C261 WORK PACKAGE ARCHAEOLOGY EARLY EAST

Updated Project Design
Pudding Mill Lane Portal (XSK10)

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Non-technical summary

This report forms an Updated Project Design (UPD) for work carried out by MOLA on behalf of Crossrail at the Pudding Mill Lane Portal (sitecode XSK10) and Ham and Wick (sitecode XTH12). MOLA's work at the site comprised several phases of Evaluation, Watching brief and Excavation carried out between January 2011 and July 2015. The main phases of work from west to east included two sewer access shafts and a pump chamber at Ham and Wick; and at Pudding Mill Lane the creation of a coffer dam in the River Lea and excavation below the river bed; a grout shaft on the west side of the portal; the creation of an Emergency Intervention Point (EIP) and Tunnel Boring Machine (TBM) reception chamber; three sections – or areas – of cut and cover tunnel and a covered ramp, and various enabling works (Table 1, Fig 1). Separate interim and fieldwork reports covering the results of this work have previously been prepared, and these should be consulted for the detailed results of the fieldwork.

This Updated Project Design brings together the results of all phases of work at the site and includes a site-wide geoarchaeolgoical assessment. The report sets out what post-excavation analysis work has been done so far; what work still needs to be done and why; and how and where the results of the excavation should be made public. The report is written and structured in a particular way to conform with the standards required of post-excavation analysis work as set out in *Management of Archaeological Projects* (English Heritage, 1991 and 1997) and the *Crossrail Central Archaeology Updated Project Design* (Crossrail 2013c; Doc No. CR-XRL-T1-STP-CR001-50001, Version 3.0, 20.05.13). More recent Historic England (previously English Hertitage) guidance, superseding MAP2 but embodying the same principles, is contained in *Management of Research Projects in the Historic Environment (MoRPHE) Project Planning Note 3*.

During the excavation of the EIP/TBM chamber, several phases of a timber structure dating to the medieval/Tudor period, possibly a fish trap, were recorded within the alluvium of the River Lea floodplain. It is proposed in this report to publish the results of the excavation as an article to be submitted to the *London Archaeologist*. The final decision lies with the Crossrail Project Archaeologist.

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1 Introduction

1.1 Organisation of the report

This report is written and structured in a particular way to conform with the standards required of post-excavation work by Historic England. All work has been carried out in accordance with the Crossrail Generic Written Scheme of Investigation (Crossrail 2012d; Doc No. CR-XRL-T1-XWI-CRG03-50001, Version 4.0, 25.09.12) the Crossrail Central Archaeology Updated Project Design (Crossrail 2013c; Doc No. CR-XRL-T1-STP-CR001-50001, Version 3.0, 20.05.13), and the documents listed below in Section 1.3.

The principles underlying the concept of post-excavation assessment and updated project design were established by Historic England (then English Heritage) in the Management of Archaeological Projects 2 (MAP2), (1991) and further developed in The Management of Research Projects in the Historic Environment (MoRPHE) (Historic England 2015), which is accompanied by specific advice on the management of archaeological projects in Project Planning Note 3: Archaeological Excavations (English Heritage 2008). MoRPHE stresses the importance of planning for the assessment of the results of fieldwork as part of the fieldwork phase of the project. It is recognised that not everything recovered from a site will have the same potential and significance, and it is through the process of assessment those elements that warrant further study can be identified, together with the necessary resources to complete analysis, dissemination and archiving (English Heritage 2008, para 4.2.1).

Following the introduction in Section 1, Section 2 provides a summary of what was known and understood of the topography, archaeology and history of the site and its immediate surroundings prior to the start of the archaeological investigation. It was this information which guided the original agreed research aims for the project, which are restated in Section 3. Section 4 provides a brief summary of the results of the archaeological work. A quantification of the site archive, including site records, finds and environmental material is given in Section 5. The specialist geoarchaeological assessment is is included in Section 6.

In Sections 7 and 8 the results of the data collection are brought together and assessed against the original project research aims, together with regional, national and international research frameworks in order to determine the significance and potential of the results, and to recommend an appropriate level of analysis and dissemination.

Section 9 forms the Updated Project Design. Revised research aims for the project are outlined in Section 9.1, together with a method statement and task list for the work required to achieve these aims and provide for dissemination of the results.

1.2 Site background

Crossrail is a new Cross-London Rail Link project which will provide transport routes across the south-east of England and London. The route will link Reading in the west with Shenfield in the north-east and Abbey Wood in the south-east. In central London, from Royal Oak in the west to Pudding Mill Lane and Royal Victoria Dock in the east, Crossrail will consist of a tunnelled section with seven new stations linked to the existing transport network.

The route involved excavation of the Pudding Mill Lane Portal, east of the River Lea, south of the Great Eastern Main Line railway embankment and about 1km south-west of Stratford Station, in the London Borough of Newham. The site extends from the River Lea in the west to Marshgate Lane in the east. The approximate centre of the main excavation area is at Ordnance Survey National Grid Reference 537750 183440.

1.3 Planning background

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

Notwithstanding these dis-applications, it is intended that agreements setting out the detail of the works and requiring relevant consultations and approvals of detail and of mitigation arrangements will be entered into by the nominated undertaker with the relevant local planning authorities and Historic England in relation to listed buildings and with the Department of Culture, Media and Sport (DCMS) and English Heritage in relation to Scheduled Ancient Monuments (SAMs).

The Crossrail mitigation response to archaeology is described in the Crossrail Generic WSI (Crossrail 2012d) and the detailed desk based assessment (DDBA; Crossrail 2008), and can be summarised as follows:

In the event that intact and important archaeological remains are identified at Crossrail worksites through this process, it may be preferable, where practicable, to preserve these where they are found (ie, preservation in situ).

However, because of the nature of major works projects such as Crossrail, experience of other similar projects suggests that preservation by record is usually the most appropriate method of dealing with archaeological finds.

Following an extensive Environmental Impact Assessment (EIA) supporting the Crossrail Bill, and the production of site-specific DDBAs, appropriate mitigation measures were scoped and specified in detail in individual project designs (site-specific WSIs – Written Schemes of Investigation) which were prepared in accordance with the principles set out in the Generic WSI, and developed in consultation with the relevant statutory authorities.

Archaeological information that is gained from fieldwork will be followed by analysis and publication of the results and will be transferred to an approved public receiving body.

This UPD has been prepared in accordance with the Crossrail Central Archaeology Updated Project Design (Crossrail 2013c; Doc No. CR-XRL-T1-STP-CR001-50001, Version 3.0, 20.05.13). All on-site archaeological work was carried out in accordance with the following documents:

- Crossrail, 2010 *Package C152 Pudding Mill Lane Portal, Archaeology Site-Specific Written Scheme of Investigation,* (Doc. No. C152-SWN-C2-RSP-CR094_PT002-0001, Version 10.0, 12.05.10)
- Crossrail, 2011 *C261 Archaeology Early East, Method Statement Archaeological Watching Briefs Pudding Mill Lane Portal* (Doc. No. C261-MLA-T1-GMS-CR094-50002, Version 2.0, 19.01.11)
- Crossrail, 2012a *Package C152 Pudding Mill Lane Portal, Addendum to WSI: Trial Trench Evaluation, Watching Brief & Detailed Excavation (XSK10)* (Doc. No. C152-SWN-C2-RSP-CR094_PT002-50001, Version 3.0, dated 19.03.12)
- Crossrail, 2012b *C261 Archaeology Early East: Method Statement Addendum Archaeological Targeted Watching Briefs on Grout Shaft and River Lea works, Pudding Mill Lane Portal* (C261-MLA-X-RGN-CR140-50090, Version 3.0 08.05.12)
- Crossrail, 2012c *C261 Archaeology Early East, Method Statement Archaeological Targeted Watching Briefs Pudding Mill Lane Portal* (Doc. No. C261-MLA-X-RGN-CR140-500036, Version 5.0, 04.09.12)

- Crossrail 2012d. Archaeology Generic Written Scheme of Investigation (Doc. No. CR-XRL-T1-XWI-CRG03-50001)
- Crossrail 2012e. Archaeology: Specification for Evaluation & Mitigation (including Watching Brief) (Doc. No. CRL1-XRL-T1-RSP-CRG03-50001)
- Crossrail 2013a *C261 Archaeology Early East, Method Statement, Archaeological Targeted Watching Brief on River Lea Works Pudding Mill Lane Portal* (Document Number: C261-MLA-X-RGN-CR140-50036 Version 6.0, 18.01.13)
- Crossrail 2014 *C261 Archaeology Early East Method Statement: Archaeological Targeted Watching Briefs Pudding Mill Lane Portal* (Doc. No. C261-MLA-T1-GMS-CRG03-50001 Version 2.0, 13.10.14)

1.4 Scope of the report

The results of all fieldwork carried out by Museum of London Archaeology (MOLA) for Crossrail at Pudding Mill Lane have previously been included in a number of Fieldwork Reports and an Enhanced Interim Statement. It is not the purpose of this document to repeat the results that have already been described in detail within these reports, but to bring together the work carried out to date, to assess the results of this work against the original research aims, and to make proposals for the Analysis and Publication of the significant archaeological remains from the site. The geoarchaeological potential and significance of the site has not previously been assessed, and so a geoarchaeological assessment is included in Section 6.

1.5 Circumstances and dates of fieldwork

This report covers several archaeological targeted watching briefs (TWBs) and general watching briefs (GWBs) carried out within the Pudding Mill Lane Portal, by Museum of London Archaeology (MOLA) under Crossrail contract C261 Archaeology Early East.

The work from west to east included the creation of a coffer dam in the River Lea and excavation below the river bed; a grout shaft on the west side of the portal; the creation of an Emergency Intervention Point (EIP) and Tunnel Boring Machine (TBM) reception chamber; three sections – or areas – of cut and cover tunnel and a covered ramp, and various enabling works (Table 1, Fig 1).

The first section of cut and cover tunnel (Section 1) was excavated immediately east of the EIP Chamber and both it and the EIP Chamber are the subject of an earlier interim report, together with General Watching Briefs on utilities diversions in Barbers Road (Doc. No. C261-MLA-X-RGN-CR140-50123). Subsequently, a General Watching Brief was carried out during remediation works south of the main portal at the National Grid Area bulk supply point, also subject of a separate fieldwork report (Doc No. C261-MLA-T1-RGN-CRG03-50029).

