PORT OF TILBURY LONDON

PLANNING ACT 2008
INFRASTRUCTURE PLANNING
(APPLICATIONS: PRESCRIBED FORMS AND PROCEDURE) REGULATIONS 2009
REGULATION 5(2) (a)

PROPOSED PORT TERMINAL AT FORMER TILBURY POWER STATION

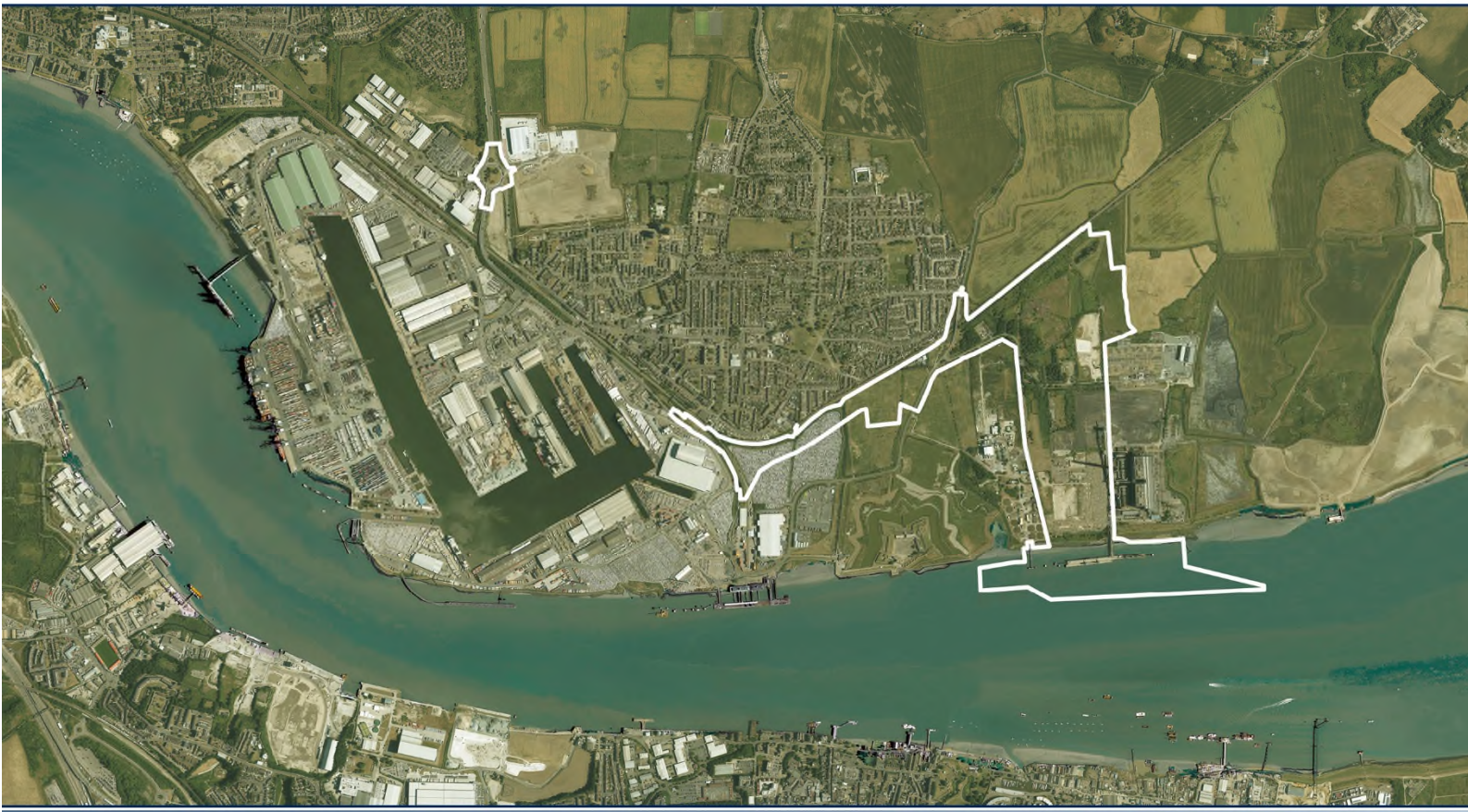
TILBURY2

TRO30003

Appendix 12D: Written Scheme of Investigation for Terrestrial Archaeological Mitigation

Errata Submission – Highlighted Changes

DOCUMENT REF: PoTLL/T2/EX/16



TILBURY2

CgMs HERITAGE
PART OF RPS

WRITTEN SCHEME OF INVESTIGATION FOR TERRESTRIAL ARCHAEOLOGICAL MITIGATION

TILBURY2 SITE
LAND AT FORMER RWE POWER STATION
TILBURY
ESSEX

OCTOBER 2017

Local Planning Authority:
Thurrock Council

Site centred at:
TQ6570075951

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Draft

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CgMs Ref:
22460

CONTENTS

LIST OF FIGURES

1.0 INTRODUCTION

1.1 This document has been prepared by CgMs Consulting, on behalf of their client POTLL as an overarching Written Scheme of Investigation (WSI) for terrestrial archaeological mitigation on land known as Tilbury2 and Infrastructure Corridor, Tilbury, Essex.

1.2 The terrestrial archaeological fieldwork will be undertaken in line with a requirement of the Development Consent Order stating that this WSI will be complied with.

1.3 If the archaeological fieldwork is to be undertaken in phases in accordance with the phased construction of the Tilbury2 and Infrastructure Corridor, following consent a detailed method statement will be produced ahead of each phase of archaeological work. Each method statement will be prepared in accordance with this WSI. It will provide the context in terms of the construction works, the objective of the archaeological works and the investigation and reporting methodology and it will be submitted to the Principal Historic Environment Consultant at Essex County Council (ECC) and Historic England (HE) for approval. No archaeological works will commence unless the method statement has been approved. The method statement will include provision for ECC/HE to monitor the archaeological work as appropriate.

1.4 Each phase of archaeological work will produce an archaeological report which will satisfy the method statement for that phase of work. On completion of archaeological works across Tilbury2 and the Infrastructure Corridor and to a timetable agreed with ECC and HE an overarching report on the archaeology of the scheme will be prepared and if appropriate further analysis and publication of the results will be undertaken in an appropriate journal. Consequently for consistency the archaeological contractor will remain the same throughout the duration of the project.

1.5 This document includes a Written Scheme of Investigation for Geoarchaeological and Palaeoenvironmental Assessment (WSI 1). This work follows on from the previous geoarchaeological work undertaken to support the DCO application. It forms a detailed method statement outlining the proposed mitigation measures for the geoarchaeological and palaeoenvironmental interest across the site. It includes the methodology for further assessment works on three boreholes identified during the previous phase of geoarchaeological work that contain the best sequences and are well distributed across the site. It also includes recommendations to undertake a single repeat borehole to obtain a better sequence for analysis. In addition, whilst the coverage of the existing geoarchaeological information for the site is in the region of 75% and therefore considered very good; geoarchaeological monitoring of selected

boreholes excavated as part of future site investigation works will also be undertaken to infill any remaining voids in the record and to aid development of mitigation against the geoarchaeological impact from the proposed development. If the monitoring exercise reveals sequences different from those observed to date, it may be necessary to obtain additional samples for palaeoenvironmental assessment/analysis. The results of any geoarchaeological work within the marine and intertidal zone will be fed into this work and an overarching report will be produced that will cover the geoarchaeological interest both onshore and offshore.

1.6 Following consultation with Historic England and the Principal Historic Environment Consultant at Essex County Council Place Services it has been agreed that the impact from the proposed development on the terrestrial archaeological interest on the site can be mitigated by a programme of archaeological work in accordance with this WSI following consent.

