Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Overarching Archaeological Written Scheme of Investigation

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Thames Tideway Tunnel
Creating a cleaner, healthier River Thames

Overarching Archaeological Written Scheme of Investigation

Also Environmental Statement – Volume 2 Appendix E.2

Thames Tideway Tunnel

Creating a cleaner, healthier River Thames

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Thames Tideway Tunnel

Overarching Archaeological Written Scheme of Investigation

List of contents

Page number

List of tables

Page number

Abbreviations and glossary

Archaeology: all physical heritage assets (above and below ground) that constitute the historic environment

Archaeological works: all mitigation being undertaken in respect of archaeology

CEMP: Construction Environmental Management Plan

COCP: Code of Construction Practice

Contractor: each Thames Tideway Tunnel Principal Contractor

CSO: Combined Sewer Overflow

EIA: Environmental impact assessment

EMS: Environmental Management System

HMP: Heritage management Plan

LLAU: Limits of land to be acquired or used

Mitigation: all measures that may be necessary to reduce the impact of construction upon archaeology to an acceptable level

NPPF: National Planning Policy Framework 2012

OAWSI: Overarching Archaeological Written Scheme of Investigation

PXA: Post-excavation Assessment and report

RCHME: Royal Commission on Historical Monuments for England

Site: a location where Thames Tideway Tunnel works may affect the historic environment

SSAWSI: Site-specific Archaeological Written Scheme of Investigation

WSI: Written Scheme of Investigation

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Executive summary

EX 1.1 This document provides an Overarching Archaeological Written Scheme of Investigation (OAWSI) for the Thames Tideway Tunnel project. The OAWSI forms part of the application for development consent (the 'application') (document 7.13) and is also an Appendix E.2 to Volume 2 of the *Environmental Statement*, which also forms part of the application for development consent (document 6.2). This reflects its role in terms of mitigating likely significant effects identified in the *Environmental Statement*.

EX 1.2 As referenced in PW10 of Schedule 3 of the Draft Development Consent Order (DCO) and detailed in the *Code of Construction Practice Part A*, archaeological works will be carried out in accordance with the Overarching Archaeological Written Scheme of Investigation.

EX 1.3 The River Thames has played an important role in London's development as one of the world's most significant global cities. Correspondingly it represents a rich source of archaeology providing information on how London developed from prehistory onwards, through settlement patterns and boundaries, river management, transport, infrastructure and trade, developments in water systems and public health, and industries associated with the Thames and its tributaries.

EX 1.4 The purpose of the OAWSI is to set out the overall archaeological mitigation strategy, procedures, standards and techniques to be followed across the Thames Tideway Tunnel project. It represents a manual for archaeologists, design engineers, programme managers and contractors.

EX 1.5 The OAWSI meets the requirement of the National Policy Statement for Waste Water to ensure that a proper record is made of significant heritage assets.

EX 1.6 The document contains a summary of current legislation and guidance pertaining to the historic environment, archaeological background to Thames Tideway Tunnel project sites, a research framework to inform and target mitigation work and define objectives, strategies for delivering those objectives and the techniques that might be employed. It also sets out the reporting mechanisms and strategies for disseminating the results to the archaeological community and wider public alike.

EX 1.7 The OAWSI covers both above- and below-ground heritage assets.

EX 1.8 The OAWSI will be implemented by Site Specific Archaeological Written Schemes of Investigation (SSAWSIs) for individual sites. These will be prepared following further work in the form of evaluation (field testing) to further define the mitigation strategies to be employed at each site.

EX 1.9 The SSAWSIs will be technical scopes of work for each construction site where archaeological mitigation has been identified as necessary, focussing on site specific detail cross-referring back to the archaeological approaches and techniques detailed in the OAWSI, to avoid unnecessary repetition.

EX 1.10 The SSAWSIs, will be developed in consultation with consultees, and submitted to each local planning authority for approval in consultation with the Greater London Archaeological Advisory Service (GLAAS), which forms part of the Historic Buildings and Monuments Commission for England (HBMCE) (informally known as English Heritage), where relevant. This process is as per requirements detailed in Schedule 3 of the Development Consent Order. It is noted that the City of London Corporation and the London Borough of Southwark have their own archaeologists, so HBMCE would not be consulted in these boroughs, with the exception of marine archaeological matters (incorporating the foreshore) at sites within these jurisdictions. As per requirements detailed in Schedule 3 of the Development Consent Order, all archaeological works shall be undertaken in accordance with the SSAWSI and carried out by a suitably qualified person or body unless otherwise approved in writing by the local planning authority.

1 Introduction

1.1.1 The purpose of the Overarching Archaeological Written Scheme of Investigation (OAWSI) is to set out the overall archaeological mitigation strategy, procedures, standards and techniques to be followed across the Thames Tideway Tunnel project (the 'project').

1.1.2 The OAWSI is a non-technical procedures manual for:

a. stakeholders and statutory consultees

b. archaeological contractors

c. design engineers, programmers and managers who will be responsible for delivering its implementation.

d. Principal Contractors

1.1.3 The OAWSI will be implemented by a series of technical scopes of work for each construction site where archaeological mitigation has been identified as necessary. Termed Site-specific Written Schemes of Investigation (SSAWSIs) these will form a requirement of the application for development consent (the 'application'). The SSAWSI will focus on site specific detail cross-referring back to the archaeological approaches and techniques detailed in the OAWSI, to avoid unnecessary repetition. This will enable a streamlined approach to defining site specific requirements. The SSAWSIs will include both a scope of work, informed by site-specific archaeological objectives, and a method statement indicating how this will be carried out. The SSAWSIs will be submitted to each local planning authority for approval in consultation with the Greater London Archaeological Advisory Service[i] (GLAAS), where relevant. It is noted that the City of London Corporation and the London Borough of Southwark have their own archaeologists, so the Historic Buildings and Monuments Commission for England (HBMCE) (informally known as English Heritage) would not be consulted in these boroughs, with the exception of marine archaeological matters (incorporating the foreshore) at sites within these jurisdictions. The OAWSI sets out the process by which SSAWSIs will be prepared.

1.1.4 The OAWSI and SSAWSIs will together meet the requirement set out in para. 4.10.20 of the *National Policy Statement for Waste Water* to ensure that '*where the loss of the whole or a material part of a heritage asset's significance is justified, the applicant should record and advance understanding of the significance of the heritage asset before it is lost…..in a timely manner in accordance with a written scheme of investigation'*.

1.1.5 The document has been developed in consultation with HBMCE, the City of London Corporation and the London Borough (LB) of Southwark.

[i] The Greater London Archaeology Advisory Service (GLAAS), within English Heritage, provides archaeological advice to local authorities and developers, as well as other parties.

1.1.6 The OAWSI is both a stand-alone document that accompanies the application and is an Appendix E.2 to Volume 2 of the *Environmental Statement*, which also accompanies the application.

1.2 Effects on the historic environment

1.2.1 The application includes an *Environmental Statement*, which sets out an assessment of likely significant effects on the historic environment and proposed mitigation.

1.2.2 The historic environment includes buried and above-ground archaeological remains, buildings, structures, monuments and heritage landscapes. The physical evidence of these assets is collectively referred to as archaeology in this document.

1.2.3 The majority of archaeological effects will occur during the construction phase, whilst the Thames Tideway Tunnel is being built, through removal of deposits for foundations and below ground structures. Physical impacts during the operational phase, upon completion of construction, will be confined to any ground settlement from tunnelling, shafts and other deep structures that may affect listed structures, as detailed in the *Environmental Statement*. No scour effects during operation are anticipated due to the incorporation of scour protection into the operational design at foreshore sites.

1.3 A staged approach

1.3.1 Defining and planning mitigation for the historic environment is undertaken in stages, each of which helps define and focus the next. This document has been produced at the end of the assessment (EIA) stage. The stages, which are further described in Section 5, including a timeline (Table 5.2.1), are as follows:

a. *Desk-based assessment (EIA/Environmental Statement)* – outlines archaeological potential from existing records and data, likely significant effects from Thames Tideway Tunnel project construction and measures to mitigate effects on the historic environment

b. *Evaluation (field testing)* – provides direct new information on actual archaeological survival and significance at Thames Tideway Tunnel project sites

c. *Archaeological mitigation design* – identifies the scope of proposed archaeological mitigation measures which are detailed in overarching terms in this document, and which will be fully specified in *Site Specific Archaeological Written Schemes of Investigation (SSAWSIs)*

d. *Mitigation fieldwork* – involves undertaking the specified programme of mitigation works through archaeological investigation and recording before and during construction

e. *Dissemination* - presents the results via post-excavation assessment, analysis, reporting and other forms of public engagement, to enhance

understanding and appreciation of the past; to include deposition of a final project archive into the public domain.

1.4 How to use this document

1.4.1 This document is intended to provide the groups listed in para. 1.1.2 with the information necessary to design, plan, support and carry out the historic environment mitigation work on the Thames Tideway Tunnel project.

Statutory consultees

1.4.2 This document provides the standards and framework from which the statutory consultees can monitor the mitigation work and provide feedback to the Thames Tideway Tunnel project and archaeological and principal contractors.

Archaeological contractors

1.4.3 The document contains generic information on archaeological and built heritage recording and sampling and allows archaeological contractors to prepare focused SSAWSIs. This document also includes the Archaeological Research Framework in Appendix B, which will ensure a consistent and targeted approach to archaeological mitigation.

Thames Tideway Tunnel delivery team and principal contractors

1.4.4 Sections 1, 5, 8 and 11, in particular, provide information on the archaeological mitigation process to allow these groups to design and plan construction programmes such as to minimise delays and risks.

1.5 Document structure

1.5.1 The document is structured as follows:

a. Section 2 describes the planning and consents framework and professional standards and guidance that are relevant to archaeological mitigation.

b. Sections 3 and 4 provide a brief introduction to the character of the archaeology that will be affected by the Thames Tideway Tunnel and the archaeological research framework that informs and targets the mitigation work.

c. Section 5 provides more detail on the stages of the mitigation process outlined in para. 1.3.1 above.

d. Sections 6 to 8 set out the techniques and approach to evaluation (field testing), mitigation design and mitigation fieldwork that will be applied at the Thames Tideway Tunnel sites.

e. Section 9 summarises the post-excavation work that will be undertaken to disseminate results.

f. Section 10 describes the archaeological reports that will be required during each stage of the mitigation process.

g. Section 11 sets out historic environment outreach opportunities and provides a summary of roles and responsibilities and communication for the main parties involved in archaeological mitigation.

h. Section 12 summarises the Health & Safety requirements of the project and the anticipated technical support and attendances that will be required during evaluation and mitigation fieldwork phases.

i. Section 13 lists relevant Thames Tideway Tunnel documents and a wider historic environment bibliography.

j. Appendix A contains a list of relevant HBMCE Historic Environment Local Management (HELM) documents

k. Appendix B contains the Archaeological Research Framework.

l. Appendix C contains information on the scope of built heritage recording required at each site.

1.6 Related documents

1.6.1 As referenced in PW10 of Schedule 3 of the Draft DCO and detailed in para 12.5.1 of the *Code of Construction Practice Part A*, archaeological works will be carried out in accordance with the *Overarching Archaeological Written Scheme of Investigation.*

1.6.2 The OAWSI forms part of a structured set of environmental management documents for the Project which is set out in the CoCP. The *CoCP* sets out standards and procedures for environmental protection, to manage and control the potential impacts of construction. The *CoCP* is provided in Vol 1 Appendix A of the *Environmental Statement*. It contains general requirements (*Part A*), and site-specific requirements for each site (*Part B*).

1.6.3 Within the CoCP, provision is made for preparation of a Construction Environmental Management Plan, which will include those matters detailed in Section 2.3 of the CoCP Part A, including a Heritage Management Plan, whose content is defined in Section 12 of the CoCP Part A. Relevant stakeholders, as defined in the CoCP, will be consulted on the content of the CEMP, including local authorities and HBMCE.

2 Legislation, policy and guidance

2.1.0 The archaeological mitigation strategy, procedures, standards and techniques described in this document follow established practice which has evolved through legislation, policy and guidance related to the historic environment.

2.1 Legislation

2.1.1 Nationally significant archaeological sites (both above and below-ground remains) can be identified as scheduled monuments and are protected under the Ancient Monuments and Archaeological Areas Act 1979. However, no likely significant effects on scheduled monuments or their setting are predicted to result from the Project.

2.1.2 Since 1990 archaeology has been a material consideration in the planning process and it is protected through planning policy and guidance detailed in para. 2.2.1 below.

2.1.3 The Burial Act 1857, the *Disused Burial Grounds Act 1884* and *1981*, the *Pastoral Measure 1983*, and the *Town and Country Planning* (Churches, Places of Religious Worship and Burial Grounds) Regulations 1930 together provide a legal requirement for the exhumation and re-interment of human remains. The *Environmental Statement* has not identified any known disused burial grounds within Thames Tideway Tunnel project sites. Any unexpected discoveries of human remains will be dealt with under the Contractor's procedures for unexpected discoveries (see also Section 8.6).

2.1.4 The *Treasure Act 1996* and the *Treasure (Designation) Order 2002* covers finds of treasure – generally items of gold or silver over 300 years old (including two or more coins in the same find); or ten or more coins of base metal in the same find; plus any object such as a container associated with a treasure object. Treasure must be reported to the local Coroner and then taken to a designated local museum where it can be kept safely pending further decisions. The local museum would also offer specialist opinion on whether a reported object does fall under the definition of Treasure. The Museum of London is the designated museum for Greater London (apart from the Boroughs of Kingston and Waltham Forest). The British Museum advises the Secretary of State whether or not a museum wishes to acquire the treasure (in which case the Coroner would hold an Inquest). For finds within the City of London only the Museum of London has this advisory role.

2.1.5 In terms of above ground assets, the *Planning (Listed Buildings and Conservations Areas) Act 1990* provides powers to protect designated above ground assets and forms the basis for defining receptor sensitivity in the *Environmental Statement* and hence the mitigation strategy. Listed structures (e.g. buildings, bridges, river walls, street furniture) within the LLAUs for each site and the tunnel alignment have been identified in the *Environmental Statement* and mitigation measures proposed.

2.1.6 Additionally, the *CoCP* contains good practice measures to protect listed and other historic structures during the construction process.

2.2 Policy

2.2.1 The archaeological mitigation strategy, procedures, standards and techniques also conform to the requirements of relevant planning policy. The *National Policy Statement for Waste Water (NPS)*: A framework document for planning decisions on nationally significant waste water infrastructure (Defra, 2012)[1], is the primary basis for deciding development consent applications for wastewater developments. It sets out a requirement for the applicant to record and advance understanding of the significance of heritage assets to be lost in whole or part in accordance with a Written Scheme of Investigation.

