



METROPOLITAN POLICE SPECIALIST TRAINING CENTRE Gravesend DA12

County of Kent

Geoarchaeological Deposit Model Report

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**METROPOLITAN POLICE SPECIALIST TRAINING
CENTRE
Gravesend
Kent
DA12 2HN**

Geoarchaeological Deposit Model

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Summary

This report presents the results of a deposit model exercise carried out by Museum of London Archaeology (MOLA) on the Metropolitan Police Specialist Training Centre, Gravesend, Kent DA12 2HN. The report and deposit model were requested by Kent County Council as geoarchaeological mitigation. The application site is bordered by the southern bank of the River Thames to the north, a rifle range to the east, the Police Training Centre and Thames-Medway Canal to the south, and Gravesend to the west. The application site is centered at NGR 567280, 174230.

The deposit model identifies deposits of archaeological and palaeoenvironmental potential across the application site, based on data from previous geotechnical investigations within the application site and geotechnical and geoarchaeological investigations in the wider area.

The application site is located within the current floodplain of the River Thames. Across the application site, the predominantly Cretaceous Chalk bedrock is overlain by Pleistocene floodplain gravels. The surface of these gravels across the application site represents the topography at the beginning of the Holocene, broadly equivalent to the early Mesolithic. Two geotechnical boreholes undertaken on the application site recorded the surface of the gravels at c-11.35m OD on average. This suggests that the topography was low lying, which, according to age / depth modelling (Bates & Whittaker 2004, Stafford et al 2012), the application site was probably inundated from the mid-Mesolithic onwards as a result of the knock on effects of relative sea level rise.

The floodplain gravels are sealed by a succession of Holocene floodplain deposits consisting of alluvium and interdigitated thin layers of peat, reaching 11.70m thick on average. The peat layers probably represent periods of hiatus in sea level rise and minerogenic deposition. These deposits can be related to the sequence described by Devoy (1979, 1982) at the type site for this part of the Thames at World's End, Tilbury. A lower band of peat was identified at -11.40m OD in BH01 which may equate to Tilbury II (Mid-Late Mesolithic) and an upper band of peat was identified in all boreholes which reached the depth at c. -3m OD which may equate to Tilbury IV (Mid-Late Bronze Age).

As a consequence of the thickness of the alluvium, the application site is considered to have high palaeoenvironmental potential for the survival of palaeoenvironmental proxy indicators such as pollen, diatoms and ostracods which can be assessed to reconstruct environmental change and the interaction between human activity and the environment. Peat in particular has a high potential for the recovery of organic remains suitable for radiocarbon dating which can provide a chronostratigraphic framework to the sequence.

Given that the application site would have been subjected to flooding from the mid-Mesolithic, there is a low-moderate potential for artefactual remains relating to the Upper Palaeolithic and early Mesolithic habitation of the landscape prior to inundation at the surface of the Pleistocene deposits. Similarly, as the rise in sea levels precluded permanent settlement on the application site, it is considered there is a low-moderate potential for artefactual remains relating to human exploitation of the wetland landscape from the later Mesolithic through to the post medieval period periods (e.g. trackways, boats and fish traps).

The Holocene deposits are capped by an average 1.55m of modern made ground which is of no archaeological potential.

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1 Introduction

1.1 Site background

- 1.1.1 The Metropolitan Police Specialist (MPS) Training Centre site is situated east of the town of Gravesend, in north Kent, close to the south bank of the River Thames (Fig 1). The centre of the application site is at NGR 567280, 174230. The application site currently comprises an area of hardstanding which is used as a car park at the MPS Training Centre.

1.2 Origin and scope of the report

- 1.2.1 This report has been commissioned from MOLA by the Metropolitan Police. This geoarchaeological report has been prepared within the terms of the relevant standards specified by the Chartered Institute for Archaeologists (CIfA 2014).
- 1.2.2 A geoarchaeological deposit model and report was requested for the development by the Kent County Council archaeological advisor. This deposit model and report serves to mitigate the impact of the development.
- 1.2.3 A geoarchaeological deposit model provides information about the archaeological resource by examining geotechnical data relating to the application site. The data is used to assess the potential of the deposits preserved on the application site for the survival of archaeology and palaeoenvironmental remains.
- 1.2.4 Deposit modelling can be particularly useful when dealing with prehistoric floodplain archaeology (Howard & Macklin 1999) such as the Thames floodplain, where archaeological deposits and ancient land surfaces are likely to be deeply buried beneath alluvium.
- 1.2.5 A geoarchaeological deposit model is also of value when only a low level of cultural remains is likely to be preserved in the alluvium on the application site, but there is good potential for the reconstruction of environmental and landscape changes from soils, sediments and their ecological inclusions. In these cases the modelling can predict where deposits with high palaeoenvironmental potential are likely to exist.
- 1.2.6 *Note: within the limitations imposed by dealing with historical material, maps and geotechnical data the information in this document is, to the best knowledge of the author and MOLA, correct at the time of writing. Further archaeological investigation, geotechnical investigation, and/or more detailed proposals for redevelopment may require changes to all or parts of the document.*

1.3 Aims and objectives

- 1.3.1 Geoarchaeological deposit models look in detail at the sequence and distribution of subsurface deposits across the application site by examination of previous geotechnical data and consideration of the landscape and geological setting. Information is gained about the potential of the archaeological resource on application site by interpreting the deposits for information relating to past environments and depositional processes with reference to other sites previously investigated in the area.
- 1.3.2 The aim of the deposit modelling exercise is to provide information about the palaeoenvironment and palaeotopography to identify areas of higher and lower archaeological and palaeoenvironmental potential. The deposit model will draw on

both the data from previous site investigations as well as British Geological Survey (BGS) data. This report will also make recommendations on future work based on the predicted archaeological and palaeoenvironmental potential.