1.6 This document includes the framework for a programme of archaeological trial trenching to be undertaken ahead of construction in the first instance to determine the presence or absence of archaeological remains. It has been prepared in accordance with all relevant guidelines, including those set down by the Chartered Institute for Archaeologists (CIfA) and Historic England (HE). In the event that important remains are recorded during the trial trenching than a further programme of mitigation comprising excavation ahead of construction or archaeological monitoring during construction may be required. Any further mitigation measures required following trial trenching would be set out in a separate method statement as discussed above.

2.0 GEOLOGY AND TOPOGRAPHY

2.1 The desk-based geo-archaeological deposit model (Quest 2017) confirmed the sequence of sediments at the Tilbury2 site as Made Ground c0.5m to c3m thick (thickest towards the east of the site) capping a Holocene alluvial sequence of Lower Alluvium, Lower, Middle and Upper Peat and Upper Alluvium, recorded in thicknesses of between c12 and c16m across the site. The greatest depths of alluvium are recorded towards the south of the site probably as a result of slightly lower Gravel surfaces. Underlying the Holocene sequence was the Shepperton Gravels deposited during the Late Glacial and comprising the sands and gravels of a high-energy braided rivers system.

2.2 The Gravel surface is relatively even and lies approximately -13m and -15m OD. The gravel topography is typical of a braided river system with undulations in the surface of the Gravel indicative of shallow channels separating longitudinal gravel bars.

2.3 The sediments of the Lower Alluvium are indicative of deposition during the Early to Mid-Holocene when the surface of the Gravel was progressively buried beneath the sandy and silty flood deposits of the River Thames. The surface of the Lower Alluvium is variable but generally lies between -3m OD and -8m OD.

2.4 Lower Peat deposits were recorded either directly overlying the Shepperton Gravels or within the Lower Alluvium and was predominantly recorded towards the south of the Site. These peat deposits are indicative of a transition towards marshy conditions such as saltmarsh, sedge fen/reed swamp or woodland (Quest 2017). Radiocarbon dating indicates that the Lower Peat accumulated from the Early to Late Mesolithic date (Quest 2017).

2.5 Middle Peat deposits were recorded generally across the Site between the Lower and Upper Alluvium. The Middle Peat is indicative of a transition towards semi-terrestrial (marshy) conditions supporting the growth of sedge fen/reed swamp and/or woodland communities (Quest 2017). Radiocarbon dating indicates that the Middle Peat accumulated from the Early Mesolithic to Mid Neolithic date (Quest 2017).

2.6 The Upper Peat was recorded within the Upper Alluvium most located in the south of the Site. Again the Upper Peat is indicative of a localised transition toward marshy conditions supporting the grown of sedge fen/reed swamp and/or woodland communities (Quest 2017). Radiocarbon dating indicates that the Upper Peat accumulated during the Iron Age date (Quest 2017).

2.7 The archaeological watching brief undertaken during remediation works on Tilbury2 recorded the upper surface of Alluvium to be flat and level suggesting a degree of horizontal truncation of this deposit occurred as part of the development of the power station site (ASE 2017).

2.8 The Site is approximately level at c2.3m AOD. The presence of Made Ground indicates that the present landform is not a valid indicator of the former topography of the Site. Current ground level is entirely a product of Post-Medieval and more recent reclamation and 20th century industrial development. This is confirmed by the watching brief undertaken during remediation works which recorded Made Ground 0.55m and 1m deep relating to the construction of Tilbury Power Station A on reclaimed marsh land.

3.0 ARCHAEOLOGICAL BACKGROUND

3.1 The archaeological desk based assessment (CgMs 2017) has provided the detailed archaeological background to the Site.

3.2 This section of the Lower Thames Valley is one of the archaeologically richest in the country for evidence of the Palaeolithic period. Many finds of flint hand-axes and other flint tools and debris have been recovered from Gravel Terrace deposits bordering the Thames. These isolated finds are indicative of at least a sporadic low-level human activity during the Palaeolithic period. The presence of further evidence of isolated lithics buried at depth is possible though the potential to find lithics in situ associated with other remains of archaeological interest is considered to be very remote.

3.3 The peat deposits have been shown to provide significant palaeoenvironmental information. Evidence of prehistoric archaeology is limited in the Lower Thames Valley although the paleoenvironmental record indicates woodland clearance, cultivation and animal husbandry was taking place which suggests the presence of prehistoric farming settlements close-by. No evidence of later prehistoric activity has been recorded within the immediate vicinity of the Site and the Site's location on the Thames floodplain suggests that evidence of settlement is unlikely. Consequently, the Site is considered to have a low potential for prehistoric settlement evidence. No finds were identified during previous archaeological investigations on the site. Evidence of early prehistoric human remains, like those found at Tilbury Docks (Schulting 2013) is considered highly unlikely based on their rarity within the archaeological record.

3.4 The Site appears to have lain within an area that has been reasonably heavily exploited during the Roman period. Based on the available evidence the archaeological potential for Roman evidence on the Site, particularly evidence for salt extraction, is considered to be moderate.

3.5 The Site lay in uninhabited coastal salt marsh during the Anglo Saxon, Medieval and Post Medieval periods. Overall the potential for evidence of settlement activity is therefore considered to be low.

4.0 AIMS AND OBJECTIVES

4.1 The evaluation should aim to determine, as far as is reasonably possible, the location, form, extent, date, character, condition, significance and quality of any surviving archaeological remains, irrespective of period.

4.2 The evaluation should also seek to clarify the nature and extent of existing disturbance and intrusions and hence assess the degree of archaeological survival of buried deposits and any surviving structures of archaeological significance.

4.3 Within these parameters, the evaluation of this site presents an opportunity to address the following objectives:

1) Identify any evidence of prehistoric occupation
2) Identify any evidence of Roman salt extraction
3) Evaluate the impact of current land use
4) Provide sufficient information to construct an archaeological mitigation strategy

4.4 Research Framework

4.4.1 The field evaluation will be undertaken within the general parameters of the 'Research and Archaeology Revisited: A Framework for the East of England' (Medleycott 2011).

5.0 FIELD EVALUATION – DETAILED SPECIFICATION

5.1 The overall objectives of this evaluation are set out in Section 5. This section details the on site methodologies, report format and other related details.

5.2 The total number of trenches to be excavated will be determined as further information (e.g. detailed construction methodology) becomes available. In line with Essex County Council standard requirements the trenching will comprise a 4% sample of the development footprint (eg where the proposals have the potential to impact on sub-surface archaeological remains). A contingency of a further 1% sample will be held in reserve and will only be used if appropriate following consultation with the County Archaeological Officer. In addition there may be requirement to target a higher number of trenches within the proposed building footprints to ensure they are appropriately evaluated.

5.3 The results of the evaluation will provide the basis for considering further mitigation measures.

Evaluation Techniques

1) Following breaking out and removal of concrete slab trenches should be opened by mechanical excavator, with removal of all undifferentiated topsoil down to the first significant horizon. The machine should remove a level spit of no more than 0.25m depth moving along the length of the trench. Successive spits may be similarly removed until the first significant archaeological horizon is reached. That level should be cleaned in plan using a wide blade, ditching bucket or similar, with no teeth. If the machine has to re-enter the trench care should be taken to ensure that it does not damage underlying remains, particularly in soft conditions. *The machine must not be used to cut arbitrary trial trenches down to natural deposits, without regard to the archaeological stratification and leaving a section record only.* All machine work must be under archaeological supervision from an appropriately qualified and experienced contractor and should cease immediately if significant evidence is revealed.

2) The machine used should be powerful enough for a clean job of work and able to mound spoil neatly, a safe distance from trench edges. Mini garden excavators or bulldozers are not suitable.

3) Initially examination of all archaeological deposits should be by hand with cleaning, examination and recording both in plan and section. The objective is to define remains rather than totally remove them. Full excavation should be confined to the least significant remains (e.g. dumped layers) which may allow underlying stratigraphy and features to be exposed and recorded. Within significant levels partial excavation, half-sectioning, the recovery of dating evidence, sampling and the cleaning and recording of structures is preferable to full excavation. Depending on the stratigraphy revealed sieving and flotation of fills (at the appropriate mesh level) should be undertaken to recover small flint flakes/metalwork (i.e. a control sample of artefacts).