The excavation of the intermediate section of cut and cover tunnel (Section 2B) was followed by a hiatus during which the Docklands Light Railway (DLR) was diverted around the portal, and the final section of cut and cover tunnel (Section 3) was excavated between the DLR and Network Rail lines. A Targeted Watching Brief (TWB) was carried out during these works.

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

All fieldwork was conducted by MOLA Senior Archaeologists, David Sankey, Tim Johnston, Sam Pfizenmaier and Rob Hartle, between January 2011 and July 2015.

The event code (sitecode) is **XSK10**.

A further Targeted Watching Brief was carried out at Ham and Wick (sitecode **XTH12**) during the excavation of two Sewer Access Shafts and a Pump Chamber, but encountered no archaeological remains, and is the subject of a separate fieldwork report (Doc No. C261-MLA-T1-RGN-CRG03-50007).

1.6 Previous Reports

The principal previous Crossrail studies are as follows:

- Crossrail, February 2005a *Environmental Statement*
- Crossrail, February 2005b *Assessment of Archaeology Impacts, Technical Report. Part 2 of 6, Central Section: Westbourne Park to Stratford and Isle of Dogs.* 1E0318-C1E00-00001 [Specialist Technical Report (STR)]
- Crossrail, 2008 *Archaeology Detailed Desk Based Assessment, Pudding Mill Lane Portal* (Doc. No. CR-SD-CT1-EN-SR-00001, Version 1.0, 21.04.08)
- Crossrail, 2013b *C261 Archaeology Early East, Enhanced Interim Statement: Archaeological Excavation on EIP/TBM Chamber and Watching Briefs on Cut and Cover Section 1 and Barbers Road Utilities, Pudding Mill Lane XSK10* (Doc. No. C261-MLA-X-RGN-CR140-50123, Version 2.0, 06.02.13)
- Crossrail, 2015 *C261 Archaeology Early East, Ham and Wick Targeted Watching Brief Fieldwork Report (XTH12)* (Doc No. C261-MLA-T1-RGN-CRG03-50007, Version 2.0, 18.03.15)
- Crossrail, 2016a *C261 Archaeology Early East, Fieldwork Report: Archaeological General Watching Brief, Pudding Mill Lane Portal, Excavation works for National Grid (XSK10)* (Doc. No. C261-MLA-T1-RGN-CRG03-50029, Version 4.0, 20.01.16)
- Crossrail, 2016b C261 Archaeology Early East, Fieldwork Report: Archaeological Watching Briefs, Pudding Mill Lane Portal (XSK10) Grout Shaft, River Lea Coffer Dam, Cut and Cover Sections 2B and 3 TWB, and Utilities GWB (Doc. No. C261-MLA-T1-RGN-CRG03-50033, Version 2.0, 11.04.16)

In addition a Fieldwork Report was completed following an archaeological watching brief during ground investigations at the site commissioned by the National Grid, under the sitecode **PDN14** (MOLA, 2014 *WorleyParsons for National Grid, Fieldwork Report, Archaeological Watching Brief on Ground Investigations Bulk Supply Point, Pudding Mill Lane*, v1.0 10.11.14). This report was included as an appendix to the Fieldwork Report for the National Grid GWB (Crossrail 2016, Doc. No. C261-MLA-T1-RGN-CRG03-50029).

The above cited reports are all available from the London Archaeological Archive and Research Centre (LAARC).

Table 1 Site Details

Task	Type	Previous report
EIP/TBM Chamber	Excavation	Crossrail 2013b
Cut and Cover Tunnel Section 1	TWB	Crossrail 2013b
Sewer Diversion	GWB	Crossrail 2013b
11Kv electric cable diversion	GWB	Crossrail 2013b
Grout Shaft TWB	TWB	Crossrail 2016b
Cut and Cover 2B TWB	TWB	Crossrail 2016b
River Lea works, Coffer Dam TWB	TWB	Crossrail 2016b
Cut and Cover 3 (and covered ramp) TWB	TWB	Crossrail 2016b
Enabling Works (Services Diversion and City Mill River Works)	GWB	Crossrail 2016b
Excavation Works for National Grid	GWB	Crossrail 2016a
Ham and Wick Sewer Access Shafts and Pump Chamber	TWB	Crossrail 2015

2 Topographical, historical and archaeological background

The Pudding Mill Lane Portal site is located south of the Great Eastern Main Line (GEML) railway embankment and lies mostly to the east of the River Lea about 1km south-west of Stratford Station (Fig 1). The majority of the Crossrail works discussed in this report fall within the London Borough Newham, although a small number lie west of the Lea within the London Borough Tower Hamlets. Present ground levels vary considerably due to railway and other construction, from *c* 101m to 105m ATD in the floodplain to the east of the River Lea, rising up to 104m to 110m ATD on the gravel terraces west of the Lea.

The geology of the site consists of a Holocene alluvial sequence within the floodplain of the River Lea. The gravel topography underlying the site comprises intercutting braided channels with raised gravel areas between them, with organic deposits at channel margins. One such island has been identified to the east of the site. To the east of the Pudding Mill Lane Portal, features of Late Bronze Age–Early Iron Age date were observed cutting into a relict land surface at 101.67m ATD, with a later prehistoric land surface observed at 101.84m ATD (MoLAS-PCA 2008, Olympics Planning Delivery Zone 8: a report on the evaluation, unpublished MOL report).

As the river channels dried, a more stable marsh environment of wet woodland developed that was generally unattractive to human activity (MoLAS-PCA 2008). From the later medieval period onwards the area exhibits some evidence for increased human activity. Within the EIP/TBM chamber, wattle structures were observed that have been tentatively interpreted as the remains of multiple phases of a medieval/Tudor fish weir (Crossrail 2013b).

In the 19th and 20th centuries layers of re-deposited alluvium demonstrate the early ground raising that occurred prior to the landscaping that resulted in the topography of the site today. The site developed significantly in the post-medieval period. The waterways were used as a means of transport and a source of power, and the construction of the railway also brought significant changes to the area. Historic maps show little activity on the site until the 19th century. The Stanford map of 1862 shows development on the site for the first time, which includes the construction of the embanked Great Eastern Railway to the north, a Gas works, soap works and a small Tar works as well as other unlabelled buildings. The site continued to be developed and used for light industry during the 19th and 20th centuries as shown on later historic maps.

3 Original research aims

The following overall research themes and objectives for work at the Pudding Mill Lane portal were established in previous reports. The research themes set out below are broad areas of research to which it was thought the results of work at Pudding Mill Lane may be able to contribute. The research objectives theat follow comprise more focused questions, which it was hoped the fieldwork may be able to answer. The fieldwork objectives have been numbered for the purposes of this report.

3.1 Overall Research Themes

The original aims and objectives were listed in the WSI (Crossrail 2010) and stated that 'data collected from archaeological investigation and mitigation may contribute to the following research themes':

- Understanding London's hydrology, river systems and tributaries and the relationship between rivers and floodplains;
- Understanding the relationship between landscape, river and settlement;
- Using the understanding that comes from reconstructing London's past to contribute to wider environmental studies about contemporary concerns such as: climate change; sea level fluctuations; flood defence initiatives; links between pollution, health and quality of life;
- Understanding the reasons for evolution of the road systems, street layouts, river crossings and ferries, and their importance as engines of development and change;
- Understanding the nature and meaning of the deposition of metalwork in the Thames and at the headwaters of river tributaries;
- Understanding how water supply and drainage provision were installed and managed;
- Studying the correlation between sites associated with watercourses and meander bends, so as to understand the origin of settlements; and
- Understanding the evolving character of development in central London, in comparison to other riverine settlements.

Furthermore, the potential at Pudding Mill Lane for geo-archaeological and palaeoenvironmental deposits to be recovered will contribute to the following themes:

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

Any evidence for Post-medieval industrial activity will contribute to the following themes:

- Charting how and why different parts of London developed as specialist producers, and understanding the implications of this for London as a world city;
- Establishing how daily work and life in London reflected and contributed to the rise of London as the commercial centre of the British Empire, and to its continued eminence as a world city thereafter; and
- Examining the success with which small towns in the London region adapted to the capital's growth.

3.2 Fieldwork Objectives

The following overall objectives for the archaeological TWB investigations were set out within the Addendum to the WSI (Crossrail 2012a, Section 2.2):

ORA 1 To record evidence for post medieval industrial buildings and structures noted in the DDBA and in particular the remains of a large building with landscaped grounds recorded on the 1867AD OS edition (within Section 1 of the cut and cover tunnel).

ORA 2 To inspect, record and sample profiles in the geo-archaeological sequence of deposits present within the site to understand the site topography and date its phased development.

ORA 3 To analyse the palaeo-environmental evidence recovered from the works and contribute evidence to inform the Lea Valley Pleistocene and Holocene archaeological resource.

ORA 4 To inspect the sequence of post Pleistocene alluvial organic deposits and clay silt units for prehistoric, Roman and Medieval archaeological remains at channel edge and areas of higher ground (land and channel management, settlement and industry).

ORA 5 To identify record and if appropriate recover, any archaeological artefacts (vessels, structural remains and small finds) preserved in the deeper channel areas.

3.3 Task-specific fieldwork objectives

River Lea works

Additionally, the following fieldwork objectives were identified within the Method Statement relating to works within the River Lea channel and on the west side of the River Lea (Crossrail 2013, Section 3.3.2):

ORA 6 [If required] To record [EH Level 2] the remains of the historic wharf as they are exposed during demolition and groundworks on the western side of the River Lea: item [6] in Crossrail 2010, section 5.5.

ORA 7 To observe and record the fabric and construction details of any wharves revealed during the construction of two sheet pile coffer dams.

ORA 8 To observe and record, and if required take soil samples from, the deposits between ground level and the top of the river terrace gravels.

And also:

ORA 9 To inspect, record and sample profiles in the geo-archaeological sequence of deposits present within the site to understand the site topography and date its phased development.