1.4 Proposed development summary

- 1.4.1 The application site is currently hardstanding used as a car park within the MPS Training Centre complex. Development proposals involve the construction of a new MPS owned training facility at the location (SNC-Lavalin 2023). This will involve the construction of a new concrete building with an ancillary support building.

2 Methodology

2.1 Geoarchaeological background

In order to understand the context of the deposits existing on the application site, information has been examined from:

- Past archaeological and palaeoenvironmental work undertaken in the area
- British Geological Survey maps and other sources describing the characteristics of the bedrock, soils and substrate in the area

2.2 Data collection

Data was obtained from previous geotechnical investigation carried out at the application site (WYG 2020), as well as data from borehole records held within the BGS digital archive (BGS 2023). The geotechnical investigation comprised six boreholes, including four boreholes which reached the level of the Holocene deposits and two boreholes which reached pre-Holocene deposits. Twenty data points were obtained from the BGS digital archive within 1km of application site (BGS 2023).

2.3 Deposit model construction

In order to create the deposit model the data was entered into a digital (Rockworks 17) database. Each lithological unit (gravel, sand, silt, etc.) was assessed allowing correlation of the different deposit types across the application site. By examining the relationship of the lithological units both horizontally and vertically across the application site in a transect (Fig 5), correlations can be made between deposits, and associations grouped together on a site wide basis.

The grouping of these deposits is based on the lithological descriptions, which define distinct depositional environments, which can be related to a wider understanding of the Thames floodplain sequence gained from previous archaeological and geoarchaeological investigations undertaken in the surrounding area. Thus a sequence of stratigraphic units (facies) representing certain depositional environments and/or landforms can be reconstructed both laterally and through time for the application site (Fig 5).

The Rockworks data was transferred to ArcGIS v.10 which were used to create an 'Early Holocene surface' (Fig 3), which plots the surface topography of the Pleistocene gravels and sands. This gives an approximation of the topography of the application site as it existed at the beginning of the Holocene period (i.e. the early Mesolithic, c.10,000 years ago). The development of the Holocene floodplain is likely to have been influenced by the gravel topography inherited from the Pleistocene period. This surface would have dictated the course of later channels, with gravel high points forming areas of dry land within the wetlands, and lower lying areas forming the main threads of later channels. The model was generated through kriging interpolation with a 5% buffer around data points.

An adapted version of the BGS superficial and bedrock mapping is also presented in Fig 5 to supplement the deposit model.

2.4 Reliability of the model

Data coverage within the application site is moderate (Figs 2 & 5). Despite a good spread of data points across the application site, only two boreholes (BH01 and BH02) reached the level of the Pleistocene deposits and recorded the full Holocene sequence.

Data coverage within the immediate vicinity of the application site is poor, with the nearest BGS borehole being located c. 330m to the west (TQ67SE1091). The early Holocene topographic model (Fig 3) of the application site area includes data points from within the application site as well as BGS borehole data from within a 1km of the application site (BGS 2023). The location of the data points is marked in Fig 3.

To supplement the poor coverage of data points within the area of application site for the production of the early Holocene surface plot (Fig 3), a topographic model of the Tilbury Fort site has also been included, approximately 2.5km to the northwest of application site. This site has been subject to extensive previous investigation (MOLA 2021; Devoy 1979, 1982) and provides an informative comparison to the area around the site. Modelling for the Tilbury Fort area uses 22 data points.

3 Topographical and historical background

3.1 Introduction

- 3.1.1 In this section the landscape evolution and associated archaeology of the area around the application site is summarised. It forms the necessary background to interpret the deposit model produced for the application site and to assess the potential of the alluvial sequence. The deposits which are likely to occur on the application site, with associated archaeology, are described in chronological order. Dates in BP refer to before present i.e. before 1950.

3.2 Timescales

- 3.2.1 Human activity in Britain has taken place during the period of geological time known as the Quaternary, which spans the last 2.5 million years and is characterised by the climatic oscillations known as ‘the Ice Ages’.

- 3.2.2 The Quaternary is subdivided into the:

Pleistocene: 2.5 million – 10,000 BP

Holocene: 10,000 BP – present

- 3.2.3 Although hominins are known to have existed in other parts of the world from the beginning of the Quaternary, if not earlier, the earliest evidence for human activity yet found in Britain has been dated to the latter part of the Quaternary, about 1,000,000 years ago.

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

Prehistoric

Lower Palaeolithic (ancestral humans: hominins): 1,000,000 – 250,000 BP

Upper Palaeolithic (early modern humans) 250,000 – 10,000 BP

Mesolithic (hunter gatherer foragers): 10,000BP/8000BC – 4,000 BC

Neolithic (the earliest farmers): 4,000–2,000 BC

Bronze Age (first use of metal, more complex societies): 2,000–600 BC

Iron Age (agricultural intensification; political elites): 600 BC–AD 43

Historic

Roman: AD 43–410

Saxon / early–medieval: AD 410–1066

Medieval: AD 1066–1485

Post–medieval: AD 1485–present

3.3 Site location and topography

- 3.3.1 The application site lies on the southern bank of the River Thames, well within the current floodplain. According to the BGS mapping of the area the application site lies on Holocene alluvium which covers the Shepperton floodplain gravels (Fig 4; BGS Solid and Drift Sheet 271). The application site is east of the modern town of Gravesend, which lies on higher ground defined by river terrace gravels and outcropping bedrock. The application site and surrounds are open and relatively flat, lying approximately between 2.5m and 4m above (A)OD.

3.4 Pre-Quaternary geology

- 3.4.1 Geologically, the Lower Thames area is defined by the London Basin, a gentle synclinal fold with a west-east aligned axis. This fold means that older rocks outcrop on the edge of the syncline. The London area is bordered by outcropping Cretaceous Chalk to the north and the south. Younger geological strata, including Tertiary sands and clays, infill the centre of the syncline, which the River Thames generally follows.
- 3.4.2 According to BGS mapping (2023), the underlying bedrock at the application site is Cretaceous Chalk. There are also areas of outcropping Thanet Formation (a Tertiary deposit) in the area.
- 3.4.3 The bedrock pre-dates the evolution of hominin groups and therefore has no archaeological potential in itself. Also, within the floodplain of the Thames, the influence of the bedrock on the landscape is negligible due to the considerable thickness of the overlying Quaternary deposits.