4) Archaeological excavation may require work by pick and shovel or occasionally further use of the machine. *Such techniques are only appropriate for the removal of homogeneous or low-grade deposits which may give a 'window' into underlying levels. They must not be used on complex stratigraphy and the deposits to be removed must have been properly recorded first.* Casual "mattock testing" of features of uncertain archaeological value must not be undertaken without the prior approval of the Essex County Council archaeological officer, not to be unreasonably withheld. The depth and nature of all colluvial or other masking deposits must be established across the site.

5) Particular care should be taken not to damage any areas containing significant remains which might merit preservation in situ. Such evidence would normally include deep or complex stratification settlement evidence and structures. The County Archaeological Officer must be informed immediately if remains likely to be of national significance are encountered. Such areas should be protected and not left open to the weather, or other forms of deterioration whilst investigation will not be at the expense of any structures, features or finds which might reasonably be considered to merit preservation, it is important that a sufficient sample is studied.

6) Any human remains must also be left in situ, covered and protected. If removal is essential it can only take place under appropriate environmental health regulations together with those of the Department of Communities and Local Government, which replaced Home Office regulations. Such removal must be in compliance with the Disused Burial Grounds Amendment Act 1981. Prior written notice is also to be given to the Local Planning Authority.

7) Metal detector searches should take place at all stages of the evaluation.

8) Topsoil, subsoil and archaeological deposits are to be kept separate during the evaluation to allow sequential backfilling.

Access and Safety

9) Reasonable access to the site is to be arranged for representatives of the Local Planning Authority and County Archaeological Officer who may wish to make site inspections to ensure that the archaeological investigations are progressing satisfactorily.

10) *All relevant health and safety regulations must be followed.* A general health and safety policy must be provided by the Archaeological Contractor engaged by PoTLL or their representatives and a detailed risk assessment and management strategy for this site prepared. In particular the machine should be kept away from unsupported trench edges and public access routes should be supervised and controlled. Barriers, hoardings and warning notices should be installed as appropriate. Safety helmets are to be used by all personnel as necessary. The Archaeological Contractor will provide appropriate toilet and washing facilities for site staff.

11) *No personnel are to work in deep unsupported excavations.* Trenches deeper than 1.2m will have to be stepped or battered back.

12) Where there is reason to believe from previous uses that the ground may be contaminated, the Archaeological Contractor must include arrangements for pollution sampling and testing before any site work takes place. A search for public utility or other services will also be undertaken by the Archaeological Contractor prior to commencement.

13) *The archaeological organisation must be satisfied that the applicant or developer has provided all information reasonably obtainable on contamination and the location of live services before any site work takes place.*

14) All archaeological trenches should be backfilled upon completion, for safety reasons, unless CgMs has given written instructions to the contrary.

Recording Systems

15) The recording system must be fully compatible with that most widely used elsewhere in the County. Context sheets should include all relevant stratigraphic relationships and for complex stratigraphy a separate matrix diagram should be employed. This matrix should be fully checked during the course of the evaluation. If there is any doubt over recording techniques the guidance of the County Archaeological Officer will be sought.

16) The site archive will be so organised as to be compatible with other archaeological archives produced in the County. Individual descriptions of all archaeological strata and features excavated or exposed will be entered onto prepared pro-forma recording sheets. Sample recording sheets, sample registers, finds recording sheets, access catalogues, and photo record cards will also be used. This requirement for archival compatibility extends to the use of computerised database.

17) A site location plan comprising a general plan (e.g. OS 1:1250) showing the investigation area and development site in relation to the surrounding locality and street pattern will be provided.

18) This will be supplemented by trench plans at 1:500, which will show the location of the areas investigated in relationship to the investigation area, OS grid and site grid (if any). The locations of the OS bench marks used and site TBMs will also be identified.

19) Archaeological plans; some record of the full extent in plan of all archaeological deposits must be made. All significant deposits that significantly affect the interpretation of the site and relate to the evaluation objectives should be formally planned in relation to the trench and OS grid and be at a scale of 1:10 or 1:20. Single context planning is required on deeply stratified sites.

20) Sections containing significant deposits, including half sections, should be drawn as appropriate. Upon completion of the trench at least one long section is to be drawn, including a profile of the top of natural deposits (extrapolated from cut features etc. if the test pit has not been fully excavated). In addition to the excavation of man made deposits some assessment of "naturally deposited" levels

will be necessary, especially when these are organically preserved and laid down within archaeological timescales.

21) All archaeological plans and sections should be on drawing film at a scale of 1:10 or 1:20 and should include context numbers and OD spot heights for all principal strata and features.

22) An adequate photographic record of any significant archaeological remains is required, in both plan and section, illustrating in both detail and general context the principal features and finds discovered. This will consist of black and white prints and colour transparencies (on 35mm film) supported by standard digital photography. The photographic record will also include working shots to illustrate more generally the nature of the archaeological operation mounted. The transparencies will be mounted in suitable frames.

23) A Harris Matrix stratification diagram should be compiled and fully checked during the course of the excavations.

Finds and Samples

24) A high priority should be given to dating any remains and so all artefacts and finds are to be retained. Consideration should also be given to the recovery of specialist samples for scientific analysis, particularly samples for absolute dating, structural materials and cultural/environmental evidence. Different sampling strategies may be employed according to established research targets and the perceived importance of the strata under investigation. Minimum levels of data acquisition should be defined according to the "information recovery levels" summarised by Carver (1987). The default data acquisition level for all pre-modern assemblages is level D. Close attention will be given to sampling for date, structure and environment.

25) The strategy for sampling archaeological and environmental deposits and structures (which can include soils, timbers, animal bone and human burials) will be developed in ongoing consultation with the County Archaeological Officer and the Historic England Scientific Advisor during fieldwork. Once developed a separate WSI setting out the agreed sampling strategy can be produced if required.

26) A high priority will be given to the sampling of river and other anaerobic deposits (such as peat) where organic materials may be preserved.

27) Organic samples will be subject to appropriate specialist analysis. There may be a requirement to submit timbers to dendrochronological analysis and to process some samples to provide C14 dating. Other forms of specialist analysis may also be appropriate.

28) The finds retrieval policies of the County Council will be adopted. All identified finds and artefacts will be retained, although certain classes of building material can sometimes be discarded after recording if an appropriate sample is retained. No finds will, however, be discarded without the prior approval of the County Archaeological Officer.

29) All finds and samples will be treated in a proper manner and to the standards of the UK Institute of Conservators Guidelines. All sampling will be undertaken in accordance with appropriate Historic England guidelines including Environmental Archaeology (2011), Geoarchaeology: Using Earth Sciences to understand the archaeological record (2015), Animal Bones and Archaeology Guidelines for Best Practise (2014) and Dendrochronology (1998). It may also be necessary to consult with the recent Historic England guidance 'Preserving Archaeological Remains (2016) and in particular Appendix 2 which provides approaches to be used in order to understand the preservation conditions on the site.

30) The detailed processing and assessment of finds and samples will be included the detailed project design/s prepared following consent.

31) They will be exposed, lifted, cleaned, conserved, marked, bagged and boxed in accordance with the guidelines set out in the UK Institute for Conservation "Conservation Guideline No 2". Appropriate guidelines set out in the Museums and Galleries Commissions "Standards in the Museum Care of Archaeological Collections (1991)" will also be followed.

32) All artefacts from the evaluation will, as a minimum, be washed, marked, counted, weighed and identified.

33) Bulk environmental soil samples for plant macro fossils, small animal bones and other small artefacts will be taken from appropriately sealed and dateable archaeological contexts

34) Bulk environmental soil samples will be processed by flotation and scanned to assess the environmental potential of deposits.