2.3 Professional standards and guidance

2.3.1 Relevant professional standards and guidance that apply to the historic environment, include:

a. *PPS5 Planning for the Historic Environment: Historic Environment Planning Practice Guide* (Department of Communities and Local Government, English Heritage & Department for Culture, Media and Sport, March 2010) or any successor document – whilst PPS5 has been replaced by the NPPF, this practice guide remains relevant as a guide to good practice, and is referenced in Section 4.10 of the NPS.

b. *Understanding historic buildings: a guide to good recording practice.* (English Heritage, 2006), and the Department for Communities and Local Government and Department for Culture, Media and Sport, *Revisions to principles of selection for listed buildings* (March 2007).

c. *By-laws, standards and policy statements of the Institute for Archaeologists (IfA)*[2] - provides detailed technical guidance and standards for all aspects of archaeological work.

d. *Standards for Archaeological Work London Region, External Consultation* (Greater London Archaeological Advisory Service, 2009), and *Planning Advice Note 3: Archaeology in the City of London, Archaeology Guidance* (City of London Corporation Department of Planning and Transportation, 2004) - provide detailed technical guidance and standards for archaeological work undertaken in Greater London boroughs and the City of London and have informed the approach to mitigation.

e. *The London Research Framework* (Museum of London and English Heritage, 2002) and the *Greater Thames Estuary Historic Environment Research Framework* (English Heritage 2010) - have been used to identify themes that encompass the historic environment assets along the Thames Tideway Tunnel route for the purposes of informing the archaeological research framework document (Appendix B).

2.3.2 A more extensive range of guidance from HELM (English Heritage Historic Environment – Local Management) is given in Appendix A which will be consulted where appropriate by archaeological contractors undertaking fieldwork.

2.3.3 Archaeological mitigation will be coordinated by professional archaeologists who are suitably qualified and experienced (e.g. members of the Institute for Archaeologists (IfA) or equivalent standing). Organisations undertaking and coordinating fieldwork will normally be expected to have IfA accreditation as Registered Archaeological Organisations (RAO).

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3 Archaeological background

3.1 Introduction

3.1.1 The changing hydrology and topography of the Thames (including confluences with its major tributaries) and repeated attempts to manage it, is a dominant theme influencing all assets along the route of the Thames Tideway Tunnel. River regimes have driven patterns of past human settlement and resource utilisation from the earliest times and were a principal factor in the development of London as a world city.

3.1.2 Built and buried heritage assets associated with the changing hydrology and development along the river are present along the route and within some Thames Tideway Tunnel sites.

3.1.3 The potential and known heritage assets at each Thames Tideway Tunnel site are described in the site-specific volumes of the *Environmental Statement* (Vol 4 to 27). The following section describes the general types of heritage assets anticipated across the project.

3.2 The river and foreshore

3.2.1 Within the river and foreshore, built and buried assets may include:

a. In situ strata and features from prehistoric and later periods, before the Thames was canalised. These may include settlement and land use evidence; including timber structures such as fish traps and platforms and associated artefacts such as scatters of pottery or flint. Some of these remains are exposed to erosion of the foreshore. They may correlate with buried features on the landward side.

b. In-river structures, such as jetties, stairs, pontoons, dolphins, barge beds, mooring posts, revetments, river walls and bridge abutments. These structures may include evidence of related commercial and industrial activity that has disappeared on adjacent landward sites.

c. Other in situ evidence of past commercial and industrial activity such as sunken boats, shipbuilding and breaking, or dumped materials from former industries nearby (e.g. pottery production waste)

d. Associated environmental indicators (such as plant, animal and insect remains) providing evidence of past landscapes and river regimes. These may occur within peat or other organically-preserved strata.

e. Artefacts of any date that are not in-situ. Although re-deposited by river action they may be of individual intrinsic interest.

3.3 On land

3.3.1 On land-based sites, built and buried assets may include:

a. Buried prehistoric activity, including trackways and boats (where former marshland and channels are present); occupation (on former

dry land, often gravel islands or river terraces), and ritual activities (within channels or at the edges of them).

b. Evidence of prehistoric to post-medieval agriculture such as plough marks, field boundaries and farm buildings.

c. Evidence of Roman, Saxon or medieval settlement and land reclamation including buried remains of buildings, pits, ditches, river defences, wharves and boats and possibly burials.

d. Post-medieval industrial archaeology, such as wharves, warehouses, shipyards, docks and factories. This includes remains of London's 19th and 20th century public infrastructure such as railways; and Bazalgette's pioneering sewers and pumping stations.

e. Post-medieval rural or urban settlement including housing; workshops and craft activity; including associated yards and gardens; refuse and cess pits etc.

f. Associated palaeoenvironmental evidence of past landscapes and human interaction with them.

3.4 Types of effect

3.4.1 The likely significant effects predicted as a result of the development of the Thames Tideway Tunnel sites occur mainly during the construction phase and include activities which remove, disturb or alter above ground or buried heritage assets, or their settings, or from changes to the fluvial regime of the River Thames around foreshore construction sites which could lead to scour of buried heritage assets during the construction period. Effects could also arise from the implementation of scour protection measures. As noted in para. 1.2.3 no physical effects during operation are predicted, including from scour around structures.

4 Archaeological research framework

4.1 Purpose

4.1.1 As indicated in Section 3, the anticipated built and buried heritage assets within Thames Tideway Tunnel sites are very varied. In developing and implementing a detailed mitigation strategy to address effects on these different assets it is necessary to have a framework of archaeological priorities and objectives. This allows the assets that have the greatest significance[ii]3 and potential to enhance public appreciation of the historic environment to be identified and targeted. The work undertaken on the Thames Tideway Tunnel sites will be carried out with reference to the project Archaeological Research Framework (contained in Appendix B) and the overarching archaeological research frameworks for Greater London and the Thames (see para. 4.2.1 for further discussion of this).

4.1.2 This research framework will therefore assist in scoping the archaeological mitigation work and will inform the choice of sampling strategies and techniques.

4.1.3 The framework will also ensure a uniform approach, so that individual site-based priorities in the SSAWSIs are consistent with the archaeological objectives of the project as a whole.

4.2 Basis for the research framework

4.2.1 The Thames Tideway Tunnel archaeological research framework is based on the results of EIA baseline data gathering, which has identified the potential types and classes of heritage asset that may be present at Thames Tideway Tunnel sites and it also draws on the relevant research frameworks and strategies for Greater London and the Thames, namely:

a. A Research Framework for London Archaeology (Museum of London and English Heritage, 2002)

b. A Strategy for Researching the Historic Environment of Greater London (Rowsome, P, et al. 2011)[4]

c. Greater Thames Estuary Historic Environment Research Framework (Heppell, EM, 2010)[5].

4.2.2 These documents define the key research themes for Greater London and the Thames estuary and strategies for their investigation.

[ii] In determining significance at the EIA stage, potential and known heritage assets have been considered against four values set out in English Heritage *Conservation principles*, *policies and guidance*, (2008). These values remain valid during the mitigation design and fieldwork stages and complement the research framework objectives.

4.3 The Thames Tideway Tunnel archaeological themes and research objectives

Overarching archaeological themes

4.3.1 As part of the EIA process data has been collected from a wide range of sources, from which five overarching archaeological and historical themes have been identified. The social and historical context of these themes are detailed in the Archaeological Research Framework document in Appendix B. The themes are as follows:

a. Palaeoenvironment and prehistory

b. Settlement patterns and boundaries

c. River management, transport, infrastructure and trade

d. London's water systems and public health

e. Industries associated with the Thames and its tributaries

Research objectives

4.3.2 The research themes are supported by research objectives, reflecting the priorities of the *Research Framework for London Archaeology* and similar work undertaken on the *Greater Thames Estuary Historic Environment Research Framework*. In Appendix B, these research objectives are included at the end of each theme description.

Future development of the research framework

4.3.3 The research themes and supporting objectives will be revised and modified throughout the mitigation process and in the SSAWSIs as understanding of the heritage assets at the Thames Tideway Tunnel sites evolves.

4.3.4 The specific research themes and research objectives relevant to each site will be identified in the SSAWSIs to inform mitigation fieldwork.

5 Approach to archaeological mitigation

5.1 Introduction

5.1.1 The Thames Tideway Tunnel project has been designed to minimise environmental effects and therefore the construction design and methods take account of historic environment considerations. Control measures are included within the *CoCP* to minimise effects, for example to prevent accidental strike damage to structures of historic interest from vehicles and plant.

5.1.2 Where the EIA has identified likely significant effects, having taken account of embedded measures, mitigation has been identified where possible. An indication of likely mitigation is presented in the historic environment assessment within each site assessment volume of the *Environmental Statement* (Vol 4 to 27), which for buried heritage assets will be further refined following evaluation. Measures to mitigate the removal of built heritage assets proposed to facilitate construction of the Thames Tideway Tunnel, for example stretches of historic river wall to be removed, is summarised in Appendix C.

5.1.3 The majority of archaeological impacts will occur during the construction phase. The construction activities that will require mitigation include: utility diversions, site set-up, demolition, remediation, alteration or repair of retained buildings, temporary removal and storage of retained structures, ground works, construction of cofferdams and campsheds, dredging, construction of scour protection, landscaping and reinstatement.

5.1.4 There are two main approaches to archaeological mitigation: preservation in situ or archaeological investigation (preservation by record).

5.1.5 Preservation in situ is normally the preferred option for known assets of particularly high (i.e. national or international) significance, where feasible. No assets warranting preservation in situ have been identified at any Thames Tideway Tunnel sites. There may however be occasions where it is advantageous to the project to permanently protect remains, particularly in areas of temporary works.

5.1.6 The primary mitigation strategy for heritage assets is preservation by record, involving archaeological investigation, recording and dissemination at a level appropriate to the significance of the asset. Physical remains will be removed by archaeologists but the record and knowledge of them will be retained. When placed in the public domain, via suitable dissemination of the results, such records enhance public understanding and appreciation of the past.

5.2 Development of the phased mitigation strategy

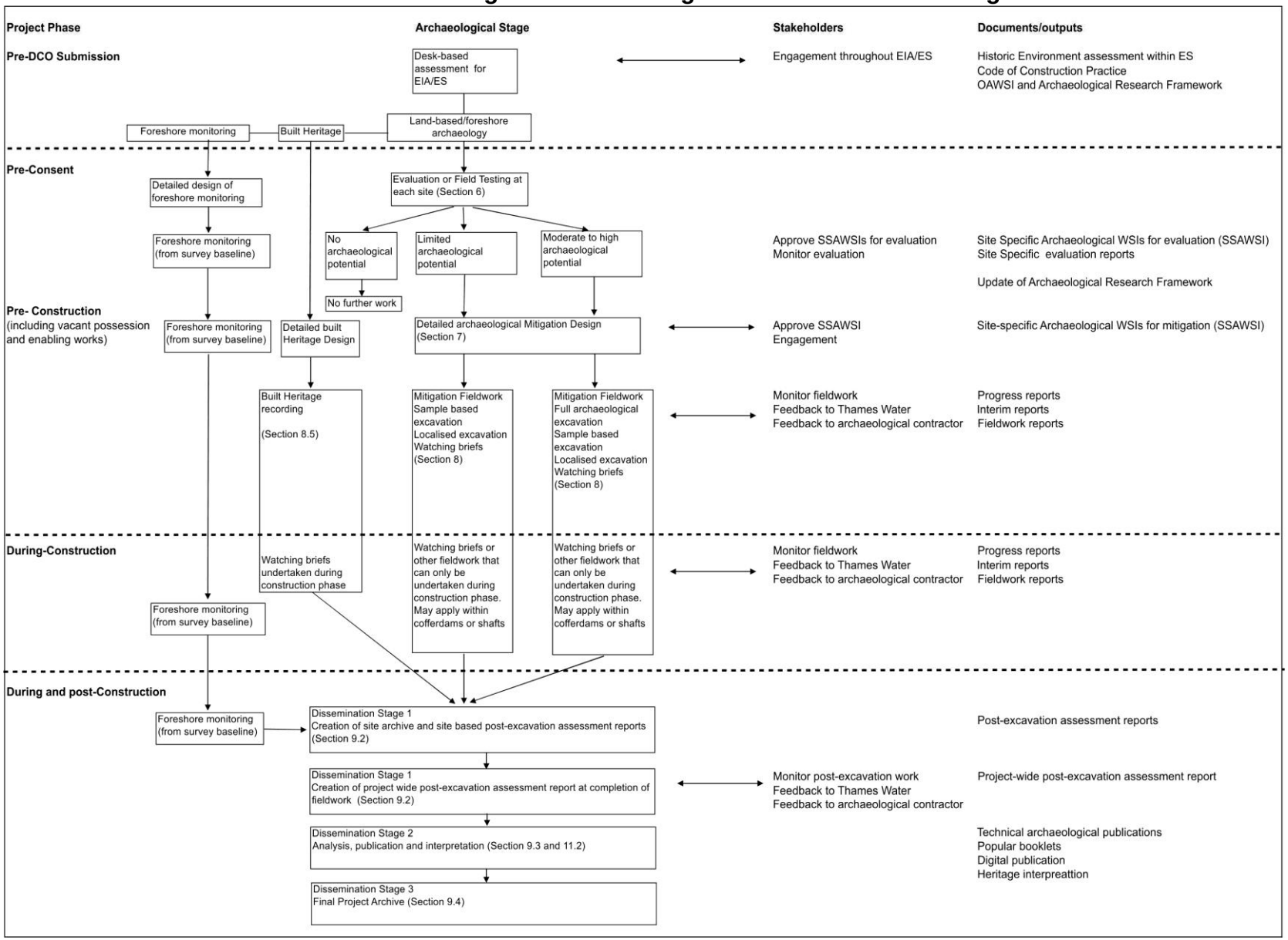
5.2.1 Development of the mitigation strategy and research framework typically occurs as a sequential process throughout the stages outlined in Table

5.2.1 Stages of archaeological assessment and mitigation below, so that each stage informs and focuses the next.

5.2.2 It is intended that elements that are essential to defining archaeological potential take place at the earliest feasible opportunity, in order to reduce uncertainty and risk within the construction programme.

5.2.3 Sections 6 to 9 of this document provide detail on the processes and techniques that form the Thames Tideway Tunnel archaeological mitigation strategy.

Table 5.2.1 Stages of archaeological assessment and mitigation



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6 Evaluation (field testing)

6.1.0 Evaluation (field testing) will be carried out prior to the start of construction. This may include work ahead of development consent being granted, in which case the scope of evaluation will be agreed with consultees through a separate series of SSAWSIs ahead of agreement of this OAWSI. The following sections set out the nature and purpose of evaluation and its likely scope.

6.1 Nature and purpose of evaluation (field testing)

6.1.1 The Institute for Archaeology (IfA) (2009) defines archaeological evaluation as "*a limited programme of non-intrusive and/or intrusive fieldwork which determines the presence or absence of archaeological features, structures, deposits, artefacts or ecofacts within a specified area or site on land … or underwater. If such archaeological remains are present Evaluation defines their character, extent, quality and preservation, and enables an assessment of their worth in a local, regional, national or international context as appropriate*[6]".

6.1.2 The aim of evaluation is to examine a representative sample of the remains affected by development in order to generate accurate information on the heritage assets actually present on each Thames Tideway Tunnel site. This information can then be used to design and programme the appropriate level of mitigation.

6.1.3 The evaluation stage will consist of trial work that is relatively small-scale, selective and sample-based whilst still sufficient to quantify, characterise and date the full range of archaeological remains potentially affected by development works.

6.1.4 Techniques will vary across land, foreshore and underwater environments, and with the deposit types and depths predicted at each site. .

6.1.5 In identifying the scope for evaluation it may be necessary to consider more detailed documentary information than covered in the *Environmental Statement*. For example, existing topographic surveys or geotechnical data (particularly borehole logs) may help to clarify archaeological survival across each site. This information may then be used to define appropriate evaluation techniques.