3.5 Quaternary deposits

- 3.5.1 The present course of the Thames was established c. 0.45 million years ago, when the ice sheets of the Anglian Glaciation diverted it from its former course through the Vale of St Albans to its present more southerly route (Bridgland 1994). Throughout the Ice Age, climatic oscillations have created cycles of downcutting and aggradation within the Thames Valley, which together with gradual tectonic uplift has led to a sequence of progressively younger Quaternary deposits down the valley sides (Bridgland 1994; Gibbard 1994). These gravelly deposits form a series of terraces which represent former floodplains of the river which were incised and left high and dry.
- 3.5.2 The present floodplain represents the most recent stage in the sequence of floodplain incision and aggradation. It was created as the river cut down from a former, higher floodplain as a result of the low sea level and large influx of glacial meltwater which followed the end of the Last Glacial Maximum c. 18,000 BP (Gibbard 1994). The river subsequently deposited coarse grained sediments (i.e. sands and gravels) across the valley floor and these deposits (Shepperton Gravel Formation) underlie the alluvium across the present floodplain and across the application site.
- 3.5.3 South of the application site above the floodplain, outcropping terrace gravels of the Corbets Tey and Mucking Formations (equivalent to the Lynch Hill Gravels and Taplow Gravels of the Middle Thames, respectively) along with Head deposits are mapped (BGS 2023), all of which refer to Pleistocene sediment accumulations, originating from varied depositional environments connected with Ice Age climatic fluctuations.

3.6 Holocene deposits

- 3.6.1 At the Pleistocene/Holocene interface, c. 10,000 BP, sea level is estimated as being as low as c. -30m OD (Bates & Whittaker 2004). Sea level was rising and continued to do so rapidly until attaining its present levels by c. 6,000 BP. However, southeast England has been sinking as a result of isostatic rebound, so relative sea level (RSL) has continued to rise. The rate of RSL rise throughout the Holocene has not been continuous, so the alluvial sequence of the Lower Thames is punctuated by interbedded organic deposits and peats. These deposits reflect periods of slowing or hiatus in RSL rise which facilitated vegetational growth (Bates & Whittaker 2004;

Devoy 1979; Sidell 2003).

- 3.6.2 Quaternary scientists and geographers are interested in the alluvial sequence for the information it provides on the pattern of local RSL rise and its implications for Holocene sea level fluctuations and climate change at a wider scale (e.g. Long *et al* 2000). Archaeologically, the significance of the interbedded peats and clays within the floodplain lies in the information they provide about past fluctuations in environment and thus the changing landscape available to be exploited and inhabited by people in the past.
- 3.6.3 The peat and alluvial sequence in the Tilbury area (on the north side of the Thames to application site, c. 1.5km to the northwest) has been extensively studied and used to form the typology for sediments in this part of the Thames. These sequences are particularly good for palaeoenvironmental reconstruction. Devoy (1979, 1982) produced a type sequence across the site area at World's End, Tilbury, to which other sites in the Lower Thames have been correlated. The Devoy model of eustatic change details phases of inundation and minerogenic deposition (Thames Phases I-V) that are interspersed with radiocarbon dated phases of marine regression defined by peat accretion (Tilbury Phases I-V).

Table 1: Chronology and height range of the Thames and Tilbury Phases I-V (Devoy 1982).

Event	Commencement	Cessation /Height at surface
Thames V	c. 1600 cal BP (-0.75 to +0.44m OD)	No data
Tilbury V		+0.40m to -0.90m OD
Thames IV	2750 cal BP (-1.8 to -0.8m OD)	No data
Tilbury IV		-0.80m to -1.80m OD
Thames III	4250 cal BP	2900 cal BP
Tilbury III		-1.90m to -5.20m OD
Thames II	7550 cal BP	5700 cal BP
Tilbury II		-6.80m to -10.07m OD
Thames I	9200 cal BP	7800 cal BP
Tilbury I		-12.3m to -25.5m OD

- 3.6.4 More recently, a cultural landscape model for the likely impact of RSL rise in the Lower Thames has been proposed (Bates & Whittaker 2004; Stafford *et al* 2012). This model proposes a series of stages of Lower Thames sedimentation and suggests that where the topography of the 'pre-Holocene template' i.e. the surface of the Pleistocene gravels lay below -6m OD it was a wetland area at least by the late Mesolithic; by the early Neolithic land around -2m OD was inundated; and from the Late Neolithic to Early Bronze Age surfaces below 0m OD were inundated. Such wetland expansion caused islands of higher land to be created, as the surrounding lower-lying land turned to marsh and mudflats. These islands may have become targeted for exploitation and are often associated with evidence for prehistoric activity. Finally, during the late prehistoric and historic (Roman and later) periods, submergence of the floodplain occurred, depositing essentially minerogenic sediments up to the level that underlies modern made ground today.

Table 2: Stages of Lower Thames sedimentation and environment (after Bates & Whittaker 2004).