35) In the event of discovery of any human remains (articulated or disarticulated, cremated or unburnt), a Ministry of Justice Licence will be obtained prior to any further disturbance (including where remains are to be left in situ). Initially the remains will be left in situ, covered and protected, pending discussions with the ECC Archaeological Officer regarding the need for and appropriateness of their excavation/removal or sampling as part of the works. Where deemed appropriate, the human remains will be fully recorded, excavated and removed from the Site in compliance with the Ministry of Justice Licence.

36) Finds, discovered by the Archaeological Contractor, falling under the statutory definition of Treasure (as defined by the Treasure Act of 1996 and its revision of 2002) will be reported immediately to the relevant Coroner's Office, the Finds Liaison Officer (FLO) who is the designated treasure co-ordinator for Essex County Council, the landowner and the Archaeological Advisor to the LPA. A Treasure Receipt (obtainable from either the FLO or the DCMS website) must be completed and a report submitted to the Coroner's Office and the FLO within 14 days of understanding the find is Treasure. Failure to report within 14 days is a criminal offence. The Treasure Receipt and Report must include the date and circumstances of the discovery, the identity of the finder (put as unit/contractor) and (as exactly as possible) the location of the find.

37) The pottery specialist employed by the archaeological contractor will be familiar with local pottery types and with a record of publications in the region.

38) The spot dating of pottery will be employed, where appropriate, to inform the onsite evaluation methodology.

Reports and Archives

Draft Report

39) A draft report on the results of the evaluation will be prepared, both in bound paper format with colour images, and also in electronic format on CD as a PDF with a minimum file size of 300dpi.

40) The summary report should include:

i. The archaeological contractors site/finds code

ii. Perceived archaeological potential of the site and vicinity from documentary sources – historic, cartographic, archaeological, SMR, geographical, topographic and environmental.

iii. The aims and methods adopted in the course of the evaluation.

iv. Illustrative material including maps, plans, sections, drawings and photographs as necessary: photographs should include images of work in progress together with any significant features revealed.

v. The nature, extent, date, condition and significance of the archaeological finds with specialist opinions and parallels from other sites if required.

vi. The anticipated degree of survival of archaeological deposits across the site, as affected by its present state and recent past (e.g. extent of quarrying).

vii. Copies of the draft evaluation report will be sent to CgMs consulting for onward submission to the County Archaeological Officer. Once approved a final copy will be submitted to the HER.

viii. The HER will receive a CD containing an archive version of the final approved report and a selection of site photographs that can be used (if required) for public engagement by the HER.

ix. Once the HER is in receipt of the final draft an approval letter will be issued by the County Archaeological Officer for onward submission to the local planning authority.

Archives and Published Reports

41) The integrity of the site archive should be maintained. The archive of all records and finds must be prepared consistent with the principles set out in the Management of Archaeological Projects (English Heritage 1991), particularly Appendix 3.1 and Appendix 4.1.

42) The minimum acceptable standard for the archival report is defined in the "Management of Archaeological Projects" 5.4 and Appendix 3. It will include all materials recovered (or the comprehensive record of such materials) and all written, drawn and photographic records relating directly to the investigations undertaken. It will be quantified, ordered, indexed and internally consistent. It will also contain a site matrix, a site summary and brief written observations on the artefactual and environmental data.

43) United Kingdom Institute for Conservation guidelines for the preparation of excavation archives for long term storage (1990) will be followed. Arrangements for the curation of the site archive will be agreed in writing with the recipient Museum who will issue a museum acquisition number before site work commences. Details of such arrangements will be copied to the County Archaeology Officer and the Local Planning Authority before site works commence.

44) In principal, the site archive is to be deposited with the appropriate museum within 3 months of the completion of work. It will then become publicly accessible. The contractor will need to hold discussions with the museum curator prior to archaeological work commencing regarding the collection and discard policy relevant to the site, and to observe such requirements. If the museum is unable to accept the archive an alternative solution regarding the storage of the archive will be found. The County Archaeologist will be advised once the relevant museum has been approached regarding this archive.

45) County Historic Environment Record Summary Sheets should be completed for the site, as per the County HER manual and appended to the final report.

46) In addition, at the start of work (immediately before fieldwork commences) an OASIS online record http://ads.ahds.ac.uk/projects/oasis/ must be initiated and key fields completed on Details, Location and Creators Forms. All appropriate parts of the OASIS online form must be completed for submission to the HER.

This should include an uploaded .pdf version of the entire report (a paper copy should also be included with the archive). A copy of the OASIS summary sheet in digital form should be emailed to the Hon. Editor of the Essex Archaeology and History Journal ([redacted]) for inclusion in the annual roundup of projects.

47) A timetable for all stages of the project must be agreed before the first stage of work commences, including monitoring by the County Archaeological Officer.

6.0 OTHER MATTERS

6.1 Archaeological Contractor

6.1.1 The Archaeological Contractor will have a proven track record in undertaking field evaluation and investigations on large rural sites and the relevant geology.

6.1.2 The field team deployed by the Archaeological Contractor will include only full time professional archaeological staff.

6.1.3 The Archaeological Contractor should preferably be a body on the CIfA Register of Archaeological Organisations and will be consistent throughout the project.

6.2 Standards

6.2.1 CgMs Consulting endorses *the Code of Practise* and the *Code of Approved Practise for the Regulation of Contractual Arrangements in Field Archaeology* of the Chartered Institute for Archaeologists.

6.2.2 All staff supplied by the archaeological contractor would be of a standard approved by POTLLs archaeological consultants and be employed in line with the Chartered Institute for Archaeologist's Codes of Practise and be members of the Chartered Institute for Archaeologists.

6.2.3 Provision would be made for monitoring of all stages of the project by the client and the local planning authority and their representatives.

6.3 Insurance and Health and Safety

6.3.1 The archaeological contractor will maintain both public liability and professional indemnity insurance to suitable levels of coverage. Full details of insurance cover can be supplied on request.

6.3.2 All work will be carried out to comply with the Health and Safety and Work etc Act 1974 and the Management of Health and Safety Regulations 1999.

SOURCES CONSULTED

Chartered Institute for Archaeologists Guidelines:

http://www.archaeologists.net/sites/default/files/node-files/code_conduct.pdf
http://www.archaeologists.net/sites/default/files/node-files/ifa_code_practice.pdf

National Guidance:

Department of Communities and Local Government *National Planning Policy Framework* 2012

Guidelines:

Historic England 2011 *Environmental Archaeology: A Guide to the Theory and Practise of Methods from Sampling and Recovery to Post Excavation*

Historic England 2015 *Geoarchaeology: Using Earth Sciences to Understand the Archaeological Record*

Historic England 2014 *Animal Bones and Archaeology: Guidelines for Best Practise*

Historic England 2016 *Preserving Archaeological Remains; Appendix 2 Preservation Assessment Techniques*

Historic England 1998 Dendrochronology

MAP2 Management of Archaeological Projects (Second Edition) 1991

MoRPHE Management of Research Projects in the Historic Environment The MoRPHE Project Managers' Guide 2009

MoRPHE Management of Research Projects in the Historic Environment PPN 3: Archaeological Excavation January 2008