ORA 10 To analyse the palaeo-environmental evidence recovered from the works and contribute evidence to inform the Lea Valley Pleistocene and Holocene archaeological resource.

Cut and Cover tunnel (Stage 3) and covered ramp

The following task-specific research questions were also identified within the Method Statement relating to the Cut and Cover tunnel Stage 3 and covered ramp (Crossrail 2014, Section 3.3.3):

ORA 11 Are any prehistoric land surfaces identified, and what is their date? If prehistoric land surfaces are present, are they contemporary with surfaces previously identified at Pudding Mill Lane (MoLAS-PCA 2008, Trench PDZ8.04/5.35(C))?

ORA 12 Can information about the location and extent of the gravel island identified during previous investigations and boreholes in the area of Pudding Mill Lane be refined?

ORA 13 Is there any direct or indirect evidence for prehistoric activity (such as artefacts and structures, or plant microfossil and macrofossil evidence)?

ORA 14 Is there evidence for the formation of peat in marginal areas, and at what date did it start and cease to form?

ORA 15 Within any later alluvial deposits, is it possible to identify evidence for anthropogenic management of the increasingly wet and marshy landscape?

General watching brief

The following site-specific objectives were set out within the *Addendum to Method Statement Archaeological General Watching Briefs Pudding Mill Lane Portal* (Doc. No. C261-MLA-T1-GMS-CRG03-50002, Version 2.0, 01.12.14):

ORA 16 To record the archaeological sequence (as restricted by contamination), mitigating the impact of the works.

ORA 17 To identify the rail lines and the associated industrial archaeological features, allowing them to be related to any future work on the site.

ORA 18 To identify the levels and nature of the Holocene alluvial sequence (if exposed in this work).

ORA 19 To compare the results of this general watching brief with those of the earlier and future archaeological fieldwork in and around Pudding Mill Lane.

4 Site sequence: interim statement on field work

The archaeological and geoarchaeological remains recorded during fieldwork at Pudding Mill Lane are reported on in detail in previous Fieldwork Reports (Crossrail 2016a, 2016b) and an Enhanced Interim Statement (Crossrail 2013). To summarise, the most significant archaeological remains were encountered during the excavation of the EIP/TBM chamber in the western part of the site (Crossrail 2013). Excavation revealed several phases of a medieval/Tudor structure interpreted as a possible fish weir, cut into and sealed by alluvial deposits of the River Lea. Radiocarbon dating of the timber stakes associated with the structure(s) produced calibrated dates ranging from 1262–1633 (at 98.4% probability).

Alluvium of similar appearance was recorded across the site during several phases of watching brief, but dating evidence for its deposition was extremely limited. A feature (possibly a natural channel) was recorded below the alluvium and sampled at the east end of the Cut and Cover tunnel area 2B (Crossrail 2016b).

19th and 20th century structural remains associated with the industrial development of the area following the construction of the railway were recorded across the National Grid area (Crossrail 2016a), and probable 19th or 20th century timbers were also recorded at two locations (Crossrail 2016b).

5 Quantification

5.1 Post-excavation review

The following tasks have been completed for assessment:

— All plans digitised

— All provisional ceramic dating done

— All finds recorded and reported on within previous fieldwork/interim reports

— C14 dating of timbers

The following work should be done at the next step of analysis:

— site matrix to be established on BONN

— subgrouping to be completed

— establish final group structure

— establish land use sequence and diagrams

— all photographs to be cross referenced and indexed

5.2 The site archive and assessment: stratigraphic

Numbers of contexts, plans, sections, photographs for each of the site codes which form part of the Assessment.

Type	Description	Quantity	Notes
Contexts	All phases	165	Includes 99 timber sheets
Plans	'A4' 1:20 (no. of sheets)	10	10 multi-context plans on 34 sheets; digital topographic survey
Sections	'A4'	9	9 sections on 11 sheets
Timbers	'A4'	50	50 drawings on 27 sheets
Environmental	A4	38	
Trench sheets	A4	12	
Photographs	Site photographs	521	Digital

Table 2 Stratigraphic archive

5.3 Site archive and assessment: finds and environmental

Category	Description	Weight
Building material		1.370kg
Post-Roman pottery	40 sherds	4.033kg
Accessioned finds	7 items (4 clay tobacco pipe, 1 glass, 1 iron, 1 lead)	NA
Bulk glass		1.135kg
Animal bone	31 hand-collected fragments; two archive boxes	*c* 7.500kg
Bulk samples	Flots and retained soil from 9 bulk samples	

Table 3 Finds and environmental archive general summary

6 Geoarchaeological Assessment

By Virgil Yendell

6.1 Introduction

This specialist report provides the results of the geoarchaeological assessment of observations and sections recorded during all phases of archaeological investigations at Pudding Mill Lane (XSK10). This assessment does not include any work on palaeoenvironmental proxies (e.g. pollen, diatoms and ostracods) or radiocarbon dating as it is envisaged that such work will be undertaken during the analysis phase. As such this assessment focuses upon on the site-wide deposit sequence and broadly inferred palaeo-landscape.

On-site methodology

On site, detailed descriptions of exposed deposit sequences were only possible where logistical and safety concerns allowed. As such the majority of the deposit logs recorded lacked some detail, including the greater distinction between organic and inorganic bands within the alluvial clay. When circumstances allowed more detailed recording was possible, and description monolith tins were placed vertically into the side of exposed sections in order to retrieve continuous stratigraphic samples. The number of tins used was dependent upon the depth and/or significance of the stratigraphic sequence and its suitability for sampling. Each monolith tin was plotted on section drawings and related to Above Tunnel Datum (m ATD). A preliminary interpretation of the soil and sediment characteristics of the sequences was made and an overview of the stratigraphy produced. All of the sediments examined were described according to standard sedimentary criteria loosely following Jones et al (1999) and Tucker (1988) (relating to colour, compaction, texture, structure, bedding, inclusions, and clast-size). The monolith samples were sealed, labelled and kept in controlled storage during the assessment and analysis stages of the work.

Off-site methodology

The sequence of deposits was logged and entered into a digital database (Rockworks15), which was used to compare the stratigraphy across the site. Cross-sections were drawn through the data points and correlations were made between key deposits which were then interpreted into facies (a series of site-wide deposits which are representative of certain environments), and a preliminary attempt was made to impose distinct chronological periods.

The Rockworks data was then transferred to ArcGIS v.10.1 and a topographic plot of the early Holocene surface was created. Although a certain amount of reworking of the gravel deposit has taken place over time this topographic plot provides an approximation of the early Holocene (i.e. the early Mesolithic, *c* 10 000 years ago) landsurface. This assessment focuses upon sequences from cut and cover 2b and 3, Evaluation trench section 1, the grout shaft and the coffer dam and a number of broader descriptions taken from the watching brief in general. Deposit descriptions made during the watching brief are supported by sub-surface deposit data from previous investigations in the area that provide more detail in the wider landscape. The locations of the data points are provided on Fig 4, an elevation plot of the surface of the gravels (the early Holocene topography) in Fig 5, and a south-west to north-east transect showing the deposit sequence across the site in Fig 6.

6.2 Geoarchaeological discussion

The site lies within the western part of the floodplain of the River Lea, atop the Shepperton Gravels/Lea Valley Gravels overlain by varying finely grained minerogenic (clay and silt) and organic deposits representing different floodplain environs and processes.

Facies 1 Pleistocene gravels

The site lies within the wider landscape of the western Lea Valley, with the lowest gravels signifying the main thread of the early Holocene River Lea, *c* 300m to the east of the site and outside of the area considered in Fig 5. The site lies upon the floodplain of the river, with minor channels of the early Holocene river flanking the site to the east and west. The south-western limit of the site appears to lie either within or on the margins of the western minor channel or backwater whilst the north-eastern half of the site is situated upon a low island within the floodplain (Fig 5, Fig 6).

The late Pleistocene gravels forming the Lea valley were laid down during the end of the last glacial period as the glacial outwash waters abated as the climate ameliorated (Corcoran et al 2011). To the west, the edge of the Lea valley rises to *c* 110m ATD approximately 500m from the site and down to 96m ATD 300m east of the site near the main river thread. Within the site the gravel surface was recorded at *c* 99m ATD in the south-west where the western minor channel/backwater margins are located, rising gradually to 100m OD outside of the channel and atop the floodplain, with an even more gradual rise to over 101m OD atop the low floodplain island in the north-east of the site and a final drop down to the floodplain at 100.5m OD in the north east of the site. The slope of the southern/south-western edge of the early Holocene floodplain island is far more gradual than the eastern and western slopes (Fig 5). Being on the downstream end of the island the effect of erosion would probably have been less. Flow around the southern edge of the island may have been sluggish or intermittent with the western channel more akin to a pooling backwater in the early Holocene than a flowing channel. This interpretation is suggested by the general elevation of the floodplain (*c* 100 to 101m ATD) to the south of the island and the absence of any low channel areas as found in the deepest parts of the minor and major channel routes, despite a reasonable coverage of data points.

During the early prehistoric period as glacial waters abated water flow separated into a network of channels formed across the relatively flat floodplain separated by gravel and sand bars and larger islands, being remnants of the glacial outwash deposits. Evidence for prehistoric activity has been recorded on similar areas of raised gravel within the Lea Valley (Corcoran et al 2011). Immediately to the east of the site, features of Late Bronze Age–Early Iron Age date were observed cutting into a relict land surface at 101.67m ATD, with a later prehistoric land surface observed at 101.84m ATD (MoLAS-PCA 2008). However, on the whole the surface of the early Holocene island recorded at this site appears to be slightly below this level (under 101.5m ATD, Fig 5). The most likely interpretation is that this gravel island was inundated during the Late Bronze Age. Age depth modelling of radiocarbon dated peats directly overlying gravel in the mid to lower Thames does suggest that by the Late Bronze Age regional inundation driven by rising RSL (Relative Sea Level) would be at these elevations (Stafford et al 2012) and this is confirmed at other locations in the Lea Valley (Corcoran et al 2011). Another suggestion (pers com Dave Sankey) is that during the later Holocene the main route of the River Lea migrated across its floodplain from the east, moving westward across the area that would have been the early Holocene island and eroded any evidence of earlier prehistoric soil formation or prehistoric human activity. The latter suggestion appears less likely and will be discussed further in the section below.