Stage	Time period	Characteristics
1 Late Glacial	(1a) 30-15ka BP	Late glacial period; low sea level; reworking of river terraces under periglacial conditions; downcutting by river greatest at Glacial Maximum (height of cold period) c.18ka BP.
	(1b) 15ka-10kaBP	Valley infilling and deposition of Shepperton gravels; late glacial braided channel system; high fluvial energy.
2 Early Holocene	10 – 6/7ka BP	Early period of landscape stability across floodplain; low fluvial energy ; complex vegetation mosaics; sedimentation largely sand bodies within river channels and areas of localised peat growth. Mesolithic
3 Middle Holocene	6/7 - 5 ka BP	Major landscape instability; sea level rise associated with extensive flooding (initially freshwater then brackish); expansion of wetland environments across previously dryland areas; mainly minerogenic sedimentation (clay/silts); numerous temporary and ephemeral landsurfaces existing within flooded zone. Mesolithic / Neolithic
4 Late Holocene	5 - 3ka BP	Apparent sea level fall and associated reduction of tidal influence; period of organic sedimentation under brackish conditions (alder carr peat development) equating with Devoy's Tilbury III; expansion of wetland environments inland; topographic variation lost. Neolithic / Bronze Age
5 Later Holocene	3-1ka BP	Final submergence of floodplain with minerogenic (clay/silt) sedimentation dominating; no organic sedimentation; brackish tidal conditions as tidal head moves up lower Thames. Late Bronze Age; Iron Age; Roman; Medieval periods.
6 Later Holocene	1ka BP - present	Human manipulation of floodplain (flood defences and drainage channels); sedimentation rates reduce. Medieval post-medieval periods.

3.6.5 In the post medieval period the application site remained peripheral to developments at Tilbury and Gravesend. The land was probably drained during the 19th century, and mapping from the late 19th / early 20th century shows the application site as an undeveloped plot of land near to the bank of the Thames, north of the Thames and Medway canal (WYG 2020).

3.7 Previous work

- 3.7.1 Previous work by MOLA at Tilbury Fort c. 1.5km to the west of the application site on the north bank of the Thames (MOLA 2021) discovered long sequences of Holocene alluvium with interdigitated peats, comparable to the sequences examined by Devoy in the area (1979, 1982).
- 3.7.2 Furthermore, significant palaeoenvironmental reconstruction work has been carried out at by MOLA Purfleet and Littlebrook, c. 10km west of the application site (MOLA 2019, Stastney *et al* 2021). Although there is considerable distance between the sites, they are located on the same broad stretch of the Lower Thames and provide an indication of the general vegetational history.
- 3.7.3 At Purfleet, sedimentation began at the end of the Mesolithic, where the topography was colonised by alder carr type woodland, which expanded and contracted in relation to RSL rise variations and according to local topographic variations (MOLA 2019).
- 3.7.4 Work at Littlebrook has defined several key vegetational phases in the region (Stastney *et al* 2021). At 11,000-10,000 BP the woodland coverage was about 80%, reducing to 55% by 8000-7000 BP. The earliest evidence of agriculture was dated to 6052-5651 cal BP and associated with elm decline but not a significant reduction in total woodland cover. Between 4000-3000 BP a sharp decline in woodland coverage occurred with grassland habitats becoming dominant. Interestingly, these vegetation changes were not correlated with wetland extent and seem to be primarily the result of anthropogenic influence (Stastney *et al* 2021). This work also demonstrates the potential for palaeoenvironmental reconstruction from assessment

of floodplain deposits in the region.

4 Geoarchaeological deposit model

4.1 Introduction

- 4.1.1 The geoarchaeological deposit model characterises the application site in terms of three main facies: the pre-Holocene deposits, the Holocene deposits, and the made ground deposits. This section discusses the deposits present across the application site in terms of these facies.

4.2 Site wide deposits

Facies 1: Pre-Holocene deposits

- 4.2.1 The plot of the early Holocene surface (Fig 3) is a starting point from which to understand the evolution of the application site throughout the Holocene, as the geomorphological characteristics of the early Holocene surface has influenced the development of the landscape throughout the Holocene.
- 4.2.2 The early Holocene surface is approximated by the topography of facies 1, the pre-Holocene deposits (Fig 3). The uppermost pre-Holocene deposits here relate to the floodplain gravels or the Shepperton Gravel Formation which was laid down by the Thames in the late Pleistocene. The Pleistocene gravels occasionally contain Palaeolithic artefactual remains but as the gravels were reworked from higher river terrace deposits and redeposited across the floodplain, these Palaeolithic remains are often degraded and of little significance due to their *ex situ* context.
- 4.2.3 The Pleistocene gravels were only reached in BH01 and BH02 within the application site, which recorded very similar elevations, -11.39m and -11.30m OD. BH01 and BH02 targeted the western and eastern portions of the application site respectively, and therefore suggest that the early Holocene surface is relatively flat across the application site, which is approximately 65m wide. As the reproduction of the BGS mapping shows (Fig 4), the application site is well within the wider Thames floodplain, being some 0.95 km from the river terrace to the south (consisting of outcropping Chalk bedrock or the Mucking Gravel river terrace as the Taplow terrace is termed in this part of the Lower Thames; Bridgland, 1994).
- 4.2.4 Wider modelling of the area within 1km of the application site suggests that the early Holocene topography undulates, and may generally decline towards the east toward a route of a possible Pleistocene palaeochannel at c -11m OD (Fig 3). Notably, the site appears to occupy a higher area of Pleistocene topography than the Tilbury area on the northern bank of the Thames, suggesting deeper channel reworking there during the Pleistocene (Fig 3). According to the cultural landscape model (Bates & Whittaker 2004; Stafford *et al* 2012), both areas will have been subject to inundation by the Mid-Mesolithic (Stage 3; Table 2), but the land around the application site may have persisted as a dry zone further into the Mesolithic than at Tilbury Fort.
- 4.2.5 Interestingly, BGS mapping shows several areas of Head deposits forming linear features on a north-south axis (Fig 4). These probably reflect the courses of late Pleistocene channels which drained off the higher terrace to the south into the floodplain where the application site is located. It is likely that the topographic trends suggested in Fig 3 reflect a complex drainage system operating in this part of the floodplain. Indeed, the area probably has remained fluvially complex as can be seen by the multiple drainage channel routes within the contemporary mapping today (Fig 1, right inset). It should be noted however, that the resolution of the early Holocene

topographic modelling at this stage (with so few data points) does not facilitate a projection of the courses of these channels.

Table 3: Facies 1 depths and elevation within the application site.