Possible land based evaluation techniques

6.1.6 On land based sites, or parts of sites (i.e. where a site straddles both land and foreshore) the following techniques may be employed, as appropriate, and these will be detailed in SSAWSIs for evaluation at each site, as described below:

a. land based geoarchaeological boreholes to sample and examine alluvial deposits with palaeoenvironmental potential

b. Monitoring of geotechnical trenches.

c. Archaeological trenches, through either extending and deepening geotechnical trenches or through identifying further archaeology specific trenches.

d. Any further geotechnical investigations undertaken to establish ground conditions to be archaeologically monitored by means of a Watching Brief, where it is considered that these works would provide useful information.

e. Deposit modelling utilising the above data, and historic sources.

Possible foreshore based evaluation techniques

6.1.7 On foreshore based sites the following techniques may be employed, as appropriate, and these will be detailed in SSAWSIs for evaluation at each site:

a. 3D topographical survey of the foreshore

b. Foreshore condition monitoring

c. Analysis of vibrocores

d. Finds and environmental sampling

e. Geophysical survey

f. Deposit modelling utilising the above data, and historic sources.

SSAWSIs for evaluation

6.1.8 The objectives of evaluation at each site will be defined in SSAWSIs, reflecting the project-wide research framework (Appendix B). These documents will specify the detailed scope and detailed methodology for each site. The SSAWSIs will be submitted to statutory consultees prior to the start of work. It is anticipated that these documents will be prepared prior to development consent being granted and that most of the evaluation work will also have been completed prior to development consent being granted.

6.1.9 It is envisaged that the evaluation may need to take a staged approach. The first stage will involve the evaluation of areas of known major impacts (i.e. within the footprint of deep excavations for chambers, culverts and shafts), the locations of which are specified within the zones shown on the Site Works Parameter plans for each site. Other works, such as land remediation, site set up including foundations for welfare facilities, access works, utility diversions, and landscaping may also have an impact on archaeology. When the contractor is determining the construction site layout, the evaluation results from the first stage will be reviewed to ascertain whether a second stage of evaluation is needed in the area of other works, for example, where archaeological deposits may survive at a shallow depth, rather than having been removed by previous developments or capped under modern made ground, or where such works cover a large area.

6.1.10 The requirement for a staged approach will be carefully considered for each site and the stages set out clearly in the SSAWSI. This will ensure that all works, whether major or otherwise are subject to the appropriate

level of evaluation, and that all parties are aware that evaluations may need to occur prior to the start of works.

6.1.11 Production of each SSAWSI will be informed by a site walkover inspection to ascertain the condition and layout of the site, access arrangements and any health and safety or other issues that may affect the scope of archaeological work. The SSAWSI's will be submitted to each local planning authority for approval in consultation with the Greater London Archaeological Advisory Service (GLAAS), where relevant. As noted previously, the City of London Corporation and the London Borough of Southwark have their own archaeologists, so HBMCE) would not be consulted in these boroughs, with the exception of marine archaeological matters (incorporating the foreshore) at sites within these jurisdictions.

Reporting

6.1.12 The results will be presented in an evaluation report, with suitable description, quantification, plans and illustrations to support the conclusions regarding the archaeological significance of the site (see also Section 10.2 for further details on reporting).

Combining evaluation and mitigation fieldwork

6.1.13 Where evaluation results are negative or demonstrate a lower archaeological potential than predicted in the *Environmental Statement* this may allow mitigation to be completed by:

a. scoping out all or part of the site from further work or reducing it to Watching Brief status

b. carrying out additional fieldwork investigation as part of the evaluation, preferably without a programme break between the two stages

c. undertaking further off-site analysis of the evaluation results, including documentary research where relevant.

Evaluation priorities and programme

6.1.14 Evaluation will be required at all sites where there is potential for surviving archaeological remains and where no evaluation has been undertaken to date.

6.1.15 Priorities will be archaeological sites that have been identified at the EIA stage as being potentially significant, but where this has not yet been quantified.

6.1.16 Programme information and updates on evaluation will be provided to statutory consultees via the Archaeology Forum (see Section 11.2). .

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7 Detailed mitigation design

7.1.1 Once the results of the evaluation are known and the significance of actual archaeological deposits and features has been assessed, the scope of archaeological mitigation will be detailed.

7.1.2 This detailed mitigation design will proceed in tandem with the engineering design development for the project and be developed in discussion with archaeologists, engineers, programmers and construction managers and statutory consultees on the historic environment.

7.1.3 The process will involve a review of archaeological and construction priorities, so that appropriate techniques of archaeological investigation and recording can be programmed (before or during the construction phase).

7.1.4 The scope and detailed methodology for mitigation fieldwork will be described separately for each site in SSAWSIs covering the mitigation phase.

7.1.5 Where possible the intention is to take archaeological mitigation off the construction critical path and carry out as much work as possible prior to main construction activities commencing.

7.1.6 Programme information and updates on archaeological mitigation will be provided to statutory consultees via the Archaeology Forum (see Section 11.2).

Contents of the SSAWSI for mitigation

7.1.7 The objectives of mitigation fieldwork at each site will be defined in SSAWSIs, reflecting the development of the project-wide research framework (Appendix B) following evaluation. These documents will specify the scope and detailed methodology for each site.

7.1.8 As with the evaluation phase, the production of each SSAWSI will be informed by a site walkover inspection, to ascertain any changes in the condition and layout of the site, access arrangements and any health and safety or other issues that may affect the scope of archaeological work.

7.1.9 Each SSAWSI will include the following sections:

a. Construction impacts: a description of the site-specific Thames Tideway Tunnel works which will have an impact upon the historic environment (including works plans and sections as appropriate)

b. Archaeological objectives: in response to the construction impacts detail of the site-specific mitigation objectives and archaeological data sought and how they will contribute to developing the project-wide research framework set out in the OAWSI

c. Archaeological scope of works: to include works plans and sections as appropriate. The SSAWSI will cross-refer to general classes of work described in the OAWSI and identify clearly any variation in techniques to address site-specific conditions

d. Non-archaeological constraints: any restrictions on the scope of works that may affect achievement of the stated objectives.

e. Technical attendances: the plant, equipment and other technical services that the archaeologists require from others in order to carry out the specified archaeological works

f. Programme and resources: the time and staff resources required to implement the scope of works, including a programme chart and details of site personnel, support staff and specialists, including CVs where appropriate

g. Contingency arrangements: to be deployed if the archaeological results are significantly different to those predicted

h. Public outreach and engagement proposals

i. Health, safety and welfare methodology: description of how a safe working environment will be ensured via relevant legislation, guidance, standards and good practice

j. Changes and revisions: the SSAWSI will include version control and a clear procedure for updating and amending the scope of works in the light of new information.

8 Mitigation fieldwork strategy

8.1 Introduction

8.1.1 The strategies that may be used during mitigation fieldwork are described below. This section is structured as follows:

a. archaeological excavation (full or sample excavation) including on-going foreshore survey and monitoring

b. general and targeted watching briefs

c. significance of sites and likely archaeological mitigation requirements

d. historic building recording.

8.2 Archaeological excavation and foreshore survey and monitoring

8.2.1 The Institute for Archaeology (IfA) (2008) defines an archaeological excavation as: "a programme of controlled, intrusive fieldwork with defined research objectives which examines, records and interprets archaeological deposits, features and structures and, as appropriate, retrieves artefacts, ecofacts and other remains within a specified area or site on land, inter-tidal zone or underwater. The records made and objects gathered during fieldwork are studied and the results of that study published in detail appropriate to the project design.[7] "

8.2.2 Archaeological remains may be investigated and recorded by full excavation (also known as single context excavation) or selective sample-based excavation, depending on the specified archaeological objectives and predicted significance (which will be detailed in the SSAWSIs).

8.2.3 Full excavation is most appropriate for deeply stratified, complex sites, particularly those of an urban nature. It entails the planning and complete excavation of each context separately[iii]. The stratigraphy of the site can then be reconstructed at the post-excavation stage.

8.2.4 Sample-based excavation is more appropriate for diffuse or shallower archaeological remains. It entails:

a. The topsoil or made ground is removed by machine under archaeological supervision until the subsoil or first significant archaeological horizon is reached

[iii] An archaeological 'context' is the basic unit of archaeological recording (in Greater London), and is used to describe and record evidence which represents a single process or event that happened in the past, for example; the profile and extent of a ditch cut is one context and will be recorded separately, the subsequent ditch fills are other contexts.

b. Archaeological deposits are hand cleaned to define the edges of discrete features and a survey plan, photographic and written record is made of the visible features

c. Different classes of archaeological remains and features are selectively excavated to techniques and sample percentages, which will be set out in the SSAWSI. Sections (of circular or linear features) and quadrants (of large circular or sub-circular features) may be used to recover artefacts and record internal stratigraphy. Certain types of features (burials, hearths, stratified remains or significant features) may be hand excavated in their entirety by the archaeologist and recorded. Palaeoenvironmental sampling of buried soil horizons and bulk sampling of certain deposits will also be undertaken to retrieve additional evidence.

8.2.5 The spatial extent of archaeological investigation within a site will depend on the significance of remains and their potential to contribute to the stated objectives in the SSAWSI.

Foreshore sites

8.2.6 Although exploratory evaluation is feasible at the majority of foreshore sites, further full mitigation can only be completed prior to construction where a relatively low archaeological potential has been established (e.g. where only a survey and investigation of surface features is necessary).

8.2.7 For foreshore sites with more significant archaeological interest, once temporary cofferdams are installed, archaeological investigation of affected areas within them may commence. The focus will be in the location of construction of permanent structures, but a level of impact from preparatory stripping and truncation of temporary works areas of the foreshore is also likely.

8.2.8 Where there is evidence for in-situ structures (e.g. fish traps or jetties) or original land surfaces with evidence of human occupation (e.g. hearths or plough marks), it will be necessary to record and excavate these features and their associated deposits fully. Where there are bulk deposits (e.g. reclamation deposits behind waterfronts, or naturally deposited alluvium) it is proposed to record representative samples of material.

On-going foreshore monitoring and survey

8.2.9 Areas outside cofferdams that may be subject to scour erosion will be subject to a survey and monitoring regime before and during construction. Depending upon the results, localised investigation of any areas being adversely affected by scour may be required, to the extent possible within the tidal conditions of the river.

Land-based sites

8.2.10 For the construction of permanent infrastructure at land based sites, the nature of archaeological investigations will follow a sliding scale of selective intervention, ranging from full hand excavation to more sample-based techniques. The application of these techniques is described below.

Shallow archaeological deposits

8.2.11 On sites where the depth of made ground is shallow and the shafts and other constructions affect significant deposits that are up to approximately 3m deep, where possible early access will be made for archaeological investigations well in advance of construction. Installation of temporary support could extend the depth accessible in this way. In the case of shaft locations this will minimise the intervention needed during construction.

Deep archaeological deposits

8.2.12 On sites with deep made ground, where shafts and other works affect made ground/archaeological deposits that cannot be accessed prior to construction (for depth or other reasons) archaeological investigations will be carried out during construction.

8.2.13 Where investigation within land-based shafts is required, a predictive model will be established at the evaluation stage (e.g. via a geo-archaeology borehole at the shaft location, combined with geotechnical data within the vicinity). This will enable the relevant archaeological deposits and the depth at which they occur to be identified in advance. A corresponding time allowance for investigations will thus be programmed.

8.3 Watching brief

8.3.1 An archaeological watching brief is defined by the Institute for Archaeologists (IfA) (2008) [8] as:

a. a formal programme of observation and investigation conducted during any operation carried out for non-archaeological reasons.

b. to allow, within the resources available, the preservation by record of archaeological deposits, the presence and nature of which could not be established (or established with sufficient accuracy) in advance of development or other potentially disruptive works.

c. to provide an opportunity, if needed, for the watching archaeologist to signal to all interested parties, before the destruction of the material in question, that an archaeological find has been made for which the resources allocated to the watching brief itself are not sufficient to support treatment to a satisfactory and proper standard.

d. a watching brief is not intended to reduce the requirement for excavation or preservation of known or inferred deposits, and it is intended to guide, not replace, any requirement for contingent excavation or preservation of possible deposits.

8.3.2 There are two types of watching brief: a general watching brief and a targeted watching brief, which are defined below.

General Watching Brief

8.3.3 Under a general watching brief, the archaeological attendance monitors the works as they occur, with no particular requirements on the Principal Contractor's method of operation. It may be used for areas where there is

a low probability of archaeological remains being present, or for some enabling works such as utilities.

Targeted Watching Brief

8.3.4 Under a targeted watching brief, the archaeological attendance involves a closer monitoring and supervision of the works. There may be particular requirements on the Principal Contractor's method of operation e.g. types of plant. It may be used for areas where more care is needed in ground works e.g. for temporary site compounds and haul roads where there may be a need to minimise damage so as to preserve archaeological remains in situ (as an alternative to archaeological excavations).

8.3.5 Both types of Watching Brief have two components:

a. Monitoring attendance: to observe the works and make a basic record (e.g. notes and photographs).

b. More detailed investigation and record (e.g. selective hand excavation) if significant remains are revealed during the works, for which additional archaeologists may be required.

8.3.6 Sites for which Watching Briefs may be are detailed in paras. 8.4.5 and 8.4.7.

8.4 Significance of sites and likely mitigation requirement

8.4.1 This section outlines the provisional levels of significance of each site, as identified through the EIA process, and the mitigation techniques likely to be appropriate at such sites. These will remain as provisional until further evaluation works (described in Sections 6) have been carried out. At that point the significance of each site, based upon the local and regional context and the Research Framework (Appendix B), will be re-evaluated and appropriate mitigation correspondingly set out in the SSAWSI.

Sites of high and medium-high significance

8.4.2 Full advance archaeological hand excavation is likely to be needed at sites of high and medium-high significance, but only of selected areas, where the most important archaeological features and strata identified in evaluation are present. For the remainder, a more targeted strategy is likely to be sufficient. This approach will be agreed with each local planning authority where applicable, through the approval of the SSAWSIs, in consultation with the Greater London Archaeological Advisory Service (GLAAS), or in the case of the City of London Corporation and the London Borough of Southwark, in consultation with their local authority archaeologists.

8.4.3 Desk-based research and site walkovers have provided an initial indication of overall site significance. The sites that have been identified as being of high and medium-high significance are set out below. This rating may change following evaluation:

a. Albert Embankment Foreshore – high potential for prehistoric landsurface with possible manmade timber structure dating to Mesolithic period.

b. Chambers Wharf (landbased and foreshore) – high potential for prehistoric landsurface, together with medieval and later waterfront remains.

c. King Edward Memorial Park – moderate potential for prehistoric landsurface and medieval and later remains.

d. Barn Elms – high potential for prehistoric (Iron Age) settlement.

Sites of medium significance

8.4.4 At sites of medium significance the emphasis is likely to be on selective sampling techniques throughout, with full hand excavation only occurring if localised features of high significance are present (but not to a sufficient extent for the site as a whole to be considered of that level of significance). Conversely, if there are local areas of low significance these are likely to be subject only to a Watching Brief during construction (see Section 8.3).