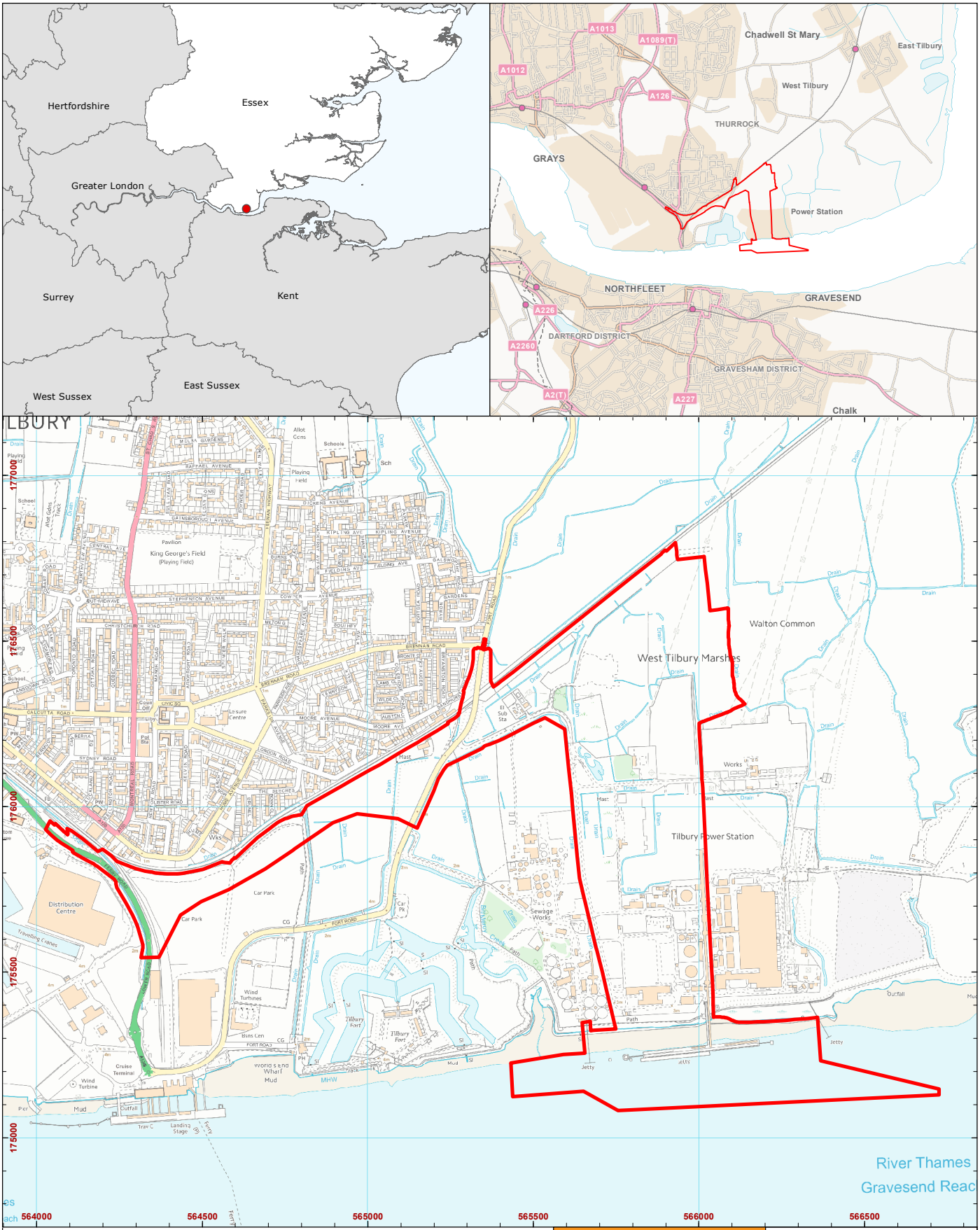
Museums and Galleries Commissions *Standards in the Museum Care of Archaeological Collections* 1991

United Kingdom Institute for Conservation (UKIC) *Conservation Guideline No 2* (n/d)

United Kingdom Institute for Conservation (UKIC) *guidelines for the preparation of excavation archives for long term storage* 1990

Site Specific:

CgMs 2017 *Archaeological Statement Tilbury2 land at Former RWE Power Station, Tilbury, Essex*
CgMs 2017 *Archaeological Desk Based Assessment Tilbury2 Former RWE Power Station, Tilbury, Essex*
Quest 2017 *Tilbury2 Land at Former RWE Power Station, Tilbury Geo-archaeological fieldwork, Radiocarbon Dating and updated Deposit Model*
ASE 2017 *Archaeological Watching Brief Land at the Former RWE Power Station, Tilbury, Essex*



Site Boundary

N

Scale at A4: 1:16,000

0 440m

CgMs CONSULTING

Planning • Heritage

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Figure 1:
Site Location

APPENDIX WSI 1:

Written Scheme of Investigation for Geoarchaeological and Palaeoenvironmental Assessment (Quest 2017)

QUEST
QUATERNARY SCIENTIFIC

University of Reading

TILBURY 2 & INFRASTRUCTURE CORRIDOR, TILBURY, SOUTH ESSEX

Written Scheme of Investigation for Geoarchaeological and Palaeoenvironmental Assessment

NGR: TQ 65800 76000

Date: 26th October 2017

Written by: D.S. Young & C.R. Batchelor

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v1	02/06/17	D.S. Young		C.R. Batchelor		First edition
v2	08/06/17	D.S. Young		C.R. Batchelor		Updated redline; amendments to text
v3	09/08/17	D.S. Young		C.R. Batchelor		Updated as required by HE
v4	26/10/17	C.R. Batchelor		C.R. Batchelor		Updated following findings of field investigations

CONTENTS

1. OVERARCHING GOAL OF RESEARCH IN THE LOWER THAMES VALLEY

The Tilbury 2 site, including its infrastructure corridor (National Grid Reference: centred on TQ 65800 76000; Figure 1) provides an opportunity to test the hypotheses generated by previous studies in the Lower Thames Valley. Geoarchaeological and palaeoenvironmental investigation of the site is required to provide a detailed reconstruction of its environmental history, which can be compared and integrated with records from nearby sites, including those investigated by Devoy (1979; The World's End/Broadness Marshes), Tilbury Fort (Batchelor, 2009), Tilbury Docks (Spurrell, 1889; Schulting, 2013), Tilbury North (Batchelor *et al*., 2014), Tilbury C (Wessex Archaeology, 2008) and upcoming works in the marine and intertidal zones adjacent to the present site (Wessex Archaeology, 2017). This will enable a detailed reconstruction of spatial and temporal variations in the environment, and make a significant contribution to achieving the overarching goal of the research programme.

The long-term goal of our research programme in the Lower Thames Valley is to compile a high-resolution spatial-temporal model of the changing environment of the wetland and dryland during the Middle and Late Holocene (last 7000 years). This integrated model, we propose, should be generated by the compilation of environmental archaeological records from intercalated alluvial and peat sequences (wetland), and archaeological stratigraphy (wetland and dryland). Individual recording sites should be analysed at high resolution to provide a detailed three-dimensional spatial reconstruction of changing environmental conditions, which, coupled with the archaeological records, will permit micro-scale (local) and meso-scale (regional) modelling of the interactions (e.g. economic and dietary activities) between human groups and their environment. In particular, we need to continue to source information on floodplain development, channel migration and abandonment, marine incursion, terrestrialisation (peat and soil formation), vegetation structure and composition (both wetland and dryland), animal husbandry, cultivation, and the exploitation of wild plants and animals.

The Tilbury 2 site and its infrastructure corridor offer the potential to provide detailed records of spatial and temporal changes in the environment due to the known presence of thick, intercalated alluvial and peat sequences. The stratigraphic boundaries between alluvium and peat indicate highly significant successions from aquatic to semi aquatic, and then semi terrestrial to fully terrestrial ecosystems. These successions result in changes in the composition and diversity, and potential availability to humans, of plant and animal resources. However, our records from the Lower Thames Valley (Batchelor, 2009; Branch *et al*., 2012; Green *et al*., 2014) indicate significant changes in environmental conditions, in particular vegetation structure and composition, *during* the main period of Middle Holocene peat formation. These changes occurred due to: (1) natural succession and human impact, and (2) episodic fluvial inundation of the peat surface prior to the main period of marine incursion (alluviation). Recording these changes enables us to address questions relating to human adaptability and survivability against a background of changing environmental conditions, and human modification of the natural environment.

2. SITE CONTEXT

The site is situated on the River Thames floodplain, immediately to the north of the present course of the river and east of Fort Road. The British Geological Survey (BGS) show the site underlain by Cretaceous Seaford and Newhaven Chalk Formation bedrock, and describes the Alluvium overlying it as 'Clay, Silty, Peaty, Sandy' (http://mapapps.bgs.ac.uk/geologyofbritain/home.html). In fact, the alluvial deposits of the Lower Thames and its tributaries are almost everywhere underlain by Late Devensian Late Glacial Gravels (in the Thames valley, the Shepperton Gravel of Gibbard, 1985, 1994), and this gravel is widely recorded in boreholes in the vicinity of the site. The site lies *ca.* 1.25km to the south of the geological and topographical boundary of the East Tilbury Marshes Gravel (Gibbard, 1985).