Facies 1	Depth (m bgl)	Elevation (m OD)
Average	13.50	-11.35
Maximum	13.50	-11.39
Minimum	13.50	-11.30

Facies 2: Holocene deposits

- 4.2.6 During the Holocene the land surface became increasingly waterlogged due to the knock on effects of rising RSL, and minerogenic deposits and peat accumulated across the application site (facies 2; Fig 5). These deposits represent Stages 3-5 in the cultural landscape model (Table 2; Bates & Whittaker 2004), and have high potential for the preservation of palaeoenvironmental proxy indicators (e.g. pollen, diatoms and ostracods) which can be used to reconstruct the past environment. Only BH01 and BH02 within the application site recorded the full Holocene sequence (Fig 5), which was found to be 11.40m and 12m thick respectively and 11.70m thick on average (Table 4).
- 4.2.7 The earliest deposits in the Holocene sequence, directly overlying the Pleistocene gravels, is organic silty clay in BH01 and sandy clay in BH02. These represent different depositional environments and suggests a complex local fluvial regime possibly related to the potential channels draining into the floodplain (Fig 4), or simply tidal channel activity throughout the Holocene. As shown in Fig 3 there may be a general decline in topography towards the east, although the difference on site between gravel surface elevations between BH01 and BH02 is very slight. As suggested above, it is possible that a palaeochannel ran to the east of the application site, which the sandy deposits recorded in BH02 may indicate. The organic clay in BH01 will have accumulated in a lower energy depositional environment, further away from the active channel zone. However, the exact courses of palaeochannels cannot be identified at this stage due to the paucity of data points.
- 4.2.8 Overlying the organic silty clay in BH01 is a thin deposit of clayey peat (0.20m thick) which is absent from BH02. Again, this indicates a more stable environment in this western end of site where significant vegetational growth was able to take place. This peat deposit is present from -9.49m to -9.29m OD which corresponds to the Tilbury II peat identified by Devoy (1979; Fig 5). In Devoy's borehole SB21/1, the location of which is shown in Fig 3, this unit was dated to the Mesolithic, 6083-5331 cal BC (Fig 5; Devoy 1979, 1982). Peat is a particularly good preservational environment in terms of ecofacts and artefacts and typically provides material suitable for radiocarbon dating. Recovery of Mesolithic peats is relatively rare across the Thames floodplain due to their depth, and they are significant in that they can provide an early, datable window into the earlier Holocene environment.
- 4.2.9 Above the thin clayey peat in BH01 and sandy clay in BH02 a thick deposit of silty clay was present, from approximately -9.5m OD (Fig 5). This may relate to the period of minerogenic deposition associated with rapidly rising sea levels in the later Mesolithic (Stage 3, Table 2; Bates & Whittaker 2004). Several of the window sample boreholes (WS01, WS02 and WS04) sampled the upper levels of this unit. This unit represents a relatively prolonged period of continuous and relatively low energy inundation.
- 4.2.10 Overlying this unit a thin layer of peat was identified at c. -3m OD in all the boreholes apart from WS03, which did not reach that level (Fig 5). This is a similar level to Devoy's Tilbury IV peat, which in SB21/2 was dated to 1736-1305 cal BC

(Devoy 1979, 1982). This date would place the peat layer in the Mid-Late Bronze Age, and possibly corresponds with the latter stages of a period of RSL rise hiatus and peat development identified as Stage 4 in the cultural landscape model (Table 2; Bates & Whittaker 2004). These peat deposits have the potential to preserve the remains of timber structures, such as trackways, which were used by prehistoric communities to traverse and access the floodplain, and examples of these are known throughout the Lower Thames (Meddens 1996).

- 4.2.11 The peat deposits identified in the boreholes are generally thin (no more than 0.30m thick) and less frequent compared to peats at Tilbury Fort (MOLA 2021; Fig 5). Also, whereas Devoy's sequence recognises five stages of peat development (Devoy 1979, 1982), only two peat units are recognised within the sequences recorded on site. This difference is probably related to a different depositional environment operating in the area of the application site on the south bank of the Thames to that on the north side, probably relating to variations in the local fluvial regime, such as a more active erosional fluvial regime on the south bank which may have impeded peat formation.
- 4.2.12 The upper layer of peat is overlain in the boreholes by further clay deposits which probably relate to renewed minerogenic deposition associated with Stage 5 of the cultural landscape model (Table 2; Bates & Whittaker 2004). At this stage, topographic variation is lost, and the tidal head moves up the Lower Thames, with a switch to full estuarine conditions defined by salt marsh and mudflats.

Table 4: Facies 2 depths and elevation within the application site.

.Facies 2 characteristics (site wide)	Thickness (m)	Depth (m bgl)	Elevation (m OD)
Average	11.70	1.55	0.57
Maximum	12.00	13.50	1.71
Minimum	11.40	13.50	0.01

Facies 3: Made ground

- 4.2.13 The thickness of made ground (facies 3) deposits vary from a maximum of 2.10m to a minimum of 0.82m, averaging 1.55m across the application site (Table 5; Fig 5). These deposits represent levelling and bedding installed for the construction of hardstanding which currently characterises the application site. These deposits directly overly the Holocene alluvial sequence and may have truncated the upper levels of the Holocene deposits to a small extent (Fig 5). The made ground represents 20th century activity and is therefore not archaeologically significant.

Table 5: Facies 3 depths and elevation within the application site.