Facies 2 Prehistoric to Late medieval alluvium

A preliminary broad Holocene time frame has been applied to the predominantly non-organic fine grained minerogenic sequence. Significant differences in the elevation of the underlying early Holocene surface (signified by the top of the pre- Holocene gravels) across the site have identified a minor route channel within the early Holocene Lea Valley in the south west of the site (Fig 5, Fig 6), which aligns roughly with the modern River Lea. The depression the channel formed in is filled with clay, indicating the natural silting of this backwater or minor channel. The nature of the silting could be suggestive of a period of landscape stability and slow accumulation of clays within the lower-lying channel areas during the Mesolithic, although the elevation (99m ATD) is somewhat higher than the deepest parts of the minor and major early Holocene channels which may suggest that the area is situated on the channel margins or within a backwater, and that the silting up is likely to have occurred later in the prehistoric period.

In the west of the site, within Evaluation section 1 and in the very north of the site, near British Geological Survey borehole tq38se1493 (Fig 3, Fig 6), the clays accumulated between 100 and 101m ATD may be indicative of a return to more unstable landscape conditions and an increase in sedimentation or waterlogging, possibly connected to the sea level fluctuations that led to the widespread development of peat across the wider Thames valley during the Mesolithic to Iron Age, and possibly to the medieval period. On the whole these sediments are more minerogenic than organic, but organic sediments were recorded directly on the surface of the gravels in Evaluation section 1 (Fig 3), and an indication of the date of these sediments should be acquired (via radiocarbon dating or palaeoenvironmental proxy) in order to ascertain when the early Holocene island began to be inundated, whether these are prehistoric or historic organic sediments, and whether they record any indirect evidence of human activity (indications of agriculture in the area via pollen etc). Possible remains of a fish weir were found within these basal organic sediments and the overlying minerogenic deposits, but whether these are contemporary with the basal organic deposits is not certain. The piles of the fish weir were radiocarbon dated to the late medieval/Tudor periods (Crossrail 2013b) but it is possible that these were driven from a higher level, particularly considering the horizontal parts of the wooden fish weir were recorded above 101m ATD (Crossrail 2013b). Waterlogging and channel abandonment drove peat formation across the Lea Valley but unlike that of the Thames Valley where Mesolithic deposits were drowned and eroded out in the Lea Valley they survived and these units still have the potential to represent this Mesolithic preservation.

No further records of soil or waterlogged wetland soils developing within or directly on the gravel surface were made. The possibility that any such prehistoric deposits have been eroded away has been previously discussed (see facies 1) and there is some chance that a later prehistoric to historic meander of the River Lea laterally migrated across what was once the early Holocene island and eroded away the earlier prehistoric sediments. Dating of the organic deposits mentioned in the previous paragraph as well as additional dating and palaeoenvironmental work on the lower parts of the alluvial and organic sequence across the site would indicate if there is any merit to this interpretation.

The deposits above *c* 101m ATD are in many cases a continuation of the fine grained alluvial deposition seen at lower levels. Across the Thames valley such deposition is associated with a regional trend for rising water levels as a result of relative sea level (RSL) rise which created a gradual widespread transition from marshland to mudflats/saltmarsh as alluvium was intermittently deposited on the floodplain from the very late prehistoric/early Roman period at the earliest.

Such alluvial deposition would have made occupation on the floodplain unlikely, as even the higher areas of the early Holocene island were inundated with clay and silt deposition. Even so the alluvial floodplain would have been suitable for some activities such as pasturing animals, fish traps, osier beds, retting pits, to which feature [123] and the fish weir may be related. As increased waterlogging drove a general trend towards the abandonment of such activities on the marginal floodplains, the ditches would have ceased to be maintained allowing for the silting up of features such as [123]. The lowest fills of feature [123] may contain palaeoenvironmental indications of its primary use as well as other human activities (such as vegetation clearance, farming and drainage management) occurring in the wider area.

6.3 Conclusion and recommendations

The site wide deposit sequence has been characterised into 2 facies summarised below.

- Facies 1 is formed of last Pleistocene gravels representing the floodplain of the River Lea with minor channels of the early Holocene river flanking the site to the east and west. The south western limits of the site appear to lie within or on the margins of the western minor channel or backwater (Fig 5 and Fig 6) whilst the north eastern half of the site is situated upon a low island within the Lea Valley floodplain. The gravel surface was recorded around 99m ATD in the south west where the western minor channel or backwater margins are located, rising to 100m OD outside of the channel and atop the floodplain, with a more gradual rise to over 101m OD atop the early Holocene low floodplain island in the north east of the site and a final drop down to the floodplain at 100.5m OD in the north east of the site. The surface of the early Holocene island

recorded on the site is marginally lower than at adjacent sites, which provided evidence for Bronze Age/Iron Age activity. This could have resulted in the inundation of the site occurring earlier than at other nearby and contemporary dry land human activity levels. This facies contains no palaeoenvironmental potential.

- Facies 2 includes alluvial clay and organic deposits of a broad prehistoric and historic date. Low lying areas in the south-west of the site have the greatest potential for recording earlier prehistoric deposits and palaeoenvironmental evidence. Thin organic sediments are recorded directly on the surface of the gravels and despite their proximity to the medieval/Tudor fish weir (Crossrail 2013b), independent dating should be undertaken (via radiocarbon dating or palaeoenvironmental proxy) to investigate the nature and date of the inundation of the island. Radiocarbon dating and palaeoenvironmental work on additional parts of the lower sequence would help to investigate the suggestion that a later prehistoric or historic meander of the River Lea eroded away earlier prehistoric sediments. The alluvial deposition represented by facies 2 would have made occupation on the floodplain unlikely, but some agricultural activities (e.g. pasture, fish traps, osier beds, retting pits) would have been possible. The lowest fills of feature [123] may provide palaeoenvironmental indications of its primary use as well as other human activities (such as vegetation clearance, farming and drainage management) occurring in the wider area.

7 Potential of the data

7.1 Realisation of the original research aims

Fieldwork Objectives

The following overall objectives for the archaeological TWB investigations were set out within the Addendum to the WSI (Crossrail 2012a, Section 2.2):

ORA 1 To record evidence for post medieval industrial buildings and structures noted in the DDBA and in particular the remains of a large building with landscaped grounds recorded on the 1867AD OS edition (within Section 1 of the cut and cover tunnel).

Within Section 1 of the Cut and Cover tunnel, a fragment of brick foundation [114] may be part of a building shown on the 1862 Stanford map; possibly part of the Soap Works.Further post-medieval structural remains were identified during the GWB of the National Grid site.

ORA 2 To inspect, record and sample profiles in the geo-archaeological sequence of deposits present within the site to understand the site topography and date its phased development.

The alluvial sequence was inspected and recorded across the TWB investigations, and samples were taken alongside detailed records within the EIP/TBM chamber

ORA 3 To analyse the palaeo-environmental evidence recovered from the works and contribute evidence to inform the Lea Valley Pleistocene and Holocene archaeological resource.

An initial assessment has been made of the potential of the geoarchaeological evidence from the site. Further analysis work will be required to realise this potential.

ORA 4 To inspect the sequence of post Pleistocene alluvial organic deposits and clay silt units for prehistoric, Roman and Medieval archaeological remains at channel edge and areas of higher ground (land and channel management, settlement and industry).

The holocence alluvial sequence was inspected for archaeological remains across the site. Medieval/Tudor structural remains associated with a possible fish trap at the channel margins were recorded within the EIP/TBM chamber. A cut feature [123] was observed sealed below layers of alluvium within Cut and Cover 3. This contained no finds, and is of uncertain date and function.

ORA 5 To identify record and if appropriate recover, any archaeological artefacts (vessels, structural remains and small finds) preserved in the deeper channel areas.

No remains were recorded in deeper channel areas.

Task-specific fieldwork objectives

River Lea works

Additionally, the following fieldwork objectives were identified within the Method Statement relating to works within the River Lea channel and on the west side of the River Lea (Crossrail 2013, Section 3.3.2):

ORA 6 [If required] To record [EH Level 2] the remains of the historic wharf as they are exposed during demolition and groundworks on the western side of the River Lea: item [6] in Crossrail 2010, section 5.5.

Not required.

ORA 7 To observe and record the fabric and construction details of any wharves revealed during the construction of two sheet pile coffer dams.

No wharves were observed during this work.

ORA 8 To observe and record, and if required take soil samples from, the deposits between ground level and the top of the river terrace gravels.

The alluvial sequence was observed and recorded from a temporary bridge. Alluvial clay was observed between 102.08m ATD and 99.25m ATD, with gravel recoprded at 99.25m. The site conditions precluded taking samples of the alluvium within the River Lea.

ORA 9 To inspect, record and sample profiles in the geo-archaeological sequence of deposits present within the site to understand the site topography and date its phased development.

Although general observations and records were made during the excavation of the coffer dam, it was not possible to closely inspect, record and sample the geoarchaeological sequence in this area.

ORA 10 To analyse the palaeo-environmental evidence recovered from the works and contribute evidence to inform the Lea Valley Pleistocene and Holocene archaeological resource.

No palaeoenvironmental remains were recovered during the work.

Cut and Cover tunnel (Stage 3) and covered ramp

The following task-specific research questions were also identified within the Method Statement relating to the Cut and Cover tunnel Stage 3 and covered ramp (Crossrail 2014, Section 3.3.3):

ORA 11 Are any prehistoric land surfaces identified, and what is their date? If prehistoric land surfaces are present, are they contemporary with surfaces previously identified at Pudding Mill Lane (MoLAS-PCA 2008, Trench PDZ8.04/5.35(C))?

No prehistoric land surfaces were identified during the work. Immediately to the east of the site, features of Late Bronze Age–Early Iron Age date were observed cutting into a relict land surface at 101.67m ATD, with a later prehistoric land surface observed at 101.84m ATD (MoLAS-PCA 2008). However, on the whole the surface of the early Holocene island recorded at this site appears to be slightly below this level (under 101.5m ATD, Fig 5). The most likely interpretation is that this gravel island was inundated during the Late Bronze Age.