8.4.5 The sites that have been identified as being of medium significance are set out below. This rating may change following evaluation:

a. Putney Embankment Foreshore – evidence for Roman, medieval and later occupation on nearby sites. May have been removed locally by scouring or dredging. Ranking may change following evaluation.

b. Heathwall Pumping Station (landbased and foreshore) – moderate potential for prehistoric landsurfaces, evidence of Saxon activity and later industry.

c. Kirtling Street (landbased and foreshore) – low to moderate potential for prehistoric and later remains.

d. Hammersmith Pumping Station – moderate (localised) potential for remains of early Saxon settlement and 17th century industry.

e. Dormay Street – moderate for prehistoric and later activity within alluvial deposits.

f. Chelsea Embankment Foreshore (landbased and foreshore) – moderate potential for prehistoric and later activity.

g. Cremorne Wharf Depot –moderate potential for prehistoric landsurfaces within alluvium on landward side of river wall.

h. Carnwath Road Riverside - moderate potential for prehistoric landsurfaces within alluvium and later activity on landward side of river wall.

i. Blackfriars Bridge Foreshore – moderate potential for river-related chance finds (ie, boats) in former Thames channel.

j. Beckton Sewage Treatment Works – moderate potential for prehistoric activity within the alluvium (at depth) at Site A only.

k. Abbey Mills Pumping Station - moderate potential for prehistoric activity within the alluvium (at depth).

l. Earl Pumping Station – potential for prehistoric activity in alluvium.

m. Greenwich Pumping Station - low potential for prehistoric to medieval remains of low significance, but the site contains the Bazalgette engine house of high significance. Overall the site is of medium significance.

Sites of low significance

8.4.6 Sites of low significance are unlikely to require archaeological excavation. These sites may be subject to a Watching Brief during construction (see Section 8.3). If localised features of medium or high significance are revealed during the Watching Brief, hand excavation may be required.

8.4.7 The sites that have been identified as being of low significance are set out below. This rating may change following evaluation:

a. King George's Park – low potential for evidence of prehistoric to medieval activity within River Wandle alluvium.

b. Falconbrook Pumping Station – moderate potential for evidence of medieval activity.

c. Acton Storm Tanks – low potential

d. Shad Thames Pumping Station – moderate potential for prehistoric remains.

e. Bekesbourne Street – low potential

f. Victoria Embankment Foreshore – low potential, channel probably dredged.

g. Deptford Church Street – low potential

8.4.8 The deposits of interest at Falconbrook, Acton Storm Tanks and Deptford Church Street are likely to be fairly shallow in depth. At these sites it may therefore be possible to extend the evaluation phase of works to mitigate the impact on any archaeology revealed, negating the need for a watching brief during the main construction phase.

8.5 Built heritage recording

8.5.1 As with buried heritage assets, preservation in situ is the preferred option for assets of high significance (listed buildings and scheduled monuments).

8.5.2 Where preservation in situ is not feasible, for example where sections of listed river wall will be partly removed, and for above ground assets of lesser significance, preservation by record is proposed. This will take the form of standing building archaeological survey and recording to an appropriate HBCME standard[9] and in accordance with RCHME[10] and IfA[11] guidelines. This will include recording of historic in-river structures such as bridges, wharves, jetties and pontoons.

8.5.3 There are five levels of archaeological survey for above ground heritage assets: the first is a photographic survey including a brief written account, followed by a basic visual record (Level 1), through to a comprehensive

analytical record (Level 4). . The recording will be undertaken prior to the demolition, alteration, or modification of the asset.

8.5.4 Buildings and structures that require recording have been identified in the *Environmental Statement* (these requirements, including the level of recording which is commensurate with the significance of the remains, are also summarised in Appendix C).

8.6 Unexpected discoveries

8.6.1 The sequential process of desk based assessment followed by site-based evaluation outlined in this document has been designed to establish a robust predictive model that minimises the likelihood of unexpected archaeological discoveries during construction.

8.6.2 Wherever practicable early evaluation will be undertaken to provide greater certainty concerning the nature and location of archaeological remains, allowing mitigation to be defined, programmed (and where possible implemented) in advance of main construction.

8.6.3 The operation of a Watching Brief during construction further contains risk, providing a contingency arrangement for managing occasional unexpected discoveries. It enables archaeologists to be on hand to advise and to handle any discoveries.

8.6.4 In the event of unexpected discoveries during construction, work will cease in the vicinity and an archaeologist be contacted immediately. The area must be made safe, sufficient for the archaeologist to inspect the remains and advise on what, if any, further investigations are required.

8.6.5 In the case of small-scale routine remains, the archaeological team may be able to investigate and record them immediately, so that construction work may continue.

8.6.6 In the case of more extensive or significant discoveries the archaeologist will liaise with Thames Water and statutory consultees (who may wish to attend site) in order that suitable mitigation may be agreed and implemented with minimum delay.

8.6.7 Contractors are also required to define procedures in the event of the discovery of human remains. These should follow those outlined above and the consents procedure described at 2.1.3.

8.6.8 Any human remains will need to be covered and screened from public view and suitable security provided pending a decision regarding how the remains be treated. Human remains will be treated in accordance with the HBMCE guidelines[12].

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9 Post-excavation work

9.1 Processing of site data and finds

9.1.1 During and upon completion of fieldwork all site records, finds and samples will be processed, packaged, entered on a database and stored, to create an initial fieldwork archive. The objective is to produce a checked, ordered and retrievable corpus of data, with supporting stratigraphic matrices and digitised feature plans, ready to be worked on when the post-excavation process begins. For the same reason, the initial processing, cleaning and cataloguing of finds and samples will also be undertaken at this stage. Initial first aid conservation and stabilisation of some artefacts may be required.

9.2 Post-excavation assessment

9.2.1 Completion of the fieldwork archive enables it to be further quantified and then examined and assessed for its potential to contribute to the archaeological research framework (Section 4 and Appendix B). The fieldwork results may contribute to some objectives and not others. Equally new information may allow additional priorities to be defined.

9.2.2 This process allows results across the project to be considered, so that those sites, themes and remains of most significance for further analytical work are recognised. Similarly the less important remains may merit less or no further work. This allows new priorities to be set, so that only meaningful data that contributes to the revised research aims is worked on at the subsequent analysis and publication stage.

9.2.3 The assessment stage therefore adds value to the mitigation process by creating a revised framework of priorities following completion of fieldwork.

9.2.4 The assessment stage leads to the production of an overarching post-excavation assessment report, with site specific reports for the most important sites in archaeological terms (see para 10.4.1), in accordance with 'Appendix 4: assessment report specification' in the *Management of Archaeological Projects*(HBMCE, 1991)[13], the IfA's *Standard and guidance for archaeological excavation* (2008)[14] and the GLAAS guidance papers (2009)[15].

9.2.5 Further details of post-excavation assessment at the site and project-wide level are given in 10.4.1 and 10.4.2.

9.2.6 In addition to these technical reports, an interim statement giving an overall view of the project and its results in non-technical language will be prepared and issued to Thames Water and relevant stakeholders on or before completion of the post-excavation assessment reports.

9.2.7 The post-excavation assessment reports will be submitted to each local planning authority and GLAAS, allowing the programme of archaeological works to proceed to analysis and publication. Approval of these

documents will be sought in terms of the scope and tasks involved in further analysis and publication.

9.3 Publication/dissemination

9.3.1 In the case of archaeological sites and results that do not advance understanding of the themes and objectives of the research framework, the minimum dissemination requirement is to submit a short summary of the results to the Greater London HER and NMR (using the appropriate OASIS archaeological report form), and for publication in the 'Excavation Round-up' of the London Archaeologist and other period-based archaeological journals as appropriate.

9.3.2 Where a clear potential has been identified in the Post-excavation assessment report further analysis of the fieldwork archive is carried out. For a large infrastructure project the report is likely to recommend a range of dissemination at technical and more popular levels.

9.3.3 In order to realise the objective of the mitigation strategy of preservation by record - to improve public understanding and appreciation of the past - dissemination of the archaeological results of a large infrastructure project may range from technical volumes (thematic or period-based) to popular booklets, temporary exhibitions, work with schools, web-based initiatives etc.

9.4 Final project archive

The project archive

9.4.1 The initial fieldwork archive (Section 9.1) plus the results, reports and data from subsequent analysis and publication will be systematised into an ordered and retrievable final project archive suitable for public access for future research.

9.4.2 The project archive will then be transferred to a nominated public receiving body (normally a local museum). This completes the planning requirements for preservation by record by placing all results into the public domain

9.4.3 The receiving body for the Thames Tideway Tunnel archaeological archive will be the Museum of London's London Archaeological Archive and Research Centre (LAARC). The final project archive should therefore be prepared to Museum of London deposition standards (2009)[16].

9.4.4 These are supplemented by the following guidelines:

a. Institute of Conservation (ICON, formerly known as UK Institute for Conservation) Conservation Guide-lines No. 2,

b. Museum of London Standards for the Preparation of Finds to be permanently retained by the Museum of London.

c. Museums and Galleries Commission's Standards in the Museum Care of Archaeological Collections, (1992),

d. Society of Museum Archaeologist's (draft) Selection, retention and dispersal of archaeological collections, (1992)

e. Archaeological Archives Forum Archaeological Archives. A guide to best practice in creation, compilation, transfer and curation (2007)[17].

Ownership of finds

9.4.5 Ownership of any finds on a site lies with the landowner (except in certain circumstances where finds are considered to be Treasure, para. 2.1.4). Approvals, licences and permissions from the landowner would be required to donate the finds to the Museum of London, to enable the Museum to carry out its obligations to curate the finds after discovery, in perpetuity, as part of the archaeological Archive from each site.

9.4.6 These approvals, licences and permissions shall be either confirmed in the Agreement and Contract regulating the archaeological works and/or confirmed by the completion of the relevant Deed of Transfer form.

9.4.7 Thames Water would need to complete relevant Agreements and Deeds of Transfer where they are the landowner. Where the landowner is different, the Thames Water would need to make arrangements for the completion of such agreements by the landowner.

9.4.8 Subsequent arrangements may be made if required between the landowner and/or Thames Water and the Museum for the conservation, display, provision of access to or loan of selected finds in or near their original location.

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10 Reporting structure

10.1 Document control

10.1.1 Each Principal Contractor will be responsible for designing and carrying out their works in a manner that enables the OAWSI to be implemented.

10.1.2 SSAWSIs will be prepared to the structure outlined at para. 7.1.9 and re-issued as new archaeological information becomes available or relevant engineering design changes occur that affect impacts.

10.1.3 All SSAWSIs will have a document control table showing the issue number, date, author, reviewer and reason for issue.

10.1.4 All SSAWSIs will contain a bibliography of relevant Thames Tideway Tunnel documents identifying which are current or superseded and including references to the particular design issue and date of the engineering drawings and reports that the SSAWSI is addressing.

As archaeological mitigation progresses a series of report outputs will be produced. A description of these is set out below. Such reports will be produced in the following order: evaluation reports upon completion of evaluation works which will outline the recommended next steps; mitigation reports which will be produced during fieldwork; Post-excavation Assessment reports for each excavation site to set out what, if any further analysis is required; a Post-excavation Assessment and Updated Project Design which sets out the tasks, scope and aims of the further analytical work for the entire project.

10.2 Evaluation reports

10.2.1 Evaluation reports will include as a minimum:

a. a description of the deposit sequence and individual features in each trench or other intervention with depths and ordnance datum levels (e.g. in tabular form)

b. a professional interpretation of the results and their significance (both the intervention results and collectively for the site) - including supporting specialist comment, dating evidence, historic maps etc.

   i an assessment of the contribution of the results to the site specific objectives and the project-wide research framework

   ii an indication of any non-archaeological constraints that may have restricted achievement of the specified scope of works and the resulting degree of confidence that may be placed upon the conclusions

   iii a sufficient quantification and scan of finds and samples to give preliminary conclusions about the character and date of the deposits evaluated

iv conclusions regarding predicted archaeological survival and significance across the site or those parts of it evaluated, (supported by cross sections if necessary) sufficient for the significance of each site to be ranked and compared with other Thames Tideway Tunnel sites within the wider local and regional context and the Research Framework.

v sufficient plans, sections, photographs and specialist appendices to fully explain and support the conclusions

10.2.2 An evaluation report will be submitted to Thames Water, for submission to local planning authorities and GLAAS, within four weeks of completion of fieldwork.

10.3 Mitigation reports

Progress reports

10.3.1 A weekly progress report will be submitted to Thames Water detailing the progress of the work that week, including any issues or problems.

Fieldwork report

10.3.2 A summary of the results will be provided to Thames Water, in the form of a fieldwork report, no later than four weeks after completion of fieldwork to the same general format as evaluation reports. These will also be submitted to the local planning authorities and GLAAS.

10.4 Post-excavation Assessment

10.4.1 For the most important archaeological sites, a site-specific post-excavation assessment report will be produced within six months of completion of fieldwork. This will assess the results of fieldwork against the archaeological research framework and site-specific objectives, to identify opportunities for analysis, publication and outreach (as outlined in Section 9 above).

10.4.2 On completion of all the fieldwork, a post-excavation assessment report for the entire Thames Tideway Tunnel project will be completed no later than six months after the completion of the last piece of fieldwork. It will include the recommended analysis aims and tasks and the publication formats.

10.4.3 The post-excavation assessment reports will be submitted to each local planning authority and GLAAS, allowing the programme of archaeological works to proceed to analysis and publication. Approval of these documents will be sought in terms of the scope and tasks involved in further analysis and publication.

11 Communication

11.1 Roles and responsibilities

11.1.1 Detailed information on team structure and lines of communication will be provided in the SSAWSIs. The following paragraphs set out general principles that will assist in the delivery of an effective archaeological mitigation strategy.

Thames Water

11.1.2 During the construction, design and programming phase, the Thames Water team will communicate sufficient technical information to the archaeological team to allow the archaeological programme of works to be defined and implemented. This includes ensuring that responsibilities for the historic environment are adequately defined at the tender and contract award stage.

11.1.3 Thames Water will provide a system for stakeholders to communicate feedback to archaeological contractors and Principal Contractors.

11.1.4 Press and publicity protocols will be communicated to archaeological contractors and Principal Contractors.

Principal Contractors

11.1.5 Contractors will manage the construction process in a way that facilitates safe access for the archaeological team to complete the programme of archaeological works that has been defined in SSAWSIs and agreed with the statutory consultees.

11.1.6 The Contractors will provide the necessary technical support and attendances as outlined below:

a. Liaising with the Thames Water team including the Thames Water archaeologist in heritage matters including seeking advice where necessary

b. Seeking the professional advice of Thames Water's archaeological contractor concerning any built or buried heritage concerns, unexpected discoveries, human remains or treasure.

c. Granting reasonable site access to statutory consultees or advisors as appropriate.

Archaeological team

11.1.7 The archaeological team will develop and update the archaeological SSAWSIs in conjunction with the Thames Water team, each Contractor and the statutory consultees.

11.1.8 They will undertake the required programme of archaeological works specified in the SSAWSIs to professional standards and best practice, including:

a. keeping to agreed timetables and work programme, and providing advance notice of cases where this would not be possible due to unforeseen circumstances or other issues.

b. Developing archaeological priories framework and research objectives through feedback of the results of the ongoing programme of archaeological works, so that existing priorities may be reviewed and new ones identified

c. Proactively communicating with the Thames Water team, Contractors and statutory consultees via progress reports and meetings;

d. Contributing actively and vigilantly (under appropriate specialist advice) to implementation of each Contractor's safety management system in order to maintain a safe working environment within which the agreed programme of archaeological works may be carried out.

Statutory consultees

11.1.9 Each local planning authority will be responsible for approving archaeological mitigation, via approval of SSAWSIs. As noted previously, for those authorities without in-house archaeologists, this will be in consultation with the Greater London Archaeological Advisory Service (GLAAS). In the case of the City of London Corporation and the LB of Southwark this role will be undertaken by the local planning authority itself.