Facies 3	Thickness (m)	Surface elevation (m OD)
Average	1.55	2.12
Maximum	2.10	2.53
Minimum	0.82	1.87

5 Assessment of potential

- 5.1.1 The deposit modelling of the subsurface stratigraphy can be used to help predict where archaeological remains might be found and where palaeoenvironmental deposits with potential for reconstructing past environments and human activity are likely to exist.
- 5.1.2 Although the model is considered a useful means of gaining a preliminary idea of the likely buried stratigraphy on the application site and the archaeological and palaeoenvironmental potential, it should not be taken as a full or correct interpretation of past environments. The deposit model is only intended to act as a tool to assist in identifying areas of archaeological interest and does not constitute a definitive statement about past environments and past human activity on the application site.
- 5.1.3 The Pleistocene deposits (facies 1) on the application site date to the late glacial period and were deposited within the cold climate braided river system of the late Pleistocene Thames. There is low potential for Palaeolithic material such as hand axes to be found within these deposits, but as they will be reworked from older terraces they would be considered *ex situ* and of low significance.
- 5.1.4 The application site is low lying on the floodplain of the Thames (Fig 4), and from the early Holocene will have been a mosaic of palaeochannels and backwaters. Given the low lying nature of the early Holocene surface, it is considered that there is a moderate to low potential for the survival of artefactual remains and soil horizons relating to Upper Palaeolithic and Mesolithic occupation of the landscape prior to inundation. Whereas other lower lying areas such as Tilbury Fort (MOLA 2021) may have become inundated earlier in the Mesolithic, the relatively higher ground around the application site (Fig 3) may have been an attractive location for human activity for a longer period. This artefactual material would likely take the form of flint scatters or burnt materials relating to temporary occupation, located in the deposits directly overlying the gravels.
- 5.1.5 The Holocene deposits of facies 2 relate to the changing environment of the floodplain and are of high archaeological potential, particularly in terms of palaeoenvironmental remains (e.g. pollen, diatoms, plant macrofossils, ostracods, molluscs, foraminifera, diatoms) which can be used to trace environmental changes over time and provide indirect evidence of human activity (e.g. woodland clearance and cereal cultivation) and hydrological change. Detailed palaeoenvironmental assessment carried out both at Tilbury (Devoy 1979, 1982) and at the Littlebrook site further upriver (Stastney *et al* 2021) demonstrates the potential of palaeoenvironmental reconstruction from the Holocene sequence.
- 5.1.6 Furthermore, organic remains preserved within these deposits, particularly the peats, can provide suitable material for radiocarbon dating which can provide a chronostratigraphic framework to the sequence. This would facilitate comparison between the sequence at the application site and other sequences assessed at sites throughout the Lower Thames, such as Devoy's work at Tilbury (Devoy 1979, 1982) and other geoarchaeological investigations at Tilbury (MOLA 2021), Purfleet (MOLA 2019) and Littlebrook (Stastney *et al* 2021).
- 5.1.7 As the site was periodically flooded from the Mesolithic, the area would never have been permanently settled, however, the floodplain deposits are considered to have a moderate to low potential for the preservation of artefactual remains relating to the exploitation of the rich wetland resources by human communities and activities associated with waterways. For example, peats are known to preserve evidence of timber trackways constructed by groups who sought to traverse the wetlands during

the prehistoric (Meddens 1996) as well as jetties, fishtraps or boats particularly relating to the historic period (MOLA 2017).

- 5.1.8 The overlying made ground deposits (facies 3) are modern in date and are of no archaeological interest, and negligible palaeoenvironmental potential.

6 Recommendations

6.1 Recommendations

- 6.1.1 The data has allowed an assessment to be made on the depositional sequence likely to be across the application site, but the lack of data points in the immediate area of the application site is a limitation. This new data adds to understanding of deposit sequences in this part of the Lower Thames floodplain and supports existing models. Future geotechnical or geoarchaeological work in the area may produce data which substantially alters the interpretation presented in this report. However, the interpretation of the depositional sequence has been aided by previous work in this part of the Lower Thames and wider modelling of regional palaeoenvironments, and therefore provides a strong indication of the nature of the underlying deposits and their archaeological and palaeoenvironmental potential.