ORA 12 Can information about the location and extent of the gravel island identified during previous investigations and boreholes in the area of Pudding Mill Lane be refined?

See above.

ORA 13 Is there any direct or indirect evidence for prehistoric activity (such as artefacts and structures, or plant microfossil and macrofossil evidence)?

No prehistoric artefacts or structures were identified. Although currently undated, the lowest fills of feature [123] in monolith <59> comprise peaty black clay, and may contain palaeoenvironmental indications of its primary use as well as other human activities (such as vegetation clearance, farming and drainage management) occurring in the wider area. Radiocarbon dating of organic remains from the fill of the feature may confirm its date.

ORA 14 Is there evidence for the formation of peat in marginal areas, and at what date did it start and cease to form?

Except within the fill of feature [123], peat formation was not recorded in the area of the Cut and Cover tunnel (Stage 3) and covered ramp.

ORA 15 Within any later alluvial deposits, is it possible to identify evidence for anthropogenic management of the increasingly wet and marshy landscape?

Although currently undated, it is possible that feature [123] is a feature associated with land management. Radiocarbon dating of organic remains from the fill of the feature may confirm its date, and provide a TPQ for the accumulation of the overlying alluvium.

General watching brief

The following site-specific objectives were set out within the Addendum to Method Statement Archaeological General Watching Briefs Pudding Mill Lane Portal (Doc. No. C261-MLA-T1-GMS-

CRG03-50002, Version 2.0, 01.12.14), and addressed in the Fieldwork Report for the National Grid GWB (Crossrail 2016a, Section 10.1). The answers are repeated here for completeness:

ORA 16 To record the archaeological sequence (as restricted by contamination), mitigating the impact of the works.

The archaeological sequence was successfully identified and recorded over the whole site in areas of impact, where possible.

ORA 17 To identify the rail lines and the associated industrial archaeological features, allowing them to be related to any future work on the site.

No rail lines were present in the National Grid bulk supply point area. A large dumped deposit consisting mainly of clinker was however seen which may derive from railway activity.

ORA 18 To identify the levels and nature of the Holocene alluvial sequence (if exposed in this work).

The top of the Holocene alluvial sequence was seen. No dating evidence was present in the alluvium, and it is possible that it accumulated throughout the Holocene, although it is likely that some is of post-medieval date. Similar alluvium recorded during the excavation of the PML Cut and Cover Section 1 was post-medieval in date.

ORA 19 To compare the results of this general watching brief with those of the earlier and future archaeological fieldwork in and around Pudding Mill Lane.

The Pudding Mill Lane Portal Cut and Cover Section 1 and EIP/TBM chamber were excavated immediately north-west of the site. A small number of post-medieval brick remains were found dating to the 18th and 19th centuries. The post medieval structural remains were not as prolific due to the prevalence of concrete foundations and smaller area investigated.

The alluvial sequence was comparable at both sites. The excavations at the EIP/TBM chamber identified a number of wattle and timber revetments, possibly part of one or more fish weirs lying within the alluvium and generally observed c 101.60 – 102m ATD. Within the alluvium at the national Grid site a section of ephemeral wattle-work [163] was recorded at c 103.10m ATD. The wattle is undated but follows a similar alignment to sections of wattle excavated to the north within the EIP/TBM chamber, and although it was recorded at a higher level, may have formed part of a similar structure.

7.2 General discussion of potential

Geoarchaeology

A geoarchaeological transect was recorded across the site, stretching for over 300m from south-west to north-east across the Lea valley floodplain (Fig 4). It was only possible to make detailed records of the geoarchaeological deposits at three locations, but nonetheless the records made as part of the transect have potential to contribute to the topographic modelling of the area.

The Pleistocene gravels contain no palaeoenvironmental potential, but low-lying areas in the south-west of the site have the greater potential. Thin organic sediments are recorded directly on the surface of the gravels and despite their proximity to the medieval/Tudor fish weir (Crossrail 2013b), independent dating should be undertaken (via radiocarbon dating or palaeoenvironmental proxy) to investigate the nature and date of the inundation of the island. Radiocarbon dating and palaeoenvironmental work on additional parts of the lower sequence would help to investigate the suggestion that a later prehistoric or historic meander of the River Lea eroded away earlier prehistoric sediments. The alluvial deposition represented by facies 2 would have made occupation on the floodplain unlikely, but some agricultural activities (e.g. pasture, fish traps, osier beds, retting pits) would have been possible. The lowest fills of feature [123] may provide palaeoenvironmental indications of its primary use as well as other human activities (such as vegetation clearance, farming and drainage management) occurring in the wider area.

Medieval and/or Tudor ?fish weir

The records and samples associated with the medieval/Tudor 'fish weir' have potential for further work. In the absence of stratigraphic information about the relationships between the timber structures, these were considered in the radiocarbon dating report (Crossrail 2013b, Section 6.2) as one 'phase', with no information about the internal sequence of events. However, a re-examination of the stratigraphic records and dating of the succession of timber structures and deposits recorded within the EIP chamber may allow for some refinement of the sequence. Further research, including an examination of documentary and/or secondary sources, may also provide some evidence for the function and dating of the structures. Any examples of either archaeologically or historically documented similar structures may also give some indication as to whether the alignments Str 31, 32, 98 and 65 form part of the same contemporary structure, or a series of repairs and/or replacements.

19th- and 20th-century remains

The buildings and features associated with the development of the site for industry from the mid-19th century onwards have limited potential for further work, beyond confirming details of the historic mapping of the site.

Two parish boundary markers recorded on the National Grid site may be of local interest, as is a quart measure inscribed with the name of a local public house, the Albion, and its landlord G Kent.

8 Significance of the data

The evidence for a possible medieval/Tudor fish weir contributes to archaeological and documentary research on the wider management of the river Lea during the medieval and early post-medieval periods, including disputes regarding the use of the river for transport and fishing (eg Fairclough 1986). In addition to the structural remains, geoarchaeological data from the associated alluvial deposits contributes to topographic modelling of the Holocene surface of the river Lea floodplain and the later development of the river. These remains are certainly of local and possibly of regional significance, in particular if the results of the proposed environmental analysis and radiocarbon dating can provide any further evidence for the date of deposition of the alluvium across the site.

Evidence for the post-medieval development of the area is relatively sparse, but includes walls and features relating to buildings shown on historic maps of the area. The two parish boundary markers and the lead/pewter measure naming the landlord of a local public house are of local significance.

9 Publication project: aims and objectives

9.1 Revised research aims

RRA 1 To analyse the palaeo-environmental evidence recovered from the works and contribute evidence to inform the Lea Valley Pleistocene and Holocene archaeological resource.

RRA 2 To what extent does the surface of the Pleistocene gravel represent the topography of the area at the start of the Holocence, and to what extent has this surface been eroded during the Holocene by river channels?

RRA 3 What is the date of the alluvial deposits associated with the structural remains recorded in the EIP/TBM chamber?

RRA 4 Do the palaeoenvironmental remains from the site provide further evidence for the character and management of the surrounding landscape?

RRA 5 Can the dating and phasing of the timber structures within the EIP/TBM chamber be refined?

RRA 6 Can the function of the timber structures within the EIP/TBM chamber be identified with more certainty? Are they part of a fish weir or some other structure?

RRA 7 What is the date of feature [123], and can palaeoenvironmental remains provide any evidence for its function?

9.2 Preliminary publication synopsis

It is proposed to publish the results of the archaeological investigations at the Pudding Mill Lane Portal as a short article of *c* 2,500 words and *c* 6 figures in the *London Archaeologist*. This decision lies with the Crossrail Project Archaeologist.

Working title:	Medieval and Tudor management of the river Lea at Pudding Mill Lane
Principal Author:	David Sankey, Virgil Yendell
Format:	Journal Article (*London Archaeologist*)
Total word count:	2500
Total figure count:	max 6

- Introduction – site location, circumstances of the excavation
- The geoarchaeologcial evidence, with updated topographic plot
- Historic background – medieval and post-medieval management of the Lea valley, with a focus on the area of the site
- The timber structures in the EIP/TBM chamber, with a discussion of their dating and function
- Conclusion

9.3 Stratigraphic method statement

Task 1 Complete analysis of the stratigraphic sequence to land use, with Oracle entry

Task 2 Complete photographic catalogue

9.4 Timber method statement

Following the completion of the geoarchaeology, stratigraphic , dating and historic survey work a short updated, fully referenced analysis version of the report should be produced with explanatory draft figures.

Task 3 Analysis and report preparation

9.5 Geoarchaeological method statement

Below is the task list for the palaeo-environmental analysis of two monolith (and associated bulk) sample sequences from the Crossrail Pudding Mill Lane site (XSK10). The work outlined below should permit the dating and further characterisation of the site-wide deposit sequence, and provide data with which to update the local deposit model.

The first set of monolith samples (M5, M6 & M8) contain silty clays lying over gravels associated with a possible fish weir. As there is no certainty that the basal organics are contemporary to the fish weir structure radiocarbon dating in addition to pollen and diatom analysis is thought necessary for this sequence. Therefore a minimum of 12 subsamples for both pollen and diatom/ostracods is suggested for the fish trap sequence. Furthermore, monolith <59> taken from a separate feature (along with bulk <60>) should be analysed. This monolith samples alluvium within a cut feature lying directly over floodplain gravels which include organic material at the base worthy of radiocarbon dating. For this sequence a minimum of 8 subsamples for both pollen and diatom/ostracods is suggested.

Task 4 Retrieve monolith samples associated with the structure (M5;M6 & M8) and natural channel <59>, examine, log & sub-sample and submit samples to specialists geoarch 2 days

Task 5 Pollen (20 subsamples @ £100)

Task 6 Diatoms/Ostracods (20 samples @ £80)

Task 7 C14 (2 dates from mono <59> and 1 date from <M8> @£395)

Task 8 Input to Rockworks and update results of local deposit model.

Task 9 The results of pollen/diatom analysis, work on plant macrofossils and insect remains, and any dating should be considered together, in order to determine their overall contribution to answering the RRAs.