11.1.10 Local planning authorities and GLAAS may wish to be satisfied, through site inspections, that the archaeological works are being conducted to professional standards and in accordance with the OAWSI and SSAWSIs. The Thames Water team, Contractors and the archaeological team will provide reasonable access for this purpose.

11.2 Consultation

11.2.1 During the EIA phase, the Thames Tideway Tunnel project has undertaken a comprehensive programme of consultation and engagement on the historic environment topic with:

a. HBMCE including the Greater London Archaeological Advisory Service (GLAAS)

b. Archaeologists at the City of London Corporation and London Borough of Southwark

c. Relevant local and national amenity societies

11.2.2 Thames Water will maintain a high level of engagement on the historic environment throughout the life of the project.

11.2.3 To aid this, progress on archaeological work undertaken and planned will be reported to statutory consultees via a proforma, the format of which will be agreed with consultees. This will be provided on a monthly basis by email, until such time as a more frequent report would be beneficial which would be agreed with consultees; if there are periods where no works of archaeological relevance are taking place reports would not be provided. In addition an Archaeology Forum will be established, with a programme

of regular meetings to provide updates on work undertaken, findings of this, and forthcoming work.

11.3 Heritage interpretation and outreach opportunities

11.3.1 Bazalgette's sewage system is of at least national significance and has shaped the development of central London from the mid-19th century. Its characteristic structures provided a thematic link to the Thames embankments in central London, where none existed previously. The monumental and more homogeneous character that it provided to the Thames helped to augment the existing grandeur of central London, providing it with a cutting edge sewer system and underground railway and setting the tone of the city as a world trade hub. The Thames Tideway Tunnel structures are designed to adapt and augment Bazalgette's system, thus preserving its significance and providing it with a new lease of life.

11.3.2 As such the Thames Tideway Tunnel project has the scope to incorporate permanent heritage interpretation across Thames Tideway Tunnel sites, celebrating the pioneering nature and significance of Bazalgette's sewage system, and the engineering achievements of the Thames Tideway Tunnel as a sensitive development of London's historic sewer system.

11.3.3 A project such as the Thames Tideway Tunnel also has the scope to generate considerable archaeological information and provide an opportunity for communicating such finds to the wider public. Interpretation of archaeological information will be informed by the reported fieldwork results and the updated priorities framework developed from them (see Appendix B). Appropriate outreach and engagement opportunities will be identified throughout the construction and operational phases of the project and could include activities such as presentations, school activities, media coverage, web-based initiatives and permanent heritage interpretation at relevant sites.

11.3.4 Proposals for heritage interpretation, both in relation to Bazalgette's sewage system and archaeological material and finds from all periods, within the design of Thames Tideway Tunnel sites, will be detailed within an Interpretation Strategy, as per the project Design Principles, and requirements detailed in Schedule 3 of the Development Consent Order. The Interpretation Strategy will also detail how outreach and engagement opportunities will be identified and delivered.

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12 Health and safety

12.1.1 All archaeological and built heritage mitigation will be undertaken according to appropriate health, safety and welfare legislation, directives, approved codes of practice and guidelines, as well as the project health and safety policy and standards.

12.1.2 Under the provisions of the *CoCP* and the HSSE Standard, each Contractor is required to produce a Construction Phase Plan.

12.1.3 The Site Specific Archaeological Written Schemes of Investigation would apply these standards to the individual circumstances of each site, providing detailed health and safety safe systems of works, including site-specific risk-assessment.

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13 Thames Tideway Tunnel bibliography

13.1.1 The following bibliography provides a running list of Thames Tideway Tunnel documents to which this document relates.

a. Thames Water. *Thames Tideway Tunnel Environmental Statement Volume 2: Environmental assessment methodology* (*January 2013*)

b. Thames Water. *Thames Tideway Tunnel Environmental Statement Volume 3: Project-wide effects assessment* (*January 2013*)

c. Thames Water. *Thames Tideway Tunnel Environmental Statement Vols 4 to 27: Historic Environment* (*January 2013*)

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Appendices

List of appendices

Page number

List of tables

Page number

List of plates

Page number

This page is intentionally blank

Appendix A : Relevant Heritage Environment Local Management (HELM) documents

- Archaeomagnetic Dating
- Archaeometallury: Centre for Archaeology Guidelines
- Coastal Defence and the Historic Environment – HBMCE Guidance
- Conservation Principles, Policies and Guidance (April, 2008)
- Dendrochronology: Guidelines on producing and interpreting dendrochronological dates
- Enabling Development and Conservation of Significant Places
- Environmental Archaeology: A Guide to the Theory and Practice of Methods, from Sampling and Recovery to Post-Excavation (2nd edn)
- Form for submitting Archaeological Science Data to Historic Environment Records
- Geoarchaeology: using earth sciences to understand the archaeological record
- Geophysical Survey in Archaeological Field Evaluation
- Guidance on Assessing the Risk Posed by Land Contamination and its Remediation on Archaeological Resource Management
- Guidelines on the X-radiography of archaeological metalwork
- Human Bones from Archaeological Sites – Guidelines for producing assessment documents and analytical report
- Identifying and protecting Palaeolithic remains: Archaeological guidance for planning authorities and developers
- Identifying and Sourcing Stone for Historic Building Repair
- Investigative Conservation: Guidelines on how the detailed examination of artefacts from archaeological sites can shed light on their manufacture and use
- Luminescence Dating
- Our Portable Past
- Piling and Archaeology
- Presentation of Historic Building Survey in CAD
- Radiocarbon Dates ALSF 2002-4
- Science for Historic Industries: Guidelines for the investigation of 17th to 19th century industries
- Seeing the History in the View: A Method for Assessing Heritage Significance Within Views
- The Setting of Heritage Assets

- Temporary Structures in Historic Places: Guidance for local planning authorities, site owners and event organisers
- Understanding Historic Buildings: A Guide to Good Recording Practice (Parts 1-3)
- Understanding Historic Buildings: Policy and Guidance for Local Planning Authorities
- Understanding Place: Character and context in local planning
- Waterlogged Organic Artefacts: Guidelines on their Recovery, Analysis and Conservation
- Waterlogged Wood
- Where on Earth Are We? The Global Positioning System (GPS) in archaeological field survey

Appendix B :Thames Tideway Tunnel Archaeological Research Framework

B.1 Introduction

Purpose

B.1.1 This document sets out the archaeological research framework for the Thames Tideway Tunnel, based on the sources and data available at the completion of the EIA phase.

B.1.2 The purpose of the framework is to provide a structure of research priorities to be considered when developing a mitigation strategy to apply to the wide variety of above and below ground heritage assets likely to be present along the Thames Tideway Tunnel route. It has been informed by the EIA process.

B.1.3 The research framework allows the whole mitigation strategy (evaluation, mitigation fieldwork and post-excavation work) to be focused and informed, so that it prioritises the sites and types of archaeological remains agreed to have the most potential to enhance public appreciation of the historic environment.

B.1.4 The research framework is linked to the current agreed priorities, objectives and strategies for Greater London and The Greater Thames Estuary (para. B.1.8).

B.1.5 The framework categorises some of the main topics and themes under which human history along the Thames Tideway Tunnel route and the development of London as a world city may be described. The dominant project-wide factor in patterns of past settlement and land use has been the Thames itself.

Structure

B.1.6 The document comprises two main sections. The first section sets the scene with a description of the physical development and influence of the river and its tributaries. The major fluctuations in sea level and river regime that have occurred since the Palaeolithic (Old Stone Age) have profoundly influenced the shaping of the natural landscape along the Thames Tideway Tunnel route and past human activity within it. This climate-driven process provides the setting and environmental context for the second section of this document; discussion of five Route-wide Heritage Themes (RWHTs). These group predicted heritage assets at the Thames Tideway Tunnel sites into topics that reflect the role of the river in the development of London.

B.1.7 The RWHT topics are:

a. Theme 1: Palaeoenvironment and prehistory

b. Theme 2: Settlement pattern and boundaries

c. Theme 3: River management, transport, infrastructure and trade

d. Theme 4: London's water systems and public health

e. Theme 5: Industries associated with the Thames and its tributaries.

B.1.8 The RWHTs are in turn supported by specific research objectives set out in the *Research Framework for London Archaeology* (Museum of London and English Heritage, 2002)[18] and similar work undertaken on the *Greater Thames Estuary Historic Environment Research Framework* (Heppell, 2010)[19].

B.1.9 Each RWHT is described and followed by a list of the relevant published research objectives. A number of selected sites and features have been given a unique research framework (RF) number and are referred to in the text and shown on Figures B.1.1 to B.1.4 (see Figures at the end of this document).

Development and implementation of the research framework

B.1.10 The research framework presented here, as part of the OAWSI, is project-wide. It will be supplemented in due course by a set of archaeological objectives, specified for each site where mitigation is proposed. These will be included in the SSAWSIs.

B.1.11 The project-wide research framework will be further developed as fieldwork results become available; existing priorities may be amended and new objectives defined. A review of archaeological priorities is anticipated following the first fieldwork on Thames Tideway Tunnel sites (archaeological field evaluation); and again when the potential of all mitigation fieldwork results is being considered at the post-excavation assessment stage.

B.1.12 As part of the review process it may be appropriate to form an advisory panel of relevant experts and stakeholder representatives, to provide an independent perspective and stakeholder engagement in setting archaeological priorities for the project.

Physical setting and environmental influences

Geological features of the Thames Valley

B.1.13 The route of the Thames Tideway Tunnel crosses different topographic zones and hence landscapes; comprising various geomorphological landforms and distinctive sedimentary sequences, each with differing palaeoenvironmental and archaeological potential. The features comprise: the river terraces; the Thames floodplain; the modern foreshore; and the tributary valleys and lost rivers.

River terraces

B.1.14 Flanking the valley sides both north and south of the present river are a series of gravel terraces, laid down at various times during the Pleistocene epoch (as outlined in the chronological Table B.1), when the Thames existed as a fast flowing arctic river, swollen with meltwater, carrying a large gravel bedload under cold climate conditions. The gravels are

overlain by fine grained clays, silts and sands attributed to the 'brickearth' formations commonly found in the London region, which accumulated within different environments including fluvial (riverine), colluvial (hill wash), and as semi-frozen solifluction deposits, sliding down slope in periglacial conditions. The brickearth distribution is shown on Figure B.1.2, B.1.3 and B.1.4 (see Figures at the end of this document). It is only likely to be encountered (if at all) at the Acton Storm Tanks and Deptford Church Street sites.

B.1.15 The sequence of gravel terraces form a flight of progressively younger steps descending down the valley side towards the Thames. These formed as a result of tectonic uplift, and sea level fluctuations that forced episodes of floodplain incision and aggradation as the climate lurched from arctic (Glacial) to temperate (Interglacial) conditions over the past 0.5 million years. Interglacial deposits are known to exist at the interface between river terraces, and sometimes occur as lenses of fine grained sediments interleaved within the coarse gravel sediments. These were former floodplain edge locations, where the deposits were able to survive river scour during the succeeding arctic episodes.

B.1.16 Palaeolithic flint tools and bone within the gravel are likely to be far removed from their original position, having been transported with the gravel by the ancestral Thames. Palaeolithic artefacts, including palaeoenvironmental information, located at the interface of the brickearth and gravels, or within fine-grained lenses, may be in situ. Several Thames Tideway Tunnel sites could lie at the junction between the most recent (Kempton Park) and the earlier (Taplow) terraces (for example Acton Storm Tanks; Victoria Embankment Foreshore and King Edward Memorial Park Foreshore, see Figure B.1.3 and B.1.4, see Figures at the end of this document). In these locations there is potential for Interglacial deposits relating to the Ipswichian temperate stage - the last warm stage, which took place about 125,000 years ago. The presence of such remains within the site is impossible to predict from desk-based research.

B.1.17 Other Thames Tideway Tunnel sites on the Kempton Park Terrace (Chelsea Embankment Foreshore, Hammersmith Pumping station, Albert Embankment Foreshore and Putney Embankment Foreshore) lie further from the terrace margin, and have less potential for Interglacial deposit preservation, although may contain fine-grained and organic deposits relating to Interstadial episodes within the last cold stage.

B.1.18 Post-glacial prehistoric activity (from the Mesolithic onwards) would have been focused on the river terraces and especially their edges adjacent to the floodplain and tributary valleys and streams. Although much fragile evidence from this period will have been removed by later activity, Albert Embankment Foreshore is a good example of a site that (although now being eroded by the present river channel) contains remains of a much earlier Mesolithic and Bronze Age landscape.

B.1.19 The high and dry gravel terraces flanking the lower lying marshlands of the Thames floodplain would have attracted prehistoric activity, providing relatively light and fertile soils and many spring lines and streams.

Table B.1 Later Quaternary chronology

Marine Isotope Stage (MIS)	Approx date (thousands of years ago)	Epoch	Stage name				Archaeology	Climate	
1	0.5	Holocene	Late Holocene			Historic	Post- medieval	warm	Interglacial
	1						Medieval		
	2						Roman		
	3					Prehistoric	Iron Age		
	4		Mid Holocene				Bronze Age		
	6						Neolithic		
	11.5		Early Holocene				Mesolithic		
2	13	Late Pleistocene	Devensian	Late	Devensian 'Lateglacial'	Loch Lomond Stadial	Upper Palaeolithic	cold	Glacial (last cold stage)
	15					Windemere Interstadial		warmer	
	25					Dimlington Stadial (Last Glacial Maximum, c		cold	

Marine Isotope Stage (MIS)	Approx date (thousands of years ago)	Epoch	Stage name			Archaeology	Climate	
					20,000yrs ago)			
3	58			Middle	Upton Warren interstadial	Middle Palaeolithic	warmer	
4	75			Early			cold	
5a	79		Variably referred to as Ipswichian or Devensian		Brimhampton interstadial		warmer	
5b	96						cold	
5c	103				Chelford interstadial		warmer	
5d	115						cold	
5e	125		Ipswichian				warm	Interglacial

The Thames floodplain

B.1.20 The majority of the Thames Tideway Tunnel route is located within the Thames floodplain, which was created by the Pleistocene arctic river during the last major cold stage c.18,000 to 15,000 years ago (the Devensian Glaciation), and is much wider than the river and foreshore that are exposed today, which are constrained by historic and modern river defences. Its extent is currently defined by the British Geological Survey mapping of alluvium (Figure B.1.1, see Figures at the end of this document). During the prehistoric period the floodplain was characterised by low islands separated by marshes and multiple meandering channels, attractive for settlement and resource exploitation.

B.1.21 Archaeological remains may lie within the alluvium and at the gravel/alluvial interface. The alluvium generally thickens downstream, from c. 2–3m thick in the Hammersmith area to as much as 8m thick at Beckton. The alluvial deposits reflect the changing river pattern over many thousands of years. The alluvium can include sands (from former active watercourses), clay and humic clay (from ponds and lakes), peat and organic silts (from marsh and backwaters), weathered clay (from seasonal flooding) and silts and clays (from intertidal mud and salt marsh formed as a result of estuarine encroachment upstream).