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8 Figures

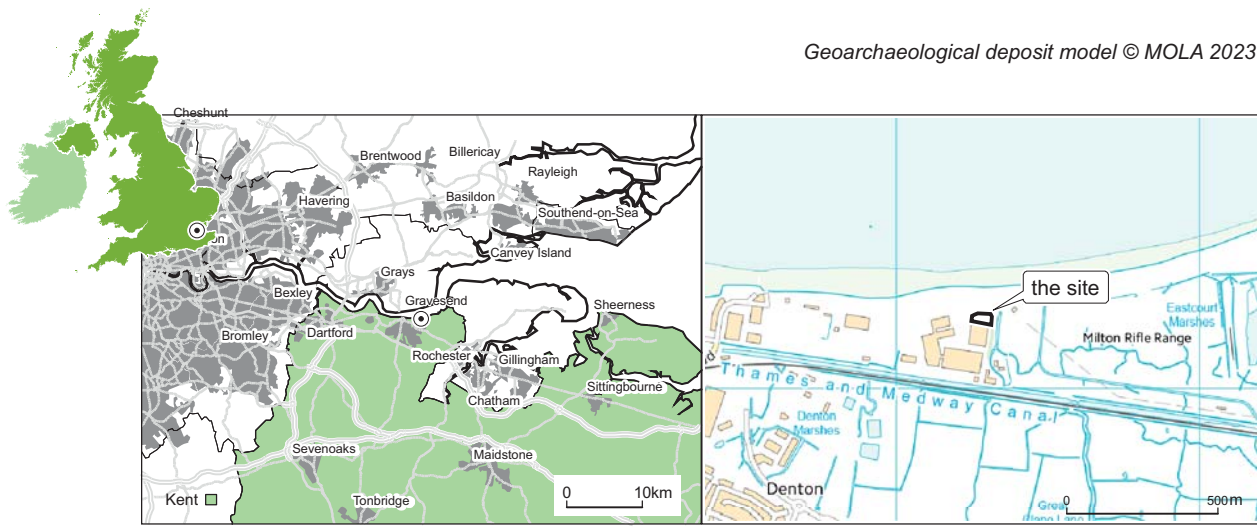


Fig 1 Site location



Fig 2 Boreholes and transect location

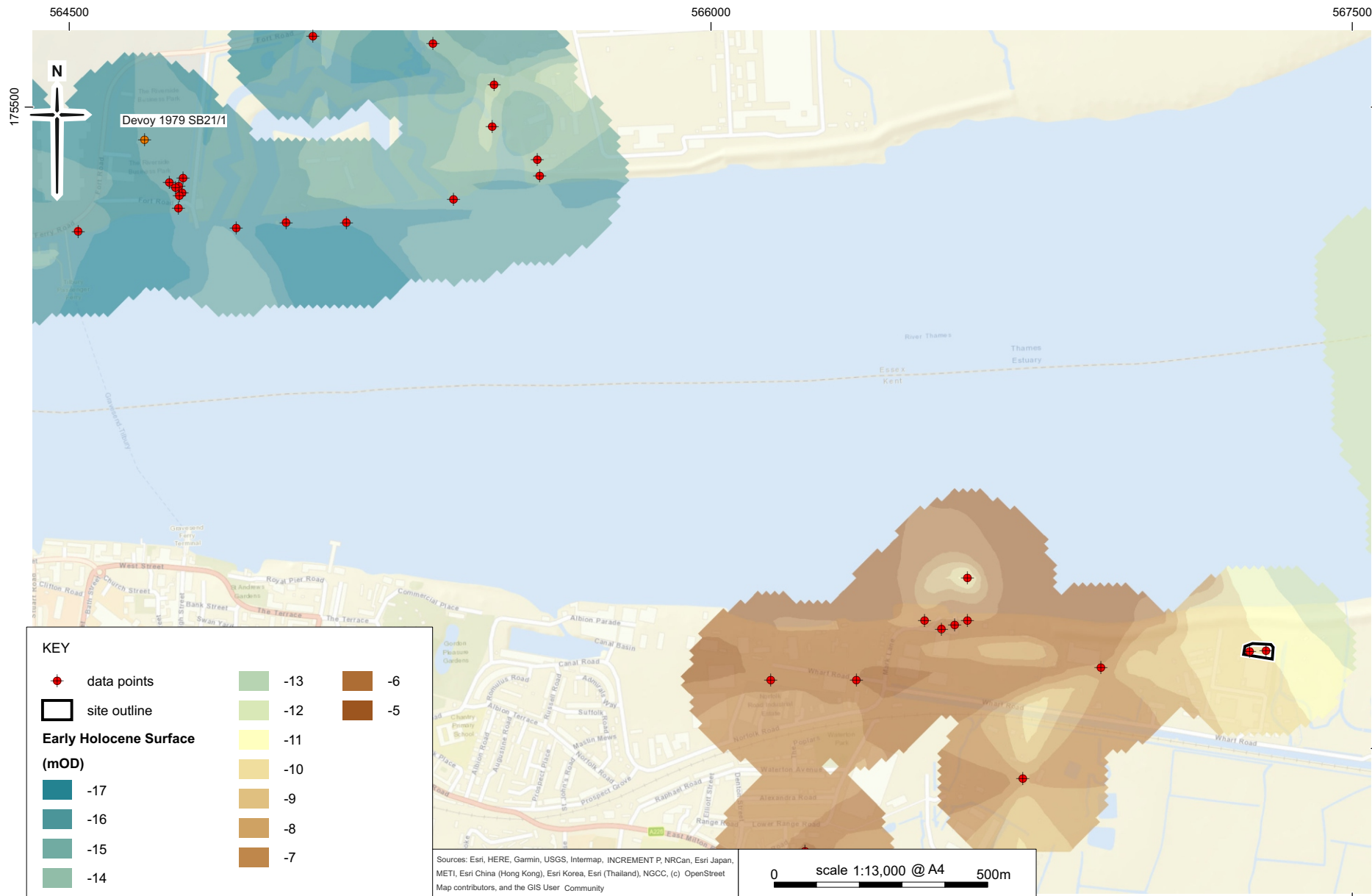