Task 10 Prepare report text

Task 11 Prepare illustrations for report to include: (cross section(s) / surface plot(s) /location plan/sample location)

Task 12 Edit/advice/organisation

9.6 Environmental method statement

Botanical analysis

Task 13 Processing

Task 14 Plant macrofossil assessment (<60>) & C14 extraction

Task 15 Scanning, id & recording of plants from 3 waterlogged samples

Task 16 Data entry, production & editing of tables

Task 17 Analysis of results, research and production of archive report

Insect remains

Retained soil from three of the samples should be processed and submitted to an insect specialist for identification of the remains.

Task 18 Liaison & packaging time

Task 19 Paraffin flotation of 3 samples

Task 20 Insect specialist c. £900

Invertebrates

Task 21 Identification of all unidentified terrestrial and freshwater species

Task 22 Preparation of ecological interpretation report

9.7 Graphics method statement

Task 23 Upload digitised site records to SDE and create intrasite ArcGIS project; support for creation of strat figures

Task 24 Preparation of final article figures

9.8 Conservation method statement

Task 25 X-radiography requirement for archive

9.9 Photographic method statement

Task 26 Preparation of site photographs for publication

9.10 Background research

Task 27 Research, including consultation of secondary sources, historic maps and site archives.

9.11 Integration of publication text method statement

Task 28 Liaison with specialist contributors

Task 29 Integrated analysis

Task 30 Preparation of final draft text and strat figures

9.12 Production

Task 31 Internal editing

Task 32 Specialist edit

Task 33 Journal page costs @ £150

9.13 Project management method statement

Task 34 Overall project management; quality control, project meetings throughout.

10 Publication project: resources and programme

Financial resources sufficient to cover the work proposed in this document have been sought via a separate document.

Task No.	Done by	Task Description	Time required (person days)
Stratigraphic			
Task 1	DS	Complete analysis of the stratigraphic sequence to land use, with Oracle entry	5
Task 2	DS	Complete photographic catalogue	2
Timbers			
Task 3	DG	Analysis and report preparation	3
Geoarchaeology			
Task 4	VY	Retrieve monolith samples associated with the structure (M5;M6 & M8) and natural channel <59>, examine, log & sub-sample and submit samples to specialists geoarch 2 days	2
Task 5	External	Pollen (20 subsamples @ £100)	
Task 6	External	Diatoms/Ostracods (20 samples @ £80)	
Task 7	External	C14 (2 dates from mono <59> and 1 date from <M8> @£395)	
Task 8	VY	Input to Rockworks and update results of local deposit model.	1
Task 9	VY	The results of pollen/diatom analysis, work on plant macrofossils and insect remains, and any dating should be considered together, in order to determine their overall contribution to answering the RRAs.	2
Task 10	VY	Prepare report text	5
Task 11	VY	Prepare illustrations for report to include: (cross section(s) / surface plot(s) /location plan/sample location)	0.5
Task 12	GS	Edit/advice/organisation	1
Botanical remains			
Task 13	Proc	Processing	1
Task 14	AD	Plant macrofossil assessment (<60>) & C14 extraction	2
Task 15	AD	Scanning, id & recording of plants from 3 waterlogged samples	2
Task 16	AD	Data entry, production & editing of tables	0.5
Task 17	AD	Analysis of results, research and production of archive report	2.5
Insect remains			
Task 18	AD	Liaison & packaging time	0.25
Task 19	Processor	Paraffin flotation of 3 sample	1
Task 20	External	Insect specialist c. £900	
Invertebrates			
Task 21	AP	Identification of all unidentified terrestrial and freshwater species	0.5
Task 22	AP	Preparation of ecological interpretation report	0.5
Graphics			
Task 23	Geomatics	Upload digitised site records to SDE and create intrasite ArcGIS project	2
Task 24	DO	Preparation of final article figures	5
Conservation			
Task 25	Processor	X-radiography requirement for archive	0.25
Photography			
Task 26	Photography	Preparation of site photographs for publication	0.5
Integration of publication text			
Task 27	DS	Research, including consultation of secondary sources, historic maps and site archives.	3
Task 28	DS	Liaison with specialist contributors	1
Task 29	DS	Integrated analysis	2
Task 30	DS	Preparation of final draft text	5
Production			
Task 31	BB	Internal editing	1
Task 32	Specialists	Specialist edit	1
Task 33		Journal page costs £150	
Project management			
Task 34	LF	Overall project management; quality control, project meetings throughout.	8

11 Acknowledgements

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13 Appendix: management, delivery and quality control

MOLA (Museum of London Archaeology) is a company limited by guarantee registered in England and Wales with company registration number 07751831 and charity registration number 1143574. The Registered Office is Mortimer Wheeler House, 46 Eagle Wharf Road, London N1 7ED). It has its own independent Board of Trustees but works in partnership with the Museum of London via a Memorandum of Understanding.

MOLA is a 'Registered Organisation' with the archaeological professional body, the Chartered Institute for Archaeologists (CIfA). The C*IfA Register* is a rigorous Quality Assurance scheme for archaeologists. In order to be accepted, MOLA has passed a Board resolution to comply with the CIfA Code of Conduct and Standards, to demonstrate that compliance through bi-annual re-registration, to submit to regular IfA inspections, and to ensure that all MOLA activities are under the overall direction of a Member grade (MifA) 'responsible post-holder'. The Registered Organisation scheme also provides procedures for investigating and handling of external complaints.

MOLA is also currently working with a specialist consultant towards achieving the ISO9001 Quality Management standard (proof can be provided if required).

MOLA subscribes to and abides by the general principles and specific terms of the *Code of Good Practice On Archaeological Heritage in Urban Development Policies* established by the Cultural Heritage Committee of the Council of Europe, and adopted at the 15th plenary session in Strasbourg on 8-10 March 2000 (CC-PAT [99] 18 rev 3). In particular to the following points: ….*archaeologists shall be aware of development costs and adhere to agreed timetables* (Para 3 'The Role of the Archaeologist'), with all work *'carried out to written statements setting out standards timetables and costs'* (para 4 ibid).

MOLA further subscribes to and ensures that its activities comply with and/or are guided by the following policies, procedures and guidance:

- Appropriate local and regional planning authority archaeology guidance – eg for London: Historic England, Standards for a*rchaeological work* (2015)
- Appropriate Archaeological Research Framework for the region – eg for London: English Heritage Archaeology Division, *Research Agenda* (1997); Museum of London, *A research framework for London archaeology (*2002); and *Historic Environment Research Strategy for Greater London* (in prep. CBA/MoL/Rowsome).
- English Heritage, *Management of Archaeological Projects* (MAP2), (1991)
- English Heritage Centre for Archaeology, *Guidelines* (various)
- Museum of London Archaeological Service*, Archaeological Site Manual (1994)*
- Museum of London Archaeological Service, *Archaeological Finds Procedure Manual* (2006)
- National archive disposition standards including Museum and Galleries Commission, *Standards in the Museum Care of Archaeological Collections* (1992) and Society of Museum Archaeologists, *Towards an Accessible Archaeological Archive: the Transfer of Archaeological Archives to Museums: Guidelines for Use in England, Northern Ireland, Scotland and Wales* (1995)
- Relevant local archive deposition standards, eg for London, Museum of London, *General Standards for the preparation of archaeological archives deposited with the Museum of London*, (2009).

MOLA governance and organisational strategy are determined by the Senior Management Group (SMG), led by the Chief Executive Officer and comprising the Finance Director, the Head of Operations, and four Directors heading the Planning, Development Services Research & Education and Northanmpton divisions. The SMG reports regularly to an independent Board of Trustees, who oversee

MOLA's performance and strategic direction. As a charitable company MOLA is monitored and regulated by the Charities Commission.

MOLA is structured to reflect its project orientation. Within Development Services the Director manages the Client Team of c 10 Project Managers (PMs). Individual PMs are responsible for developing new work for MOLA, and thereafter for designing, budgeting and delivering projects for clients. They remain the principal point of contact for the client for the duration of each project.

PMs drive projects through successive stages in accordance with client needs, forming project teams by drawing upon the skills available within MOLA Operations teams. PMs ensure that projects are completed to the highest standards within time and budget. Financial monitoring of projects against budget is undertaken by the Finance Director and PMs at monthly review meetings. Project management software is employed by MOLA Operations to plan resourcing and track and adhere to programme and budget. Project team meetings are held throughout the programme, allowing refinement of research strategies in the light of on- or off-site findings or analysis. Recording, excavation, and sampling strategies may be modified to provide optimum information retrieval in support of the research objectives. At post-excavation phase internal project management is normally devolved to a designated Post-Excavation Project Manager.

All archaeological field work is controlled and monitored on a day to day basis by the on-site Site Supervisor (SS), who reports to the designated Project Manager. Together with PMs and the Field Manager (responsible for H&S) they also liaise as necessary with the client's agents and principal contractors regarding all enabling works and H&S..

All written documentation, eg initial '*written scheme of investigations' ('wsis')*, evaluation reports, post-excavation *Assessment Report*s and final publications undergo stages of internal review and sign-off prior to final issue to clients. For both field and reporting work PMs and SSs meet and liaise with the client and the Local Authority's archaeological advisor or officer to ensure delivery according to wsis and to review progress, research aims, archaeological procedures, and site strategies as appropriate..

At all stages, what constitutes an appropriate archaeological response will be assessed against criteria of local, regional and national significance and within frameworks of valuable archaeological research topics identified in local or regional Archaeological Research Frameworks (where these exist).