B.1.22 A mosaic of islands, abandoned channels and other natural features was created from the Late Upper Palaeolithic period (ie, 11,000 years ago) onwards, which influenced the nature of human activity on the floodplain. Occupation and cultivation took place on the islands, whereas hunting, fishing and gathering the abundant wild resources available took place in the lower-lying wetland areas. As well as preserving organic artefacts and structures such as timber trackways, boats and fishtraps, the former wetland landscape also contains the remains of seeds, pollen, snails and insects, and also tree stumps from the prehistoric floodplain forest. These environmental remains can be utilised to reconstruct the changing past environment. In particular such environmental evidence provides information about the nature of the river, climatic conditions, vegetation cover and evidence of human land use. Such evidence is obtained by taking samples of the alluvial deposits for examination by specialists off-site (Plate B.2).

B.1.23 The floodplain is no longer an obvious feature of the modern landscape and townscape, particularly in central London, having been progressively drained, infilled and reclaimed from the Roman period onwards. The Thames has in effect been canalised to gain extra land and prevent the river from flooding adjacent land.

B.1.24 Archaeological evidence of the former floodplain is now preserved on the landward side of the river wall (Plate B.1), often deeply buried beneath modern development and layers of made ground built up in stages to reclaim land from the river channel.

Plate B.1 A medieval revetment at Three Quays House (City of London). Similar waterfront structures could be preserved on the landwards side of the river wall

Plate B.2 A geoarchaeologist recording and sampling alluvial deposits for environmental evidence on a Thames riverfront site

The modern foreshore

B.1.25 The foreshore is made up of the narrow margin of the modern river, which is exposed twice daily between the high and low water levels of the tidal Thames. In earlier times, before a succession of river walls had been built into the floodplain, it would have consisted of mud and salt marsh, backed by reedbeds, extending over a much wider area. Prior to the tidal head

reaching central London (in the Bronze Age) the foreshore did not exist and instead a network of islands and multiple threaded channels extended across the floodplain.

B.1.26 The modern foreshore consists primarily of:

a. earlier eroded strata that lay within the prehistoric floodplain. Archaeological structures, finds and deposits within this element of the foreshore, exposed at the lowest extent of the tide, would relate to a time when the river had a completely different landscape and environment than it does today

b. deposits and structures that lay within the earlier historic river, associated with industrial and commercial uses of the river from the Roman period onwards. These may include features such as jetties and boats relating to a period when the river was wider (before more recent river walls had been built far into the former river) and the features lay within the river itself

c. structures of relatively recent date such as barge beds, slipways and causeways, and foreshore protection material, that reflect a river wall configuration much as it is today (Plate B.1 shows an example of the baseplates for 18th century river stairs)

d. redeposited mud and gravel representing the modern flow and erosion pattern of the river.

B.1.27 The deposit sequence exposed beneath modern and historic alluvium on the foreshore is a continuation of the floodplain beneath the landward side of the modern river wall. However, it has been scoured by the river and, as a result, a horizontal sequence of deposits can be exposed at low tide, which corresponds to the vertical sequence buried beneath made ground on the landwards side of the river wall. Although such exposure means that the strata are being actively eroded away by the river, they are also visible and relatively accessible, in contrast to being deeply buried and concealed on the landward side of the river wall. A schematic diagram illustrating deposit survival on the riverwards and landwards side of a modern river wall is shown in Plate B.3. Surviving deposits of the ancient floodplain, exposed on the foreshore at low tide may contain palaeoenvironmental evidence of lost landscapes, which can sometimes include in-situ tree stumps, as well as plant remains, insects, animal bone and snails.

B.1.28 The river is a powerful agent in eroding, transporting and redepositing sediments along its banks and bed. As a result, the prehistoric deposits that lie below the foreshore are exposed as part of the erosion processes that will ultimately remove them altogether. When this happens, the formerly in situ deposits, together with any finds and features they might contain, are eroded, transported and redeposited by the river, contributing to the historic and modern spreads of foreshore gravels and inter-tidal muds, which can contain artefacts from all periods (surface finds). The finds from these mixed deposits are of little use for dating the accumulation of the deposit itself. Occasionally, however, their

significance may be considerable, as in the case of high status prehistoric votive objects such as the Battersea Shield.

B.1.29 Surface finds were in the past collected by antiquarians, and today a range of organisations recovers objects from the foreshore, including the Society of Thames Mudlarks, and the Thames and Field Metal Detecting Society. Any recovered items are recorded through the Portable Antiquities Scheme. A very wide variety of material types have been recovered. These include prehistoric lithics, pot sherds and metal objects such as spears and axes; Roman military equipment, jewellery, coinage and ceramics; medieval dress fittings, pottery, coins and pilgrim badges; and a wide range of post-medieval and industrial artefacts including those associated with ship building, repair and breaking on the foreshore. Human bone (and on two occasions an articulated skeleton) is also occasionally recovered from the intertidal zone which can date from as far back as the Neolithic period.

B.1.30 In situ structures surviving on the foreshore can have more contextual value than surface finds. Structures can consist of fish traps and base plates for riverside construction, as well as pile-driven groups of timbers, such as jetties. Significant discoveries by the Thames Archaeological Survey and the Thames Discovery Programme include three separate structures at Vauxhall (with dates ranging from the Mesolithic to Iron Age periods); Iron Age timbers at Fulham; Anglo-Saxon fish traps at Chelsea, Isleworth, Putney, Hammersmith, Barn Elms and Nine Elms; and the remains of jetties serving the palace complexes at Greenwich and Richmond. Nautical timbers are often represented on the foreshore as disjointed remains, with the timbers discovered either as isolated, mobile examples, or re-used as part of a later structure, such as a revetment or gridiron. However, hulked vessels (and assemblages of hulks) have also been recorded at a number of locations.

Plate B.3 Schematic cross section illustrating archaeological deposit survival on the riverwards (ie the foreshore) and landwards sides of modern and historic river walls

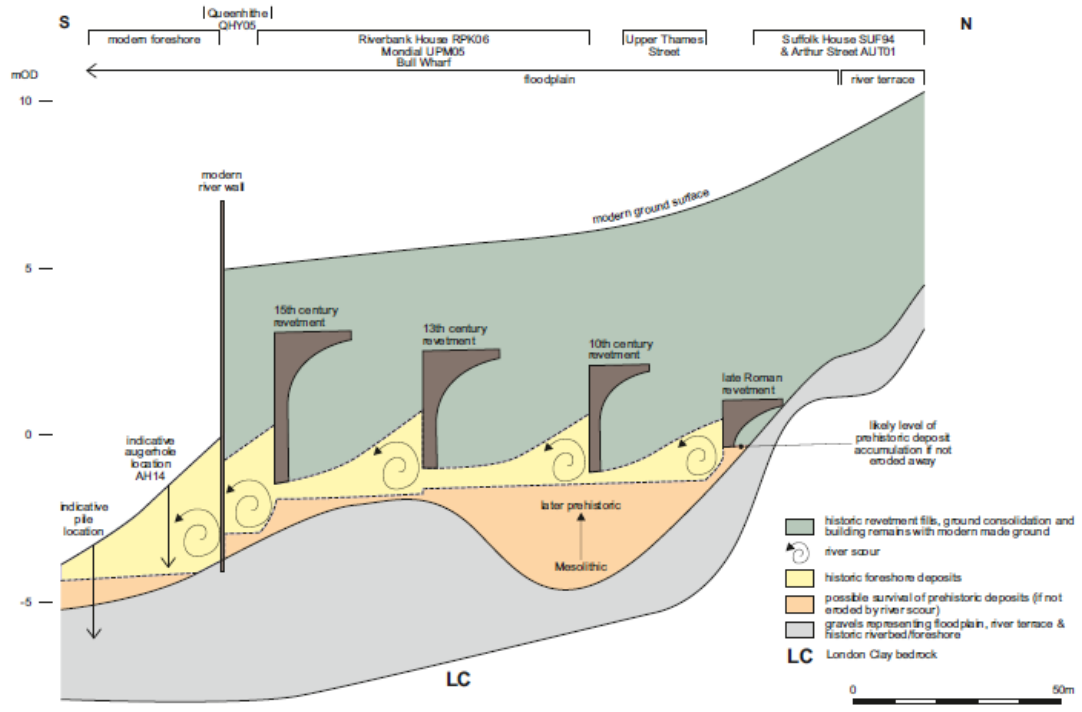

Plate B.4 Thames Discovery Programme team recording 18th century baseplates for the earlier stairs on the foreshore at Trig Lane, City of London

Tributary valleys and lost rivers

B.1.31 Tributary valleys were attractive for nomadic Mesolithic groups, supporting activities such as hunting, fishing, fowling and plant gathering. Some valleys had small floodplains, that later formed useable water meadows and farmland, whereas larger rivers such as the Lea had more complex environments similar to those of the main Thames floodplain, with marshes, islands and multiple subsidiary channels. They provided a route into the interior for Saxon and Danish boat-born migrations and were also utilised from the Roman period for industrial activities that required water, such as mills. As prominent landscape features the tributaries often formed territorial boundaries that are still reflected in modern administrative divisions.

B.1.32 The characteristics of the tributaries (including their routes, extent and deposition and scouring patterns) were strongly influenced by the changing river regime and sea levels of the Thames estuary, particularly at their confluences with the Thames. At their confluences they exhibit similar depositional conditions and environments (e.g. deep alluvial deposits) to the floodplain. The depth and complexity of scour and/or deposition is likely to be greater than further upstream.

B.1.33 The glacial/interglacial stepped terraces of the Thames may also be reflected inland, on the sides of individual tributary valleys. Here the exposure of different geological strata may result in local spring lines between permeable and impermeable layers.

B.1.34 The valleys also contain information about more specific local past environments. Palaeoenvironmental evidence for cultivation, deforestation and other large-scale land management schemes upstream may be preserved in the alluvium accumulated in the lower reaches of the tributary valleys. The archaeological evidence within the valleys therefore reflects former land use on adjacent terrain, which in turn will reflect local geological conditions.

B.1.35 Urbanisation, industrialisation and associated population growth led to increasing pollution of tributaries from as early as the medieval period. Many of the rivers in London became heavily contaminated, for example the Neckinger in Bermondsey with tannery effluent and the Fleet with butchery waste from Smithfield. They eventually became choked open sewers that backed-up at high tide, and were canalised and culverted as part of more organised drainage and public health schemes in the 18th and 19th centuries. Between c 1730 and 1760 large areas of the Fleet and Tyburn were filled in and built over, to the point where what were once substantial valleys are now only discernible by changes in street level. Only the outlying Ravensbourne, Beverley Brook and Wandle tributaries remain as open streams over much of their length.

B.1.36 The lost rivers are inextricably linked to the history of London, having influenced patterns of settlement and land use along the Thames (including the location of the Cities of London and Westminster), the formation of territorial boundaries, the courses of roads, the living conditions of Londoners, and the location and development of industry. It is no coincidence that many present sewers reflect the courses of

London's lost rivers (and the larger sewers are themselves impressive historical feats of engineering and of significance for the historic environment). The corresponding CSO outfall sites are to be located where the tributaries formerly discharged into the Thames (Figure B.1.1, see Figures at the end of this document). The continuing use of the tributary valleys and river mouths for the Thames Tideway Tunnel scheme demonstrates that the lost rivers continue to influence the lives of Londoners and contribute to public health today. The association of the modern day sewage system with the lost rivers reflects a significant element of London's heritage that can help create a local public appreciation and sense of place linking the social requirements of the present with those of the past.

B.1.37 The tributary valley sites fall into two categories. Those that lie within the immediate confluence of tributaries or lost rivers with the Thames:

a. Barn Elms (the Beverley Brook);
b. Falconbrook Pumping Station (Falcons Brook);
c. Cremorne Wharf Depot (Counters Creek);
d. Chelsea Embankment Foreshore (the Westbourne)
e. Kirtling Street (the Battersea Channel);
f. Albert Embankment Foreshore (the Effra);
g. Blackfriars Bridge Foreshore (the Fleet);
h. Chambers Wharf (the Neckinger).

B.1.38 Those that lie further upstream within the tributary valleys:

a. Abbey Mills (the Lee / Channelsea River);
b. Dormay Street and King George's Park (the Wandle);
c. Earl Pumping Station (Earl's Sluice);
d. Hammersmith Pumping Station (Parr's Ditch);
e. Acton Storm Tanks (Stamford Brook)
f. Greenwich Pumping Station (the Darent/Deptford Creek).

Archaeological themes and research objectives

Introduction

B.1.39 The five project-specific RWHT are based on the current state of knowledge about London's past but also reflect aspiration ie, topics about which further information is needed.

B.1.40 The themes allow predicted heritage assets at the Thames Tideway Tunnel sites to be grouped together into topics that reflect the role of the river in the development of London. This allows assets of similar function to be considered across different periods and across the whole route.

B.1.41 The social and historical context of each theme is discussed initially, followed by the published research objectives associated with it (Museum of London and English Heritage, 2002)[20]. Where a research objective is

relevant to more than one RWHT it has been placed under the theme felt to be most appropriate.

B.1.42 When published, each of the research objectives for London was given a unique identifier (eg P1 = prehistoric 1) which is cross-referenced below. Where a published objective is broadly (but not specifically) relevant to a RWHT it is given in *italics* as for example (*1A*).

Theme 1: Palaeoenvironment and prehistory

B.1.43 Recent geoarchaeological studies have emphasised the need to develop a holistic approach to understanding the development of the floodplain sequence, focusing not only on individual sites, but also how these can be combined into a basin wide model. The effects of climatic change over the last 18,000 years have been an important factor in determining patterns of human settlement and behaviour. By considering the palaeoenvironmental and landscape context of archaeological sites, the cause and effect relationship of past human populations with the changing floodplain landscape can be investigated.

B.1.44 As described in Section 3, a number of past landscape processes are of archaeological interest and include, but are not limited to the following:

a. The formation of the river terraces.

b. The Thames floodplain.

c. The modern foreshore.

d. Tributary valleys and lost rivers.

B.1.45 Throughout prehistory the Thames was a key factor in the occupation and activity of past populations around London. The river was responsible for the geomorphological and palaeoenvironmental structure of the Thames basin, and hence constrained the development of occupation and activity. At the same time, it provided considerable resources for subsistence and communication and was also a focus for ritual, making London an area of considerable prehistoric activity.

B.1.46 The Thames and its adjoining marshlands would have been attractive to nomadic Mesolithic hunter gatherers, providing a rich resource for fishing, fowling and plant foraging. Temporary camps, such as those represented by the concentration of flint tools recorded on the Old Kent Road (Figure B.1.3, RF 9, see Figures at the end of this document) (close to the shoreline of a large lake in the prehistoric period), are rare and important finds. Mesolithic structures and artefacts are being exposed on the present foreshore at the Albert Embankment site. Associated activity may survive in the form of *in situ* flint scatters, such as that found at Putney Bridge Road/Adelaide Road c 200m to the west of the Dormay Street site (Figure B.1.2, RF 10, see Figures at the end of this document).

B.1.47 River valley locations were also important for the advent of farming in the Neolithic and Early Bronze Age. Traces of these agricultural landscapes and more permanent settlements may occasionally be well-preserved beneath later flood alluvium, as is the case at sites such as Phoenix Wharf in Bermondsey (Figure B.1.3, RF 11, see Figures at the end of this

document) at the confluence of the Neckinger with the Thames. Such well-sealed sites may preserve evidence that does not normally survive, in this case ploughing, plus associated environmental evidence about the contemporary landscape.

B.1.48 Exposure of floodplain strata within the modern foreshore can also reveal significant prehistoric evidence, such as the Bronze or Iron Age fish trap found at Vauxhall.