Fig 3 Early Holocene surface model

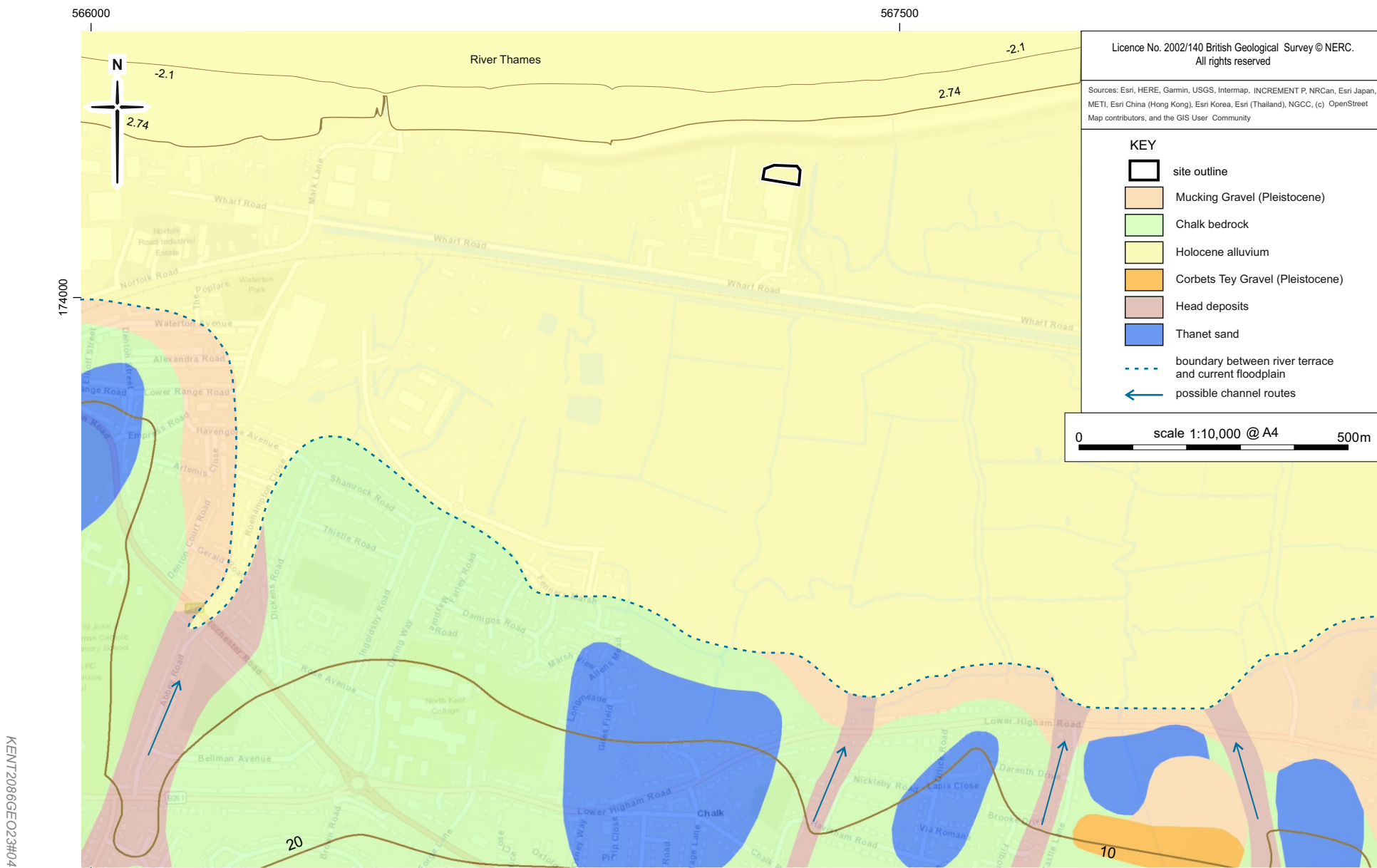


Fig 4 Underlying geology

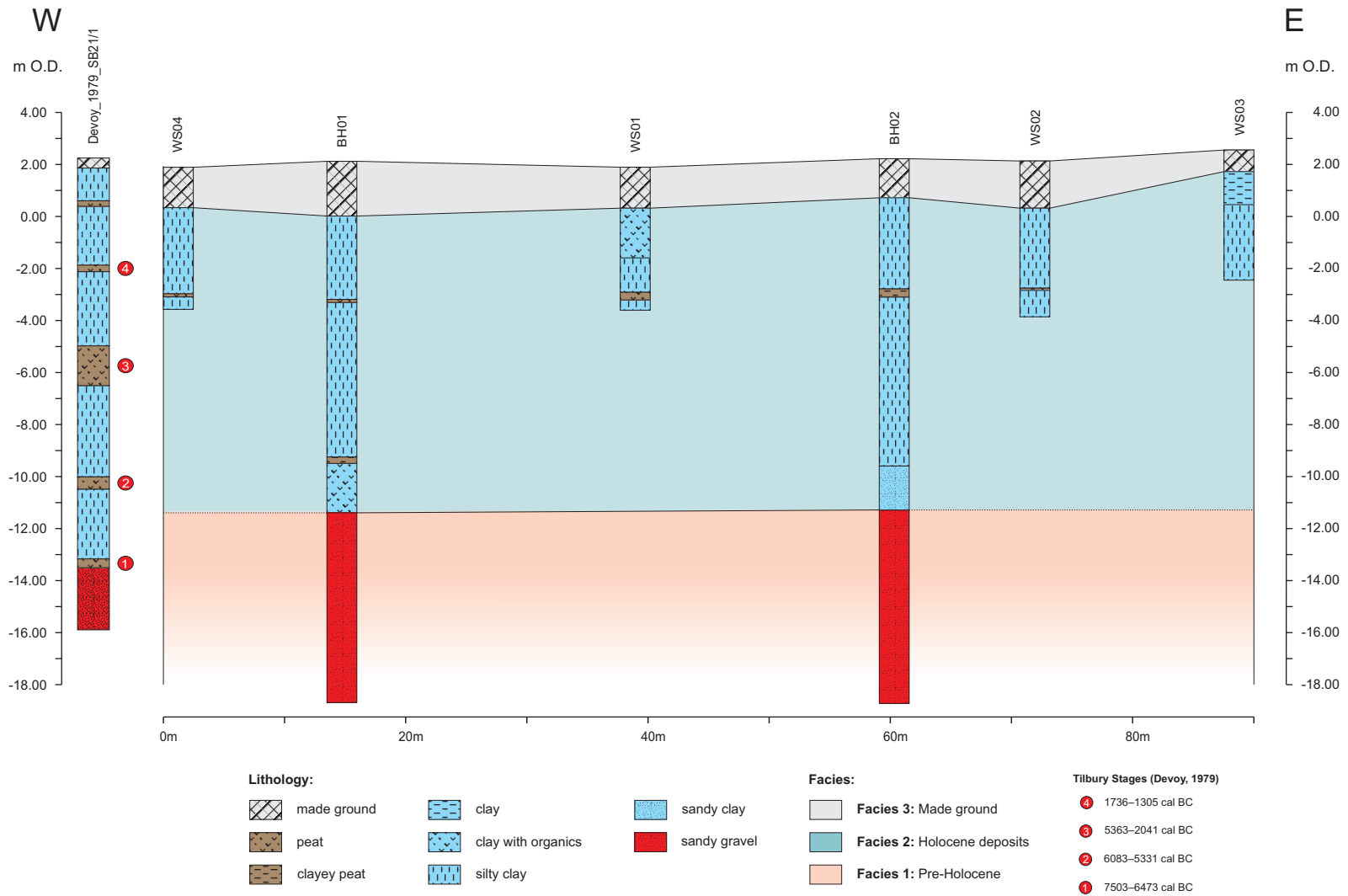


Fig 5 West-east transect through the site including Devoy's (1979) Tilbury borehole for comparison