82	Slightly silty fine to medium sand, firm, yellow grey to blue grey.	Low lying ground forming an area of shallow water	Facies 2
-8.38 m OD				
1.27	8.82 - 9.00	Coarse sand with occ pea gravel and occ to rare large subangular gravel.	Pleistocene gravels	Facies 1
-8.56 m OD		**Base of borehole**		

GPG08_SI_WS3			**Location:** 550536.805/179679.998	
Unit	**Depth of unit m bgl (Height of unit m OD)**	**Description**	**Interpretation**	**Facies**
0.68 m OD		**Ground level adjacent to section**		
1.1	0 - 1.20	Made ground	Made ground	Facies 9
-0.52 m OD				
1.2	1.20 - 1.40	Orange silty clay, Fe associated with vertical root channels, firm.	Historic overbank flood deposits forming an accretionary floodplain soil.	Facies 8
1.3	1.40 - 2.00	Blue grey silty clay, firm to soft, 2cm band of dark clay half way down, no visible organics.	Alluvial overbank flood deposits	Facies 7
-1.32 m OD				

1.4	2.00 - 3.10	Dark brown reddish, spongy peat, visible organic tissue, reeds, twigs and wood chips.	Wooded wetland. Possible fen and Alder Carr	Facies 6
-2.42 m OD				
1.5	3.10 - 3.90	Grey slightly brown silty clay, firm, abundant reddish and yellowish wood chips	Wooded wetland with increasing periods of inundation and overbank flood deposition.	Facies 5
1.6	3.90 - 4.80	Brown slightly grey organic silty clay, frequent to abundant wood chips, becoming more fibrous with depth and turning into a peaty clay, abundant twigs to base.		
1.7	4.80 - 7.70	Soft, blue grey, frequent twigs towards top of the unit, homogenous in structure, rare inclusions of bark in fine laminations in basal half, occasional mollusc frags.		
-7..02 m OD				
1.8	7.70 - 7.80	sands and gravel poor retrieval	Pleistocene gravels	Facies 1
-7.12 m OD		**Base of borehole**		

GPG08_SI_WS8			**Location:** 550685.42/179632.77	
Unit	**Depth of unit m bgl (Height of unit m OD)**	**Description**	**Interpretation**	**Facies**
	0.67 m OD	**Ground level adjacent to section**		
1.1	0.0 - 1.00	Inspection pit	Made ground	Facies 9
	-0.33 m OD			
1.2	1.00 - 1.70	Blue grey silty clay, heavy Fe staining to top, wood and roots to base, firm.	Historic overbank flood deposits forming an accretionary floodplain soil.	Facies 8
	-1.03 m OD			
1.3	1.70 - 2.00	Brown to black humic silty clay, firm, visible fragmented organics.	Wooded wetland. Possible fen and Alder Carr	Facies 6
1.4	2.00 - 2.60	Red brown spongy wood peat large fragments of twig and root.		
	-1.93 m OD			

1.5	2.60 - 6.00	Soft grey slightly blue silty clay, occasional wood chips, twigs, large bit of wood around 3.2m bgl, less organic from 3.8m down to 4m bgl, no visible laminations, possible laminations from 5m bgl, very soft but some horizontal structures.	Wetland peat with periods of inundation and overbank flood deposition.	Facies 5
1.6	6.00 - 6.70	As above but visible laminations, horizontal round wood visible, occasional wood chips		
	-6.03 m OD			
1.7	6.70 - 6.80	Humic silty clay, grey brown, frequent mollusc fragments, no visible organic tissue.	Wetland to waterlogged soil and possible Alder Carr environment	Facies 4
	-6.13 m OD			
1.8	6.8 - 8.0	Yellow grey fine sand, no visible inclusions.	Early Holocene sands and silts	Facies 2
	-7.33 m OD	**Base of borehole**		