B.1.49 Low-lying marshy areas may preserve evidence of timber trackways such as that found at Bramcote Grove, close to South Bermondsey Station (Figure B.1.3, RF 12, see Figures at the end of this document). These provided access routes linking drier islands (the focus of settlement) across the intervening marshes to the deeper channels used by boats, which are also occasionally found.

Research objectives:

a. Establishing firm regional chronologies tied into national chronological frameworks, taking the opportunity to clarify extant terrace sequences (P1; P2; S1; M1);

b. Conducting baseline surveys and using these to develop models for understanding the significance of geomorphology, ecology, ecosystems and climate, hydrology, and vegetational and faunal development on human lives (TL1);

c. Understanding the many and changing roles of the River Thames (TL1);

d. Considering the roles that landscape features may have played in human activity and settlement (TL3);

e. Addressing aspects of continuity and change in the nature of the subsistence strategies pursued by human groups, including agricultural intensification (TE1);

f. Explaining why the Mesolithic is so poorly represented in the London region (P3);

g. Reconstructing the environment and ecology on a regional basis (P3; P4; R2; *IA*: 1C);

h. Elucidating the nature of the Mesolithic to Neolithic transition (P4);

i. Establishing/refining a dated regional ceramic sequence (P4; P5);

j. Examining the influence of landscape (P4; S2);

k. Understanding the relationship between the wooden trackways in the floodplain and the settlements to which they presumably led (P5);

l. Understanding the origins of the metalwork sequence from the Thames (P5);

m. Exploring seasonal craft activities such as salt production (P5).

Theme 2: Settlement patterns & boundaries

B.1.50 The river regime was a powerful factor in determining past patterns of settlement and land use.

B.1.51 The well-watered, fertile and easily cultivated soils of the Thames floodplain, gravel terraces and tributary valleys would have been increasingly important as a more settled agricultural economy began to replace nomadic hunting and herding from the early 2nd millennium BC. A more controlled food supply and the resulting population growth and pressure on land meant that attempts were made to bring low-lying islands and marsh margins under cultivation.

B.1.52 Marks of a light prehistoric wooden plough (ard) of probable Bronze Age date have been recorded at a number of sites in Bermondsey: for example Phoenix Wharf (Figure B.1.3, RF 11, see Figures at the end of this document) and Wolsely Street (Figure B.1.3, RF 14, see Figures at the end of this document), both to the west of the Chambers Wharf site. Timber posts recorded within the Chambers Wharf site itself may be contemporary with this activity.

B.1.53 During the Roman period farming became more systematic and was linked to *Londinium* by roads, along which roadside settlements formed, often at river crossing places such as Old Ford (Sheldon, HL, 1971)[21] on the Lea and Brentford to the west.

B.1.54 Saxon activity was often defined by the Thames and its tributaries, which provided effective access to the interior; while islands provided increased security and were exploited for occupation or riparian resources until drainage and reclamation of marshland took place in the medieval period, often under the organisational skills provided by medieval monastic estates (MoLAS, 2000)[22].

B.1.55 Evidence for Early Saxon settlement (including place names of Saxon origin) has been found on many Thames tributaries, such as the Fleet and the Ravensbourne. Evidence of an early Saxon settlement including a sunken-featured building, rubbish pits and a boundary ditch was recorded adjacent to the Hammersmith Pumping Station site (Figure B.1.2, RF 15, see Figures at the end of this document). Evidence of Saxon exploitation of the Thames survives in the form of fish traps (wattlework fences), discovered during recent surveys of the Thames foreshore. Examples close to Thames Tideway Tunnel sites include those adjacent to the Barn Elms site (Figure B.1.2, RF 16, see Figures at the end of this document) and to the north-east of Cremorne Wharf, near Battersea Bridge (Figure B.1.3, RF 17, see Figures at the end of this document).

B.1.56 By the Middle Saxon period, the lost tributary rivers of London often marked territories, one important example being the estate boundaries of Late Saxon Westminster Abbey. The Thames itself was a major political boundary throughout the Saxon period dividing kingdoms on the north and south banks of the river. From the late 9th century the River Lea also marked the western frontier of the Danelaw (a historical name given to the land ruled by the Danes, who dominated the Anglo-Saxons in the area). When Alfred re-fortified London against the Danes in the 9th century this

led to the construction of associated burghal defences on the natural eyot at Southwark (the South Work) and on the Lea on the opposite side of the Thames.

B.1.57 Later Saxon sites were located further inland, although river access remained an important factor influencing settlement patterns, particularly in the urban 7th-9th century mercantile trading settlement of Lundenwic, located beside the Thames in what is now Covent Garden; and the West Minster, present from at least the 10th century on Thorney island, a strategic fording place at the confluence of the Tyburn and the Thames.

B.1.58 These islands, often reflected in eyot place names like Bermondsey, Chelsea, Thorney and Battersea and surrounded by water and fen, were particularly favoured in periods when security could not be taken for granted.

B.1.59 Throughout the Saxon period, sites at the eastern end of the route such as Earl Pumping Station and Abbey Mills Pumping Station were located within marshland used for rough grazing. However, rising river levels from the Roman until the early medieval period (after which riverside marshland began to be reclaimed) may have deterred permanent occupation at many Thames Tideway Tunnel sites which would have been located in areas prone to regular flooding.

B.1.60 From the 13th century onwards, the pattern of medieval rural villages that had grown up in the Thames Valley, centred on roads, markets, parish churches and manorial and monastic estates would have supplied local towns and London with agricultural produce, fuel and other basics. The medieval period also saw high status houses and palaces develop along the river, which facilitated travel by wealthy residents (Bluer, D, 1993, Thomas, C, 1995, Thurley, S, 1999)[23].

B.1.61 In the post-medieval period many of the proposed Thames Tideway Tunnel sites were first used as market gardens, with industry increasing with the advent of the railways.

B.1.62 Collectively, future archaeological investigation at the Thames Tideway Tunnel sites may help to elucidate the relationship between London and its rural hinterland, settlement and economy, by helping to increase understanding of when and to what extent the growth of London took over from the local economy of estates and towns, to become the dominant factor in the agricultural, industrial and suburban development along the Thames.

Research objectives:

a. Understanding the relationship between landscape, river and settlement, and the influences of the Thames (TL2), including the correlation between sites associated with watercourses and meander bends, so as to understand the origin of settlements (TD1; *4A*);

b. Researching the potential for categorisation of prehistoric settlement sites (P4);

c. Examining the concept of core/periphery model for different periods of London's past (TD2);

d. Understanding the evolving character of development in central London between Westminster and the City, and Southwark (TL2), including the relationships between different urban foci (TD1; *4A*);

e. Studying the impact of settlement on the environment (R2);

f. Analysing patterns of property ownership, continuity and change (R5);

g. Investigating the relationship between the urban centre, its hinterland and other settlements (R12; R13, S1, S4; S6; S7; M1; M5);

h. Defining the economic character of different parts of the region (and the region as a whole) through time (R1), including rural land use and agricultural exploitation (R12; S2; S7; L8; *4A*);

i. Understanding the size and character of the urban centre and issues of nucleation and desertion (TD1);

j. Contributing to our understanding of the creation of the London suburbs (TD2).

Theme 3: River management, transport, infrastructure and trade

B.1.63 As a natural east-west communication and transport route, the River Thames (and its tributaries, which generally align north-south) would have been used as a major transport and trade route from the early prehistoric onwards. The river also provided a natural barrier that hindered movement north-south across the river. River crossings were therefore of strategic importance both commercially and militarily. The means used to cross the river in the past, either by boat, ford crossings, along with the bridges built across it, also form an integral part of the story of human activity.

B.1.64 A Bronze Age timber structure has been recorded on the Vauxhall foreshore, c 200m south-west of the Albert Embankment Foreshore site (Figure B.1.3, see Figures at the end of this document) and may represent a rare prehistoric jetty or bridge. The Mesolithic wood found within the site itself may be a timber structure with a similar function. However, this foreshore site is not only significant for the presence of prehistoric features. Significant features associated with the nearby post-medieval pottery and glass manufacturing industries may also be present.

B.1.65 The importance of river traffic during the Roman period is indicated by extensive timber waterfront quays in the City and Southwark, with quays and warehouses on both banks of the Thames near the present London Bridge (Milne, G, 1985)[24]. A Roman barge, the Blackfriars boat, (Marsden, P, 1967)[25] was found in the river in the eastern part of the Blackfriars Bridge Foreshore site, and is one of three found in London, which add significantly to knowledge of Roman shipbuilding.

B.1.66 Rivers were major migration routes during the Saxon period and crossings provided an important means of communication. After the collapse of the centralised Roman administration of Britain, the Middle Saxon trading port *Lundenwic* developed in the area occupied by Aldwych, the Strand and Covent Garden. Although its waterfront area is very deeply buried and has seen little archaeological excavation, a possible Saxon jetty or fishtrap and associated foreshore deposits were recorded at Arundel House *c* 800m

north-east of the Thames Tideway Tunnel Victoria Embankment Foreshore site (Figure B.1.3, RF 24, see Figures at the end of this document).

B.1.67 During the 9th century AD, vulnerability to Viking attacks led to a relocation of the *Lundenwic* settlement, back inside the walled Roman City, which was refortified as a burgh by Alfred (*Lundenburgh*). As a result, the city became a major port again from the 10th century, with the riverfront south of Cheapside given over to wharves and warehouses, handling both local and overseas trade. Reclamation of the Lea valley was taking place with wooden piles and consolidation of the riverbank has been interpreted as the remains of a jetty or bridge abutment on the east bank of a tributary of the River Lea at Leyton Road, Stratford (Figure B.1.4, RF 23, see Figures at the end of this document).

B.1.68 The river itself was exploited for fish, and a number of fish traps have been identified along the river, typically at the confluence of tidal tributaries rivers, at Heathwall Pumping Station site and Chelsea.

B.1.69 During the later medieval period, reclamation (including the construction of river defences, and consolidation of the banks of the Thames and its tributaries) continued on a larger scale. The purpose was primarily economic, to provide good quality grazing for livestock and fertile land for crops, and in close to the city, to provide additional land for wharves, ship making and river trade. A medieval embankment recorded along Bermondsey Wall, 80m to the west of the Chambers Wharf site (Figure B.1.3, RF 21, see Figures at the end of this document) took the form of chalk consolidation revetted by large timbers.

B.1.70 For the later medieval period, archaeological evidence of the means by which goods were transported to and from London may be found in the development of riverine and sea-going vessels, such as two wrecks of 15th century ships found in the Thames east of Blackfriars Bridge Foreshore site.

B.1.71 Reused ship timbers also survive in waterfront structures, preserving in a better condition parts of vessels that rarely survive at shipwreck sites. More extensive river walls and wharves improved boat access and moorings. Embankments and revetments probably extended from Westminster to Blackwall by the 15th century. Post-medieval vessels have also been found both within the river and beneath reclaimed land. These can reveal much about shipbuilding practices and the types of river transport used on the Thames, particularly for the period before construction drawings of such craft were made.

B.1.72 Until the 18th century, London Bridge remained the only bridge crossing over the Thames. The lack of bridges meant river transport, including a large number of watermen for passenger traffic, were very important. A second bridge was built at Putney in 1729, followed by bridges at Westminster (1750), Blackfriars (1769), Battersea (1772), Vauxhall – the first iron bridge (1815), Waterloo (1817), Southwark (1819) and Hammersmith – the first suspension bridge (1826). London Bridge was replaced with a much larger stone structure in 1831, and Tower Bridge constructed in 1894.

B.1.73 In the late 19th century, many acres of land were recovered from the river to form the existing Victoria, Albert and Chelsea Embankments as part of Joseph Bazalgette's grand scheme of intercepting existing sewers into a new system contained within a combined roadway and river wall structure.

B.1.74 From 1700 London became the most important port in England, expanding so rapidly the new docks were built in the marshland to the east around the Isle of Dogs in order to accommodate the traffic. The Thames Tideway Tunnel King Edward Memorial Park Foreshore site is partly located over two former wharves: Timber Wharf and Bell Wharf. Campaigns for improvements to the port led to the West India Dock Act of 1799, which heralded a dramatic change in the riverside landscape to the east and south-east of London, where large new enclosed docks were created on both banks. These included the Shadwell Basin (completed 1831) just to the west of the King Edward Memorial Park Foreshore site. With these new docks came associated structures such as warehouses. New canals were also constructed, giving access to the Thames via the docks. Horwood's map of c 1819 shows the Earl Pumping Station located over the West Pond adjacent to the Grand Surrey Canal, built in 1802 to link the Surrey Dock to Peckham. By *c* 1830, the Port of London had spread to Blackwall, by *c* 1880 to Woolwich and by 1886 to Tilbury.

B.1.75 Since the port reached its zenith in 1939, the older wharves and docks have been increasingly unfit for modern vessels and most have been filled or modified for other uses. By the 1970s, London's older enclosed docks were unable to provide the facilities required for large modern container ships, and they became derelict and many were eventually infilled. Many of the wharves and warehouses that lined the river have since been demolished or converted to other uses.

Research objectives:

a. Identifying a pre-Roman road pattern (P6);

b. Understanding the reasons for evolution of the road systems, street layouts, river crossings and ferries, and their importance as transport networks and engines of development and change (TD4; R4; L2; S7; *2A*);

c. Refining our understanding of the chronology and function of the riverside defences and extramural evidence of defensive or military structures (R10);

d. Improving understanding of the river management features, revetments and river defences of London (*3B*);

e. Refining understanding of how the port of Roman London functioned, including its role in trade and trans-shipment and what it meant for Londoners (R4; R13);

f. Using the archaeological record to challenge or augment inferences from documentary research on national and international trade and transport (M6);

g. Identifying materially how London became a distribution centre for the western world (L9; TE2);

h. Understanding development of London's docks and waterways (TD4);

i. Considering how ethnic diversity is represented in the archaeological record (TS4), and evidence for cultural interaction between different social or ethnic groups (TS1).

Theme 4: London's water systems and public health

B.1.76 London did not require the stone aqueducts of other Roman cities, as the gravel terraces provided plentiful natural springs, which with the addition of wells with sophisticated water lifting devices provided sufficient resources (MoLAS and English Heritage, 2000)[26]. Storm water and effluent was carried mainly in timber culverts and box drains flowing into individual timber cess pits or canalised streams. A substantial Roman timber-lined drain at Miles Lane, to the east of London Bridge in the City (Figure B.1.3, RF 25, see Figures at the end of this document) was revetted with posts and planks. More permanent stone structures, large enough to access and maintain, were rare: the 3rd-century culvert and access shaft investigated at Monument House near Roman London Bridge (Figure B.1.3, RF 26, see Figures at the end of this document), is the only substantial subterranean drainage system known from Roman *Londinium*. It may have carried effluent from a major public building to the north, into the Thames downstream of the site.

B.1.77 The Roman water system was not maintained in later periods, when foul sewage from buildings was largely diverted into individual private cesspits, emptied by 'nightsoil men'. By the 14th century many were built of stone. Evidence for such features has been recorded on almost every urban archaeological site. Given the concentration of sewage in cess-pits, and the resulting contamination of the river system, this resulted in public health problems.

B.1.78 From the 13th century the City Corporation made efforts to secure fresh water supplies from the Tyburn via an organised system of conduits, cisterns and lead and wooden pipes. This system was primarily for the better-off, and most people continued to draw drinking water from communal wells and pumps in the street or from the Thames. Although the causal link to disease was not recognised at this time, the continuing pollution of tributaries with sewage and refuse had become a matter of public concern from the 15th century.