14 Figures

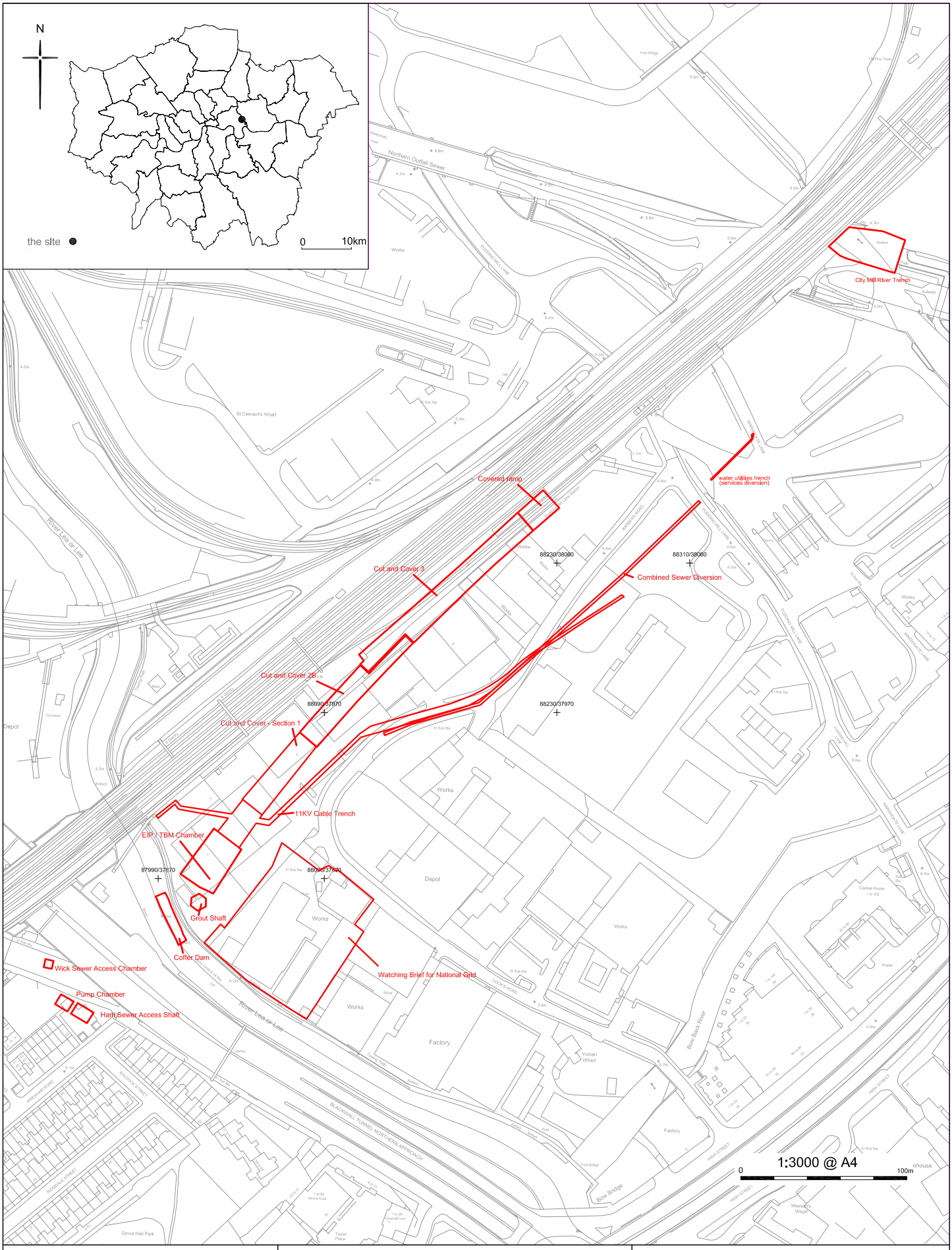

Fig 1: Area of Watching Brief
Site code: XSK10
Figure type: UPD

Type of fieldwork:
Targeted Watching Brief and Utilities General Watching Brief

Site Address:
Crossrail: PML Grout Shaft, Coffer Dam, EIP/TBM Chamber, Cut and Cover Section 2B adn 3, 11KV Cable Trench and Combined Sewer Diversion, Crossrail Pudding Mill Lane Site, Barbers Road, London E15 2PE

Trench edge / Watching brief areas included in this report

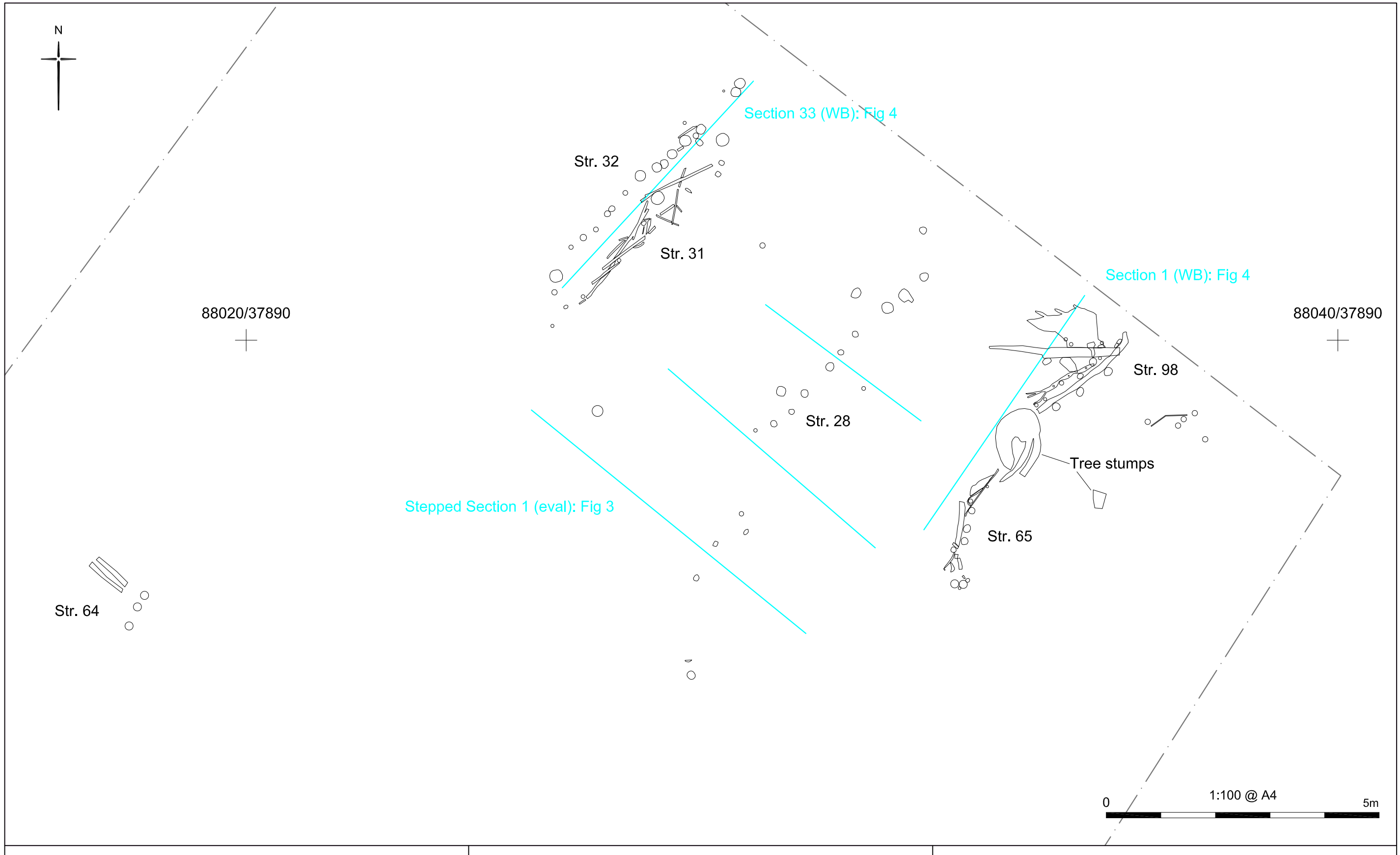

Fig 2: Plan of EIP/TBM trench, showing archaeological timbers
Site code: XSK10
Figure type: UPD

Type of fieldwork:
Excavation and Targeted Watching Brief

Site Address:
Crossrail: EIP/TBM Chamber, Cut and Cover Section 1, 11KV Cable Trench and Combined Sewer Diversion, Crossrail Pudding Mill Lane Site, Barbers Road, London E15 2PE

Trench edge / watching brief area
Str.1 Archaeological features showing structure number
Section / elevation location