A program of geoarchaeological desk-based deposit modelling, field investigations and radiocarbon dating has already taken place at the site. This has been carried out to: (1) clarify in detail the nature of the sub-surface stratigraphy across the site; (2) enhance our understanding of the nature, depth, extent and date of any former land surfaces, alluvial and peat deposits, and (3) make recommendations for further geoarchaeological investigations at the site as part of the mitigation strategy. Throughout this exercise, the findings have been put into context with the nearby works at sites such as the Worlds End (Devoy, 1979), Tilbury Fort (Batchelor, 2009) and London Distribution Park (Batchelor et al., in prep). The work of Devoy at the Worlds End is particularly important as it is often referred to as the type site for palaeoenvironmental and relative sea level studies in the Lower Thames Valley.

The full findings of work to date on the Tilbury 2 site are detailed in Batchelor & Young (2017). However, in summary, the results of the deposit modelling indicate that the sediments recorded at the site are similar to those recorded elsewhere in the Lower Thames Valley, with Late Devensian Shepperton Gravel overlain by a sequence of Holocene alluvial sediments, including peat, and buried beneath modern Made Ground. Similarly to other investigations in this area of Tilbury, at least three distinct horizons of peat are identified, towards the base, middle and top of the sequence. Radiocarbon dating of the sequences indicate they correlate most closely with Devoy's 1979 Tilbury I, II, III and IV peats. However, the range of different elevations and ages of the peat horizons in this area of Tilbury suggests that peat formation was diachronous and in some cases was highly localised. The sequences are still considered to be of regional significance, but the results of the radiocarbon dating of one borehole in particular (QBH3/3A) emphasises the importance of Tilbury which (as above) has been (and probably always will be) used as the type site for palaeoenvironmental and relative sea level studies in the Thames. Each sequence has the potential to provide information on past environmental change and human activity, through the preservation of biological remains; in particular, the sequences may provide additional information on the possible transition to ombrotrophic conditions recorded at the nearby London Distribution Park site (Batchelor *et al.*, 2014), the Early Neolithic elm decline, the Late Neolithic/Early Bronze Age lime decline, and relative sea level rise (RSL).

3. GEOARCHAEOLOGICAL, PALAEOENVIRONMENTAL & ARCHAEOLOGICAL POTENTIAL

The existing geotechnical borehole records in the area of the site thus indicate considerable variation in the height of the Gravel surface, and the type, thickness and age of the subsequent Holocene deposits. Such variations are significant as they represent different environmental conditions that would have existed in a given location. For example: (1) the varying surface of the Gravel may represent the location of former channels and bars; (2) the presence of soil and peat represents former terrestrial or semi-terrestrial land-surfaces, and (3) the various fine-grained minerogenic units represent periods of changing alluvial/estuarine hydrological conditions. Thus by studying the sub-surface stratigraphy across the site in greater detail, it will be possible to build an understanding of the former landscapes and environmental changes that took place across space and time. In addition, given the location of the site, it has the potential to contribute to highly important investigations on relative sea level rise that are applicable to the Tilbury region and the rest of the Lower Thames Valley (e.g. Devoy, 1979, 1982; Long, 1995; Haggart, 1995; Sidell and Long, 2000; Long *et al*., 2000; Wilkinson *et al*., 2000; Sidell *et al*., 2000; Sidell, 2003).

The alluvial and organic-rich sediments (in particular peat) also have high potential to provide a detailed reconstruction of past environments on both the wetland and dryland. In particular, they provide the potential to increase knowledge and understanding of the interactions between hydrology, human activity, vegetation succession and climate. Significant vegetation changes include the Mesolithic/Neolithic decline of elm woodland, the Neolithic colonisation and decline of yew woodland; the Late Neolithic/Early Bronze Age growth of elm on Peat, and the general decline of wetland and dryland woodland during the Bronze Age. Such investigations are carried out through the assessment/analysis of palaeoecological remains (e.g. pollen, plant macrofossils & insects) and radiocarbon dating, and have been undertaken at the nearby sites such as London Distribution Park (Batchelor *et al*., in prep), Tilbury Fort (Batchelor, 2009), Tilbury Docks (Spurrell, 1889) and The World's End (Devoy, 1979) (see Figures 1 & 2).

Finally, areas of high gravel topography, soils and peat represent potential areas that might have been utilised or even occupied by prehistoric people, evidence of which may be preserved in the archaeological (e.g. features and structures) and palaeoenvironmental record (e.g. changes in vegetation composition). No prehistoric archaeological features have thus far been recorded in the Tilbury area, however, human interaction with the local environment is demonstrated by the recording of Palaeolithic and Neolithic flint artefacts during excavation of the Tilbury Docks and at West Tilbury Marshes (CgMs Consulting, 2017). Furthermore, a partial skeleton was found in 1883 within peat at *ca*. 10m below ground level (bgl) at the Tilbury Docks site (Spurrell, 1889). More recent analysis (Schulting, 2013) has revealed the skeleton to be of Late Mesolithic date (8015–7860 cal BP); the Late Mesolithic is a period for which human skeletal finds are very rare in Britain (Schulting, 2013), and such a find highlights the presence of humans, and the potential utilisation of the floodplain not far from the Tilbury 2 site, during this period. Palaeoenvironmental investigations at the nearby London Distribution Park also indicate episodes of burning and changes in vegetation during the prehistoric period which may be associated with human activity (Batchelor *et al*, in prep).

Although units indicative of soil formation have not yet been identified in the geotechnical records from the present site, this could be due to the nature of the geotechnical coring and description. At nearby sites such as London Distribution Park/Tilbury North (Batchelor *et al.*, 2014) and Tilbury Fort (Batchelor, 2009) sites, peaks in magnetic susceptibility were recorded prior to the accumulation of the Middle and/or Upper Peats. Such peaks are thought to represent periods of pedogenesis (soil formation) prior to peat formation. Importantly, the timing and elevation of peat and soil formation are significant for our understanding of relative sea level (RSL) in this area of the Lower Thames Valley, and more broadly in southern England (e.g. Devoy, 1979; Long and Tooley, 1995). In addition, the processes behind peat and soil formation in relation to marine transgression and regression are not yet fully understood (e.g. Haggart 1995), and further analysis of such horizons may contribute to the understanding of these mechanisms. The existing models for the rates of RSL rise, such as that proposed by Devoy (1979; 1982) and Sidell (2003) for the Lower Thames Valley itself, and by Long *et al.* (2000) from three major southern England estuaries, are critical areas of research for studies of Holocene vegetation history and human activity in the Lower Thames Valley. Devoy's original model of peat formation and RSL was produced for the Lower Thames Valley as a whole, based upon a small number of records, and heavily influenced by the record from the World's End, Tilbury, and subsequent work in the Tilbury area has revealed inconsistencies in the timing and extent of peat formation (e.g. Batchelor, 2009, Batchelor *et al.*, 2014). Subsequently, Sidell's (2003) model demonstrates that it is not possible to apply this model to the whole of the Lower Thames Valley. In addition, it has been argued (e.g. Haggart, 1995; Sidell and Long, 2000; Long *et al.*, 2000) that the site-specific factors may mean that the World's End borehole (Devoy, 1979) represents an anomalous record. New RSL index points from the Tilbury 2 site would therefore contribute significantly to the debate in this area of research, and our understanding of rates of RSL rise in this area of the Lower Thames Valley.