B.1.79 London's effluent disposal developed around the natural watercourses flowing into the Thames, such as Stamford Brook, the Tyburn, the Fleet and the Walbrook on the north side of the Thames and Beverley Brook, the Wandle and the Ravensbourne to the south.

B.1.80 Greater regulation of waste disposal from the 17th century was undermined by rapid population growth, and pollution of the tributaries worsened. Once the tributaries were culverted, covered and out of sight the problem was largely transferred into the Thames which itself became an open sewer that failed to clear with each low tide, whilst water companies continued to distribute untreated drinking water from it.

B.1.81 The drainage of sewage, into the first half of the 19th century, was directed into cesspools, at least 30,000 of which existed in the area now

covered by Greater London, indeed it was illegal to allow sewage to enter the sewer system, which was predominantly reserved for water drainage (Bazalgette, J, 1878)[27]

B.1.82 Increasing population and the use of untreated Thames water for drinking during the post-medieval period culminated in the cholera and typhoid epidemics of the mid-19th century as cess-pools were connected to the sewer system from 1847 following orders from the Metropolitan Commissioner of Sewers (Bazalgette, J, 1878)[28]. In the hot summer of 1858 the resulting 'Great Stink' forced Parliament to re-locate from beside the Thames to a safer location in Oxford. This created the political will for change and in the 1860s and 1870s the visionary solution of Joseph Bazalgette, the Metropolitan Board of Works Chief Engineer, was constructed. This consisted of an integrated system of intercepting sewers, pumping stations and treatment works that still serve London today. This pioneering scheme also involved reclaiming land from the Thames to construct the Victoria, Albert and Chelsea Embankments.

B.1.83 Like the proposals at hand, the new sewerage system built by Bazalgette was an intercept system, designed to stop earlier sewers discharging directly into the Thames in the city. There were three main intercept sewers north of the Thames and three to the south, these operating with a mixture of gravity and interspersed pumping stations.

B.1.84 The Northern Outfall Sewer system consists of three main sections. The high level sewer runs from Hampstead, the two sections of middle level sewer run from Kilburn and Kensal Green, and the lower level sections run from Ravenscourt Park and Hammersmith. The three sections merge at Abbey Mills Pumping Station from where their contents flow on to Beckton Sewage Treatment Works. The Southern Outfall Sewer is similarly divided into high, middle and low level sections, these running from Herne Hill, Balham and Putney respectively to Deptford (now Greenwich) Pumping Station before merging and flowing onto the treatment plant at Crossness.

B.1.85 As well as the sewer pipes themselves, the system created a large amount of above-ground structures that are of heritage significance as individual assets including; Victoria Embankment (opened to the public 1869), Albert Embankment (1868) and parts of Chelsea Embankment (1874) as well as the pumping stations.

Research objectives:

a. Characterising air and water quality and pollution, throughout the archaeological record (TL4);

b. Establishing an overall understanding of water supply and drainage provision and maintenance (TD4);

c. Addressing regional variations in the health of the population over time (M3; TS2);

d. Examining through the archaeological record the environmental consequences of London's growth, and its high population density (L8);

e. Establishing through the archaeological record how sustainable and determined (or not) were public and civic efforts to put in place, and then maintain, different aspects of London's infrastructure (L2);

f. Examining the wider issues relating to poverty, social deprivation and disease in the East End of London and how these related to industrialisation (L9).

Theme 5: Industries associated with the Thames and its tributaries

B.1.86 The Thames and its tributaries were an essential source of water for industry from the earliest times. There is archaeological evidence that during the Roman period, London played an important role in the fishing industry, as both a market and a processing centre. Timber tanks at the Peninsular House site in the City (Figure B.1.3, RF 29, see Figures at the end of this document) and St Thomas Street in Southwark (Figure B.1.3, RF 30, see Figures at the end of this document) provide evidence of the processing of fish by-products as early as the first century from species found in the Thames estuary. There is also evidence of metalworking and possibly bone working taking place in areas of north-west Roman Southwark, close to the original foreshore of the Thames in the mid 1st century AD.

B.1.87 During the medieval period, the need for water for industries such as dyeing and brewing meant that many of these were located in waterfront areas and along tributaries of the Thames. For example, the large number of breweries still present in Acton today originated due to the presence of the three tributaries of the Stamford Brook.

B.1.88 From the 13th to the 16th centuries, tanners and cutlers were concentrated on both banks of the Fleet and the Upper Walbrook. Bermondsey was another area outside the City (near the Neckinger River to the west of the Chambers Wharf site) where industrial processes were located. It developed as a major centre for tanning, leather working and associated processes such as glue works.

B.1.89 Dyeing of cloth also required a ready supply of water and was one reason that led Willliam Morris to establish his model crafts factory at Merton on the banks of the Wandle in 1881. There is archaeological evidence of the area having been a centre of the scarlet-dyeing industry. At Frogmore Depot in Dormay Street (Figure B.1.2, RF 31, see Figures at the end of this document) (to the north-west of the Thames Tideway Tunnel Dormay Street site), auger samples indicated sediments characterised by the bright colours of an 18th or 19th-century dye factory nearby.

B.1.90 During the post-medieval period, the expanding scale of industry and steam power required greater supplies of coal, shipped in by river and canal, leading to a greater number of industrial jetties on the Thames. The same applies to the first gasworks and power stations, often located close to the river so that coal could be unloaded at fuelling piers (as at the former Bankside and Battersea power stations).

B.1.91 The Thames Tideway Tunnel Kirtling Street site included a 19th century mill pond, tide mill and timber docks, and part of the London Gas Light and Coke Works. The latter would have made use of the river for the

importation of coal. At Glasshouse Fields, c 150m north of the Thames Tideway Tunnel King Edward Memorial Park Foreshore site, industrial features associated with 17th-18th-century glass manufacture were recorded (Figure B.1.3, RF 32, see Figures at the end of this document). Remains of similar industrial structures along the Thames may therefore survive within Thames Tideway Tunnel sites.

B.1.92 From the mid-19th century, industry, in particular any noxious processes which also required supplies of water came to dominate much of the eastern part of the tunnel route. These included shipbuilding; distilling; fertiliser, ceramics, chemical, soap and tallow manufacture; dye works and printing.

B.1.93 The Thames Tideway Tunnel sites have the potential to produce information (following further archaeological investigation) on the nature, scale and development of production and manufacturing both in the urban and outlying areas of London.

Research objectives:

a. Defining the economic character of different parts of the region (R1);

b. Refining theories of trade specialisation over time, shifting zonation within the main settlement and peripheral areas (R13; S7;M6; L9; TE1);

c. Investigating the role of fish and fishing in the diet and economy of the region (S7);

d. Contributing to the understanding of London's place as an industrial power (L9; *7A*).

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Appendix C: Built heritage recording

C.1.1 The necessary built heritage recording for above ground built heritage assets is summarised in Table C.1.

Table C.1 Summary of built heritage recording of above ground heritage assets

Thames Tideway Tunnel site	Built heritage recording of above ground assets
Abbey Mills Pumping Station	• None proposed beyond measures outlined in the *CoCP*.
Acton Storm Tanks	• Level 1 HBMCE standing structure survey and photographic recording prior to the removal of historic machinery.
Albert Embankment Foreshore	• Level 3 HBMCE standing structure survey and photographic recording prior to and during the removal of existing river outflows, dolphins, storm flaps, and granite cobbled slipways for the construction of the southern cofferdam.
	• Level 2 or 3 HBMCE standing structure survey and photographic recording prior to and during the removal of above and below-ground fabric of the unlisted river wall.
Barn Elms	• None proposed beyond measures outlined in the *CoCP*.
Beckton STW	• Level 3 HBMCE standing structure survey and photographic recording prior to and during the removal of elements of the Northern Outfall Sewer associated with the construction of the proposed tunnel pump-out discharge chamber and discharge structure.
Bekesbourne Street	• None proposed beyond measures outlined in the *CoCP*.
Blackfriars Bridge Foreshore	• Level 3 HBMCE standing structure survey and photographic recording prior to and during the removal of sections of the Grade II listed Bazalgette Victoria Embankment wall parapet, and prior to and during removal of sections of the wall from slots cut into the wall for the cofferdams.
	• Level 2 HBMCE standing structure survey and photographic recording prior to and during the localised removal of sections of unlisted 1960s river wall, comprising a section of parapet to facilitate access; a section below the parapet to intercept the low level sewer; and sections of wall for slots cut into the wall for

Thames Tideway Tunnel site	Built heritage recording of above ground assets
	the cofferdam.
	• Level 1 HBMCE standing structure survey and photographic recording prior to the removal of five Grade II listed sturgeon lamp standards. • Level 1 HBMCE standing structure survey and photographic recording prior to the removal of two Grade II listed benches.
	• Level 3 HBMCE standing structure survey and photographic recording prior to and during the demolition of the unlisted, 20th century former London Fire Brigade Pumphouse.
	• Level 1 HBMCE standing structure survey and photographic recording prior to the removal of pontoons, platforms and dolphins and river infrastructure associated with access for shipping.
Carnwath Road Riverside	• Level 1 HBMCE standing structure survey and photographic recording prior to and during the removal of existing campshed for the construction of the proposed campshed (if this is required, depending on the river access option taken forward at this site).
	• Level 1 HBMCE standing structure survey and photographic recording prior to and during the removal of a section of the 19th/20th century river wall prior to the construction of a new wall.
Chambers Wharf	• None proposed beyond measures outlined in the *CoCP*.
Chelsea Embankment foreshore	• Level 2 HBMCE standing structure survey and photographic recording prior to and during alterations to the late 19th century (unlisted) river wall including the permanent removal of a short section of the stone parapet and three associated lamp standards, and the removal of trees.
	• Level 2 HBMCE standing structure survey and photographic recording prior to and during the removal of the late 19th century outfall apron on the foreshore.
	• Level 1 HBMCE standing structure survey and photographic recording prior to the removal of the brick boundary wall and its railings along the southern edge of the Grade II registered Ranelagh Gardens.
Cremorne Wharf Depot	• Level 3 HBMCE standing structure survey and photographic recording prior to and during removal of fabric of Grade II listed Lots Road Pumping Station for

Thames Tideway Tunnel site	Built heritage recording of above ground assets
	the installation of electrical and control equipment and cables.
	• Archaeological watching brief during removal of a small section of the late 19th/early 20th century below-ground brick sewer associated with the pumping station.
Deptford Church Street	• Level 1 HBMCE standing structure survey and photographic recording prior to the removal of the late 19th/early 20th century brick wall which crosses the centre of the site.
	• Level 1 HBMCE standing structure survey and photographic recording prior to the removal of a 19th century cobbled and kerbed entrance into the site.
Dormay Street	• Level 1 HBMCE standing structure survey and photographic recording prior to and during the removal of sections of the existing river wall on Bell Lane Creek for stabilisation works for an inter-tidal terrace.
	• Archaeological watching brief prior to and during the removal of a 19th-20th century barge bed where it is to be affected by jack-up barge or piled supports for a temporary platform.
Earl Pumping Station	• None proposed beyond measures outlined in the *CoCP*.
Falconbrook Pumping Station	• None proposed beyond measures outlined in the *CoCP*.
Greenwich Pumping Station	• Level 3 HBMCE standing structure survey and photographic recording prior to and during proposed localised modifications to the Grade II listed East Beam Engine House.
	• Level 2 HBMCE standing structure survey and photographic recording/archaeological watching brief prior and during the removal of remains of buried cooling tanks and other mid/late 19th and early 20th century sewage infrastructure.
Hammersmith Pumping Station	• Level 1 HBMCE standing structure survey and photographic recording prior to the removal of sections of the 1960s Hammersmith Pumping Station complex, including a section of boundary wall, the access steps to the main building and the screen house on the northeastern side of the building.
Heathwall Pumping Station	• None proposed beyond measures outlined in the *CoCP*.

Thames Tideway Tunnel site	Built heritage recording of above ground assets
Kirtling Street	• Level 3 HBMCE standing structure survey and photographic recording prior to and during the removal of a group of 19th/early 20th century buildings associated with the Farmiloe lead works lead works. • Level 3 HBMCE standing structure survey and photographic recording prior to and during the removal of a group of a mid/late 20th century building associated with the Farmiloe lead works.
King Edward Memorial Park	• Level 1 HBMCE standing structure survey and photographic recording prior to the removal of handrails and plinth of the existing river wall and prior to the permanent change in the appearance of the river wall following construction of the cofferdam. This will include broader background information alongside photographic recording.
	• Level 2 HBMCE standing structure survey and photographic recording prior to the removal of the bandstand and park benches.
King George's Park	• Level 1 HBMCE standing structure survey and photographic recording prior to the removal of the gate and park railings at the ornamental entrance to the park on Buckhold Road and the railings at the northern end of Neville Gill Close.
	• Level 1 HBMCE standing structure survey and photographic recording of King George's Park prior to the removal of the historic ornamental entrance to the park, and from the removal of a number of trees and landscaping.
Putney Embankment Foreshore	• Level 3 HBMCE standing structure survey and photographic recording prior to and during the removal of sewer outfalls and their associated outfall slipway (apron) beneath the Grade II listed Putney Bridge.
	• Level 2 HBMCE standing structure survey and photographic recording prior to the removal of Grade II listed bollards within the western boundary of the site.
	• Level 2 HBMCE standing structure survey and photographic recording prior to and during localised modifications of the upper section of the 19th century cobbled slipway and areas of paving.
	• Level 2 HBMCE standing structure survey and photographic recording prior to and during the removal of existing granite paving of the 19th century slipway within the temporary slipway site.

Thames Tideway Tunnel site	Built heritage recording of above ground assets
	• Level 2 HBMCE standing structure survey and photographic recording prior to and during the removal of fabric of the 19th century river wall from slots cut into the wall for the cofferdam.
Shad Thames Pumping Station	• Shad Thames Pumping Station, comprising the pumping station building, former superintendent's building and associated compound, would be subject to archaeological recording at HBMCE Level 1 prior to the commencement of works on the site.
	• Level 2 HBMCE standing structure survey and photographic recording prior to and during the removal of the three-storey former superintendent's accommodation.
	• Level 2 HBMCE standing structure survey and photographic recording prior to and during the conversion of the southern window that fronts on to Maguire Street into a door.
	• Level 2 HBMCE standing structure survey and photographic recording prior to and during the removal of the contemporary western wall of the pumping station enclosure on the north western side of the courtyard.
	• Level 2 HBMCE standing structure survey and photographic recording prior to and during the removal of the suspended pumping station ground floor slab.
Victoria Embankment Foreshore	• Level 2 or Level 3 HBMCE standing structure survey and photographic recording prior to and during the removal of a section of parapet of the existing Grade II listed river wall, and prior to the permanent concealment and alterations to of a section of river wall by the new foreshore structure.
	• Level 1 HBMCE standing structure survey and photographic recording prior to the removal of seven London plane trees which form an integral part of the Bazalgette Embankment scheme.

Thames Tideway Tunnel site	Built heritage recording of above ground assets
	• Level 1 HBMCE standing structure survey and photographic recording prior to the removal of three Grade II listed ornamental sturgeon lamp standards from the parapet wall.
	• Level 1 HBMCE standing structure survey and photographic recording prior to the removal of three Grade II listed catenary lamp standards.
	• Level 1 HBMCE standing structure survey and photographic recording prior to the removal of four Grade II listed decorative benches.

Figures

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