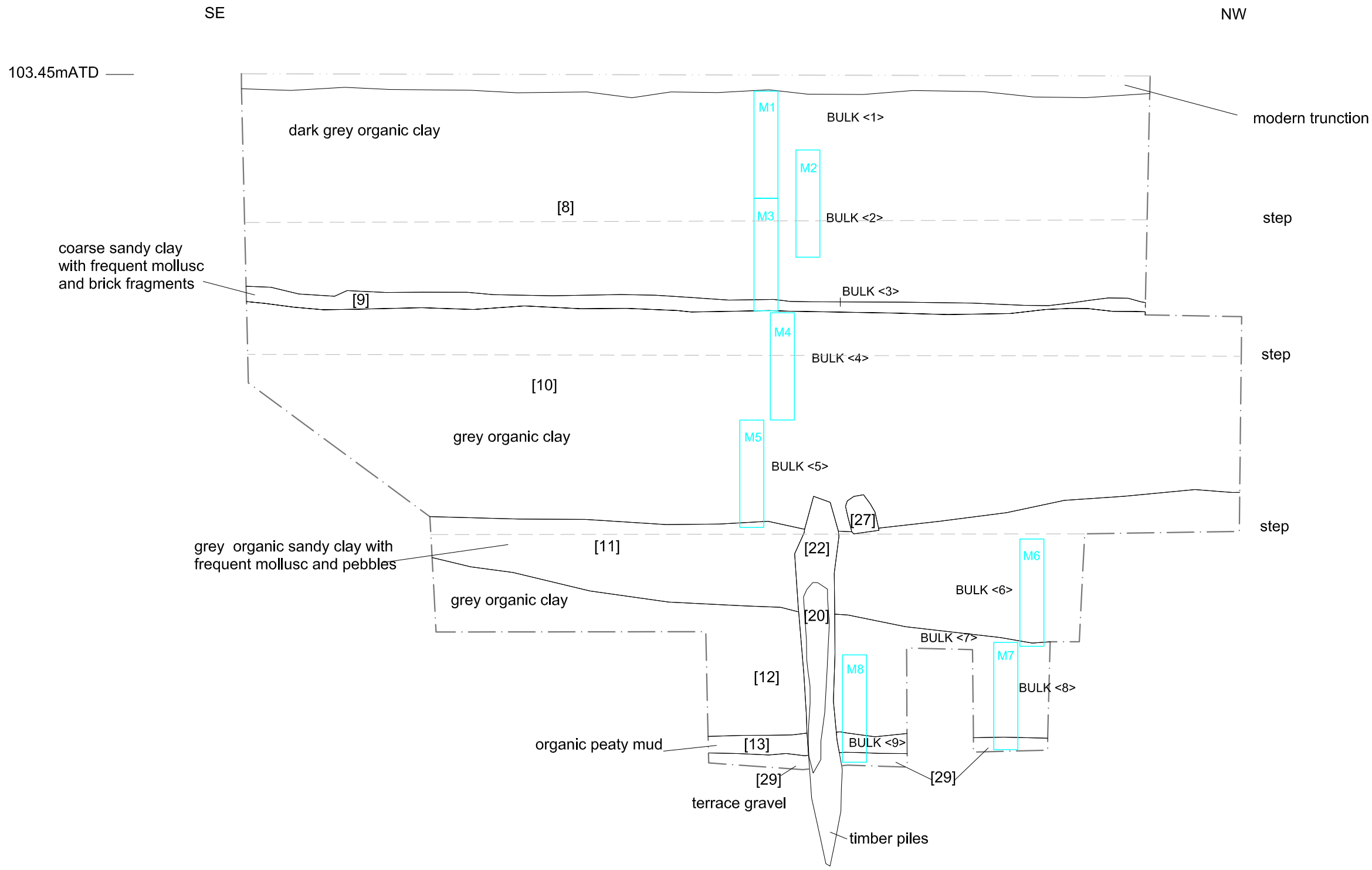

Fig 3: Evaluation section 1
Site code: XSK10
Figure type: UPD

Type of fieldwork:
Excavation and Targeted Watching Brief

Site Address:
Crossrail: EIP/TBM Chamber, Cut and Cover Section 1, 11KV Cable Trench and Combined Sewer Diversion, Crossrail Pudding Mill Lane Site, Barbers Road, London E15 2PE

- Limit of excavation
- Step of trench edge
- M1 — Monolith tin sample
- [11] — Archaeological features
- BULK<1> — Bulk sample
- 102mATD — Level of elevation (for heights in mOD, subtract 100m)

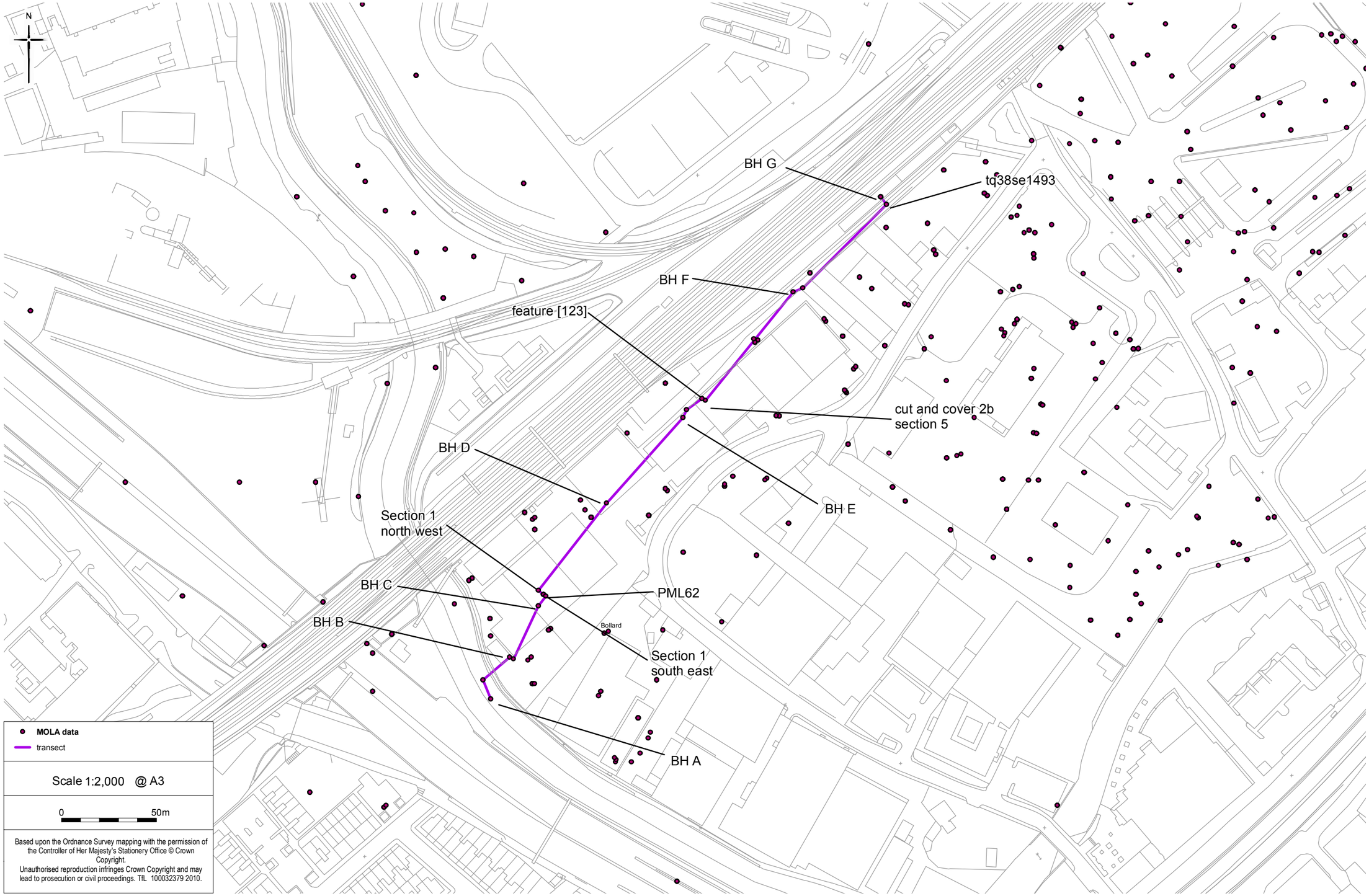

Fig 4 Location of geoarchaeological transect

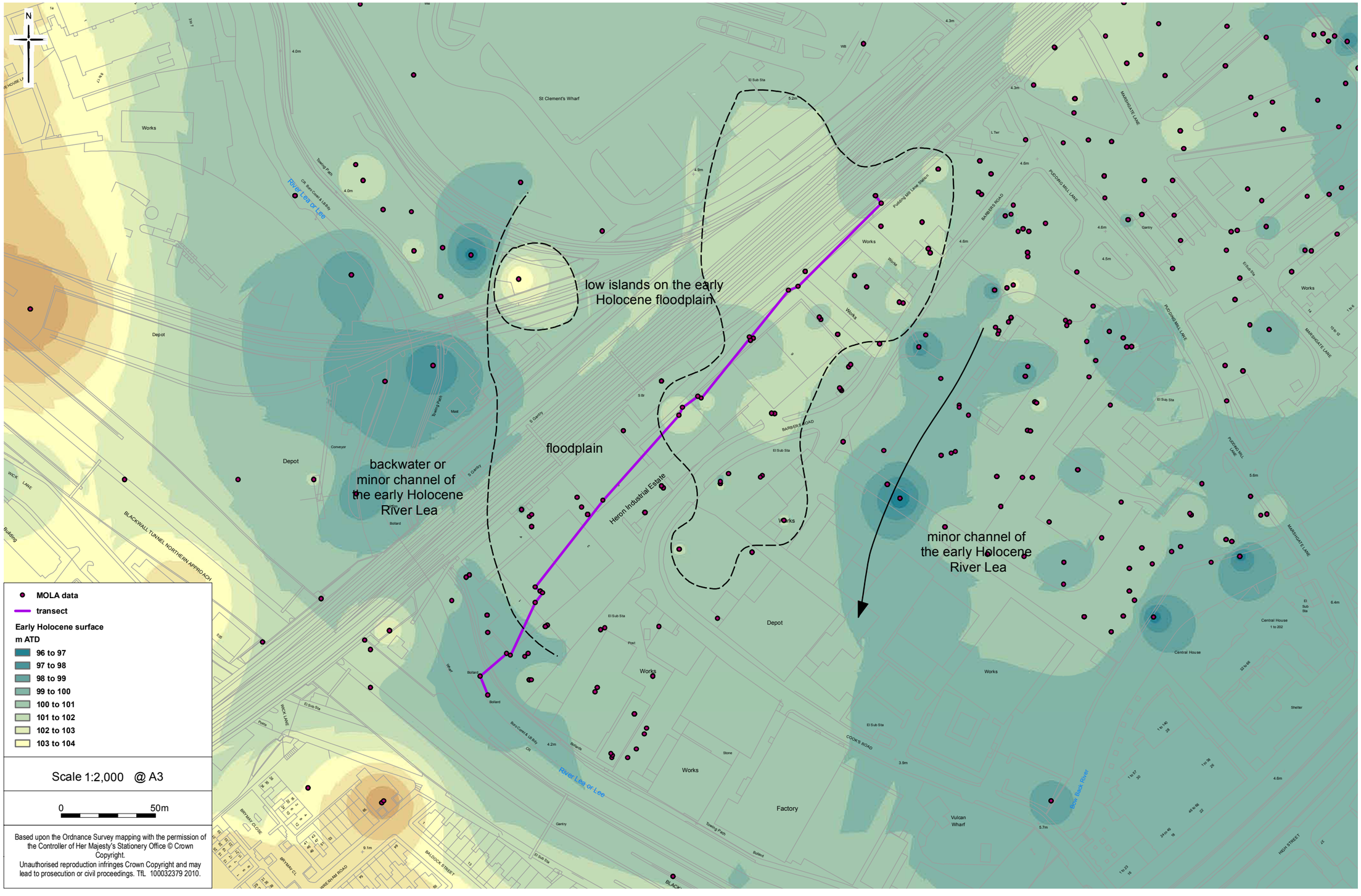

Fig 5 Early Holocene topography