4. AIMS & OBJECTIVES

As a consequence of the findings from work to date at Tilbury 2 (Batchelor & Young, 2017), it is recommended that further assessment works continue on the sequences of QBH1, QBH3/3A and QBH6. These boreholes have been selected as they represent a good spatial distribution across the site and contain the best sequences. However, it is also highly recommended that a repeat borehole is taken in the location of QBH3 as it is the most important of the three sequences. The current sequence contains voids at key points within the peat deposits; repeating this attempting a different methodology (such as dynamic sampling or geoarchaeological coring) is likely to increase the possibility of a non-disturbed and continuous set of samples. Furthermore, whilst the coverage of the updated deposit model is in the region of 75% and thus very good; advantage should be taken of further planned site investigation works that might infill the remaining voids. Either the resultant borehole logs should be supplied, or (more preferably) a geoarchaeologist should be onsite to monitor selected works. Should this monitoring exercise reveal sequences different to those observed to date, it may be necessary to obtain samples for palaeoenvironmental assessment/analysis. Finally, as outlined elsewhere, the offshore sequences are considered of limited palaeoenvironmental potential due to a lack of peat in the thin alluvium

overlying the Shepperton Gravel; as such no further work is recommended (Wessex Archaeology, 2017).

The five significant research aims relevant to the further geoarchaeological/palaeoenvironmental investigations at the site remain as follows:

1. To clarify in more detail the nature of the sub-surface stratigraphy across the site;
2. To enhance our understanding of the nature, depth, extent and date of any former land surfaces, alluvial and peat deposits;
3. To investigate whether the sequences contain any artefact or ecofact evidence for prehistoric or historic human activity;
4. To investigate whether the sequences contain any evidence for natural and/or anthropogenic changes to the landscape (wetland and dryland);
5. To integrate the new geoarchaeological record with other recent work in the local area for publication in an academic journal.

In order to address the first four of these aims, the following objectives are proposed:

1. To retrieve undisturbed continuous samples from the location of QBH3;
2. To monitor any further proposed SI works that might take place in previously unobserved areas of the site;
3. To update the existing deposit model with any new relevant data;
4. To carry out an palaeoenvironmental assessment of boreholes QBH1, QBH3 and QBH6 incorporating: (1) additional range finder radiocarbon dates (where necessary) to clarify the approximate chronology of any periods of peat formation recorded within the borehole samples; (2) organic matter and magnetic susceptibility determinations of the sediments; (2) an assessment of their palaeoecological content, and (3) recommendations for further environmental archaeological investigations (if necessary);
5. To carry out palaeoenvironmental analysis (if necessary) incorporating the recommendations made during the assessment;
6. To publish the results of the site investigations, depending on the significance of the findings.

5. ADDITIONAL FIELD INVESTIGATIONS, UPDATED DEPOSIT MODELLING, ASSESSMENT & REPORTING

5.1 Continuous, undisturbed borehole core samples will be obtained in the location of QBH3/QBH3A. The boreholes will be recovered using either Dynamic sampling or a Eijkelkamp windowless sampler and gouge set using an Atlas Copco TT 2-stroke percussion engine. These methods have greater potential for a recovering a complete continuous, undisturbed core samples and provides sub-samples suitable for not only sedimentary and microfossil assessment and analysis, but also macrofossil analysis. The recovered core samples will be wrapped in clear plastic to prevent moisture loss, labelled with the depth

(metres from ground surface) and orientation (top and base) and returned to *Quaternary Scientific* (University of Reading) for storage in a purpose built facility at 2^{0}C. This temperature prevents fungal growth on the core surface, which may lead to anomalous radiocarbon dates, and moisture loss.

5.2 Detailed laboratory-based description of the borehole sequences using the Tröels-Smith (1955) procedure for the description of sediments, noting composition, colour boundary types (sharp or diffuse) and degree of humification. Description of the sedimentary sequence recovered in the borehole core samples will provide important, primary information on the nature of the depositional environment through time. Sand and gravel indicates deposition with a high energy fluvial environment, such as braided river system, during cold climatic conditions. Fine-grained mineral sediment, such as silt or clay indicates deposition within or on the margins of a lake, pond or river. Soil and peat formation indicates the formation of semi-terrestrial or fully terrestrial conditions resulting in the colonisation of vegetation adapted to the specific local conditions.

5.3 Advantage will be taken of further planned site investigation works – particularly in the areas of any remaining voids in the existing deposit model. Either the resultant borehole logs should be supplied, or (more preferably) a geoarchaeologist should be onsite to monitor and record selected works. Should this monitoring exercise reveal sequences different to those observed to date, it may be necessary to obtain samples for palaeoenvironmental assessment/analysis as detailed in section 5.6 onwards.

5.4 Any new stratigraphic data will be used to update the site-wide model of the stratigraphic architecture. This deposit model will be created using Rockworks 16, ArcGIS and Adobe Illustrator and will assist in the reconstruction of former land surfaces or channels, and site formation and transformation processes, such as alluvial sedimentation and peat formation.

5.5 The deposit model will include three-dimensional topographic surfaces of the major depositional units across the site, as well as two-dimensional stratigraphic profiles along selected transects across the site.

5.6 An assessment of the core samples from QBH1, QBH3/3A and QBH6 will be undertaken. This assessment will consist of the following techniques:

5.7 <u>Organic matter determinations</u>

Quantification of the organic matter content is carried out by 'Loss on Ignition'. This is a quick and easy technique to undertake that provides highly useful information. In particular, it: (1) aids in the interpretation of the sedimentary sequence, indicating more terrestrial conditions (e.g. peat/soil); (2) enables the recognition of flood events during peat accumulation, that may not solely be recognised by sedimentary description, and (3) identifies the most 'organic-rich points' within an organic-rich sequence (e.g. peat) for radiocarbon dating. Fen

peat for example, frequently ranges between 50% and 80% organic. The less organic, the greater the chance of the extracted plant macrofossil remains being derived, a situation organic matter determinations helps to avoid. Each of the main sedimentary units recovered in the borehole core samples will be assessed for their organic matter content, and the results tabulated and presented diagrammatically.

5.8 Magnetic Susceptibility

As described in section 3, determination of the magnetic susceptibility of sequences from the Tilbury area have provided useful information on the nature and character of sediment accumulation. At nearby sites such as London Distribution Park/Tilbury North (Batchelor *et al.*, 2014) and Tilbury Fort (Batchelor, 2009) sites, peaks in magnetic susceptibility were recorded prior to the accumulation of the Middle and/or Upper Peats. Such peaks are thought to represent a period of pedogenesis (soil formation) prior to peat formation. Importantly, the timing and elevation of peat and soil formation are significant for our understanding of relative sea level (RSL) in this area of the Lower Thames Valley, and more broadly in southern England (e.g. Devoy, 1979; Long and Tooley, 1995). In addition, the processes behind peat and soil formation in relation to marine transgression and regression are not yet fully understood (e.g. Haggart 1995), and further analysis of such horizons may contribute to the understanding of these mechanisms. Determination of magnetic susceptibility will be carried out on selected sequences from the site as part of the strategy for environmental archaeological assessment. Magnetic susceptibility measurements will be taken under laboratory conditions using the Bartington MS2 system. The system comprises a meter and a range of sensors including: (1) the MS2B dual frequency sensor; (2) the MS2C core loop sensor, and (3) the MS2E sensor. The most appropriate of these methods and the resolution will be determined after collection and description of the cores.