GPG08_SI_BH1			**Location:** 550564.07/179750.80	
Unit	**Depth of unit m bgl (Height of unit m OD)**	**Description**	**Interpretation**	**Facies**
	0.3 m OD	**Ground level adjacent to section**		
1.1	0.0 - 0.2	Concrete	Made ground	Facies 9
1.2	0.2 - 2.7	Black, very wet, oily, occasional gravel and brick, very soft.		
	-2.40 m OD			
1.3	2.7 - 3.0	Peat fragments, very soft, very wet, possible contamination from above.	Wooded wetland. Possible fen and Alder Carr	Facies 6
1.4	3.0 - 4.2	Mid to dark brown very organic clayey silt, very soft, unconsolidated, occasional reed and organic matter visible, <2cm.		
	-3.90 m OD			
1.5	4.2 - 4.6	Very soft blue grey clay, wood fragments, round wood visible, some alder.	Wooded wetland with increasing periods of inundation and overbank flood deposition.	Facies 5
1.6	4.6 - 5.0	Band of clayey peat, soft, large wood fragments 10cm<, brown very.		
1.7	5.0 - 5.8	Soft silty clay occasional to frequent wood.		

1.8	5.8 - 6.5	Reedy peat, mid brown, spongy, soft.		
	-6.5 m OD			
1.9	6.5 - 7.5	Slightly sandy blue grey silty clay.	Wetland to waterlogged soil and possible Alder Carr environment	Facies 4
	-7.2 m OD			
5.10	7.5 - 8.0	Gravels	Pleistocene gravels	Facies 1
	-7.7 m OD	**Base of borehole**		

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10 NMR OASIS archaeological report form

10.1 OASIS ID: molas1-83628

Project details

Project name	GPG08 Green Level Pumping Station
Short description of the project	The examination of the watching brief sections and the window samples and boreholes from previous phases of the work has enabled the characterisation of the subsurface deposits across the area of the site, and provided a basis for the understanding of the evolution of the landscape from the Late Glacial to the present day. The work illustrates the complex nature of the landscape as a progressively inundated landsurface, with periods of hiatus, as water level rose, as a result of relative sea level change, during the Holocene. The surface of the Pleistocene deposits forms the basic topography for much of the Holocene. A high area of high gravel (a gravel island) was found to the east of the site and a low area of gravel, representing the route of an early Holocene channel was recorded to the centre of sitel. The gravel island would have remained high dry ground for much of the Mesolithic and early Neolithic and would have been an ideal base for past humans to venture out from and exploit the rich marginal wetland resources. The broad stratigraphic units found on site were basal sand and gravels; fluvial sands banked around the gravel island; organic clays and silty sands representing sluggish flow and pools of standing water in the area of low lying gravel; peat deposits representing a wooded wetland again concentrated in the central area of low lying gravel; increased sedimentation and the formation of fine grained minerogenic mudflats; overlain once more by wooded peat deposits; and finally alluvial silts and clays.
Project dates	Start: 01-04-2008 End: 01-10-2010
Previous/future work	No / No
Type of project	Watching brief
Site status	None
Current Land use	Vacant Land 2 - Vacant land not previously developed
Monument type	BURIED LAND SURFACE Late Mesolithic

Project location

Country	England

Site location	GREATER LONDON BEXLEY ERITH Green Level Pumping Station
Postcode	DA8
Study area	160000.00 Square metres
Site coordinates	TQ 550900 179600 50.9396212211 0.207678647084 50 56 22 N 000 12 27 E Point
Lat/Long Datum	WGS 84 Datum
Height OD / Depth	Min: -8.38m Max: -0.06m

Project creators

Name of Organisation	MOL Archaeology
Project brief originator	Jacobs
Project design originator	MOL Archaeology
Project director/manager	Robin Nielsen
Project supervisor	Virgil Yendell
Type of sponsor/funding body	Environment Agency

Project archives

Physical Archive Exists?	No
Digital Archive recipient	LAARC
Digital Contents	'none'
Digital Media available	'Database','GIS','Images raster / digital photography','Spreadsheets','Text'

Paper Archive recipient	LAARC
Paper Contents	'none'
Paper Media available	'Notebook - Excavation',' Research',' General Notes'

Project bibliography 1

Publication type	Grey literature (unpublished document/manuscript)
Title	Green Level Pumping Station. Geoarchaeological Watching brief report
Author(s)/Editor(s)	Yendell, V
Date	2010
Issuer or publisher	MOL Archaeology
Place of issue or publication	London

Entered by	Virgil Yendell (vyendell@molas.org.uk)
Entered on	1 October 2010