5.9 Pollen assessment

The analysis of pollen grains and spores (palynology) is widely used in environmental archaeology since they frequently provide valuable information on vegetation composition, structure and succession (palaeoecology), plant migration (biogeography), climate change, human modification of the natural vegetation cover and land-use (anthropogenic activity), and diet. They enable us to record vegetation succession due to natural processes, such as competition and climate change, and human activities, such as woodland clearance and cultivation. The assessment procedure will consist of recording the preservation and concentration of pollen grains and spores from each borehole sequence to provide a preliminary reconstruction of the vegetation history, detect evidence for human activities (e.g. woodland clearance and cultivation). The pollen assessment will focus on identifying sedimentary sequences that provide a record of both natural and human-induced vegetation succession, which will permit improved understanding of the processes and events that determined the nature of vegetation change at the site. To achieve this objective, the assessment will identify key indicator taxa or groups of taxa that will permit a provisional reconstruction of changing vegetation communities e.g. alder Carr, reed swamp,

cultivated ground, dryland woodland, and provide a provisional explanation for the changes recorded. Sub-samples will be extracted from the selected borehole sequences by standard laboratory procedures and subject to an assessment of potential for analysis (see Branch *et al.*, 2005). The assessment will involve identification and tabulation of the main pollen taxa (no pollen counts), and an evaluation of the overall quality of the preservation and concentration, for each sub-sample. The information provided by the preservation and concentration data is especially important because they will permit an evaluation of the stratigraphic integrity of the pollen assemblage. Recommendations for further analysis will be based upon: (1) adequate preservation and concentration of pollen to ensure a full stratigraphic analysis; (2) the samples having the potential to achieve the objectives outlined above.

5.10 Diatom assessment

Diatoms are unicellular algae and comprise a silicified (opaline silica) cell wall (frustule) with two overlapping valves (epivalve and hypovalve). Their taxonomy and ecology are well known, with different species occupying the bottom of (benthic), or floating within (planktonic), water bodies (e.g. oceans, lakes, ponds, rivers, salt marshes, ditches), and living in soil and on trees (epiphytic). They will be a valuable part of the assessment because species are indicative of a wide variety of environmental conditions (e.g. marine, brackish or freshwater) that reflect temperature, salinity (level of common salt in solution), pH (potential hydrogen), oxygen and mineral content (e.g. silica, phosphate, nitrate and iron). For example, deep alluvial sequences have recorded changes in diatom assemblages because of fluctuations in the height of relative sea level during the Holocene. Marine transgressive phases are indicated by the dominance of marine diatoms, whereas the transition to marine regressive phases (reduction or stabilisation in relative sea level) shows a progressive increase in freshwater and brackish water taxa. Sub-samples will be extracted from the borehole sequences by standard laboratory procedures and subject to an assessment of potential for analysis (see Branch *et al.*, 2005). The assessment will involve identification and tabulation of the main diatom taxa (no diatom counts), and an evaluation of the overall quality of the preservation and concentration, for each sub-sample. The information provided by the preservation and concentration data is especially important because they will permit an evaluation of the stratigraphic integrity of the diatom assemblage. Recommendations for further laboratory-based analysis will be based upon: (1) adequate preservation and concentration of diatoms to ensure a full stratigraphic analysis; (2) the samples having the potential to achieve the objectives outlined above.

5.11 Waterlogged plant macrofossil assessment

Waterlogged seeds are one of the most common plant remains found within organic-rich palaeoenvironmental sequences. Preservation by waterlogging occurs in anoxic conditions, which retards the decay process and results in the loss of internal anatomical structures. In peat and alluvium, seeds are almost exclusively preserved in a waterlogged state. The seeds and their components (e.g. stems, leaves, buds) in peat and alluvium will represent either plants growing locally (autochthonous) or plants growing at an uncertain distance from the

point of deposition (allochthonous). Analysed in conjunction with other proxies (e.g. pollen, insects), they may provide valuable information on climate change or vegetation history. Small bulk samples from the boreholes will be processed by standard laboratory procedures involving wet sieving, and subject to an assessment of potential for analysis (see Branch *et al.*, 2005). The assessment will involve identification and tabulation of the main waterlogged taxa (no macrofossil counts), and an evaluation of the overall quality of the preservation and concentration, for each bulk sample. Recommendations for further analysis will be based upon: (1) adequate preservation and concentration of waterlogged, charred and mineralised remains to ensure a full analysis; (2) the samples having the potential to achieve the objectives outlined above.

5.12 Waterlogged wood assessment

Wood preserved by anaerobic, waterlogged conditions is often found in both geological deposits, such as peat, and archaeological archives (e.g. trackways, platforms, hurdles, ditches, pits). It provides primary data on woodland composition, and hence vegetation history, woodland management, agricultural practices (e.g. fodder and bedding for animals), woodland exploitation for domestic fires (fuel), human impact on the natural environment, catastrophic, natural wild fires, material culture (wooden artefacts), time of woodland exploitation, local environmental conditions, preservation and bias in wood assemblages and technological sophistication. Small bulk samples will be processed by standard laboratory procedures involving wet sieving, and subject to an assessment of potential for analysis (see Branch *et al.*, 2005). The assessment will involve identification and tabulation of the main taxa based upon random sub-sampling of ten specimens from each bulk sample for waterlogged wood (no macrofossil counts), and an evaluation of the overall quality of the preservation and concentration, for each bulk sample. Recommendations for further analysis will be based upon: (1) adequate preservation and concentration of wood and charcoal to ensure a full analysis; (2) the samples having the potential to achieve the objectives outlined above.

5.13 Insect assessment

Insect remains are found in a range of wet and dry environments. Their robust chitinous exoskeletons are often found as well-preserved fragments. Insects provide valuable information on regional and local environmental conditions, the local human environment, human and animal diet, and the function of archaeological features, condition of human and animal mummified remains, and the contents of offerings. These applications require detailed records of modern groups of insect species and their ecological preferences, and the ability to differentiate between those species indicative of the general environment (allochtonous species) and local area (autochtonous species). Small bulk samples will be processed by standard laboratory procedures involving paraffin flotation, and subject to an assessment of potential for analysis (see Branch *et al.*, 2005). The assessment will involve identification and tabulation of the main taxa (no insect counts), and an evaluation of the overall quality of the preservation and concentration, for each bulk sample. Recommendations for further analysis will be based upon: (1) adequate preservation and

concentration of insects to ensure a full stratigraphic analysis; (2) the samples having the potential to achieve the objectives outlined above.

5.14 Mollusca assessment

Mollusca are preserved on land (e.g. soil and mires), and in freshwater (e.g. lakes), brackish water (e.g. high salt marsh) and marine (e.g. estuaries) sediments where there is an adequate amount of calcium carbonate (mainly aragonite). Mollusca have the potential to provide three categories of information useful to the project: (1) broad palaeoenvironmental reconstruction, which is dependent on recording species with particular climatic or habitat ranges; (2) human impact on the natural environment, which has the same requirements as (1) and may provide useful information on woodland clearance and land-use, and (3) human economy and diet, which is mainly (but not exclusively) confined to shellfish. For both (1) and (2), assigning species to precise ecological groups is especially important, and species will vary in their importance between geographical areas. Small bulk samples will be processed by standard laboratory procedures involving Hydrogen peroxide and wet sieving, and subject to an assessment of potential for analysis (see Branch *et al*., 2005). The assessment will involve identification and tabulation of the main taxa (no Mollusca counts), and an evaluation of the overall quality of the preservation and concentration, for each bulk sample. Recommendations for further analysis will be based upon: (1) adequate preservation and concentration of Mollusca to ensure a full stratigraphic analysis; (2) the samples having the potential to achieve the objectives outlined above.

5.15 Radiocarbon dating

Further radiocarbon dating of key horizons to confirm the age of the peat will be carried out (where necessary). Radiocarbon dating has almost single-handedly transformed our understanding of the timing of events and rates of change in archaeological records (Branch *et al*., 2005). At the present site, AMS methods will be employed using the facilities at Beta Analytic INC, Florida. Careful consideration will be given to the selection of materials for radiocarbon dating to avoid recent or geological contamination e.g. percolating humic acids, rootlets and bacterial deposits. In all instances, we will attempt to select terrestrial plant macrofossils (e.g. seeds and wood) for plants formerly growing in-situ, rather than bulk organic samples or organic detritus. A report on these results will include a critical examination of the methods employed by Devoy (1979; 1982), and a comparison of these results. Ages will be reported as an age from year zero, which is taken as A.D. 1950, when the ^{14}C content of the atmosphere was approximately in equilibrium, prior to nuclear bomb testing. This age will be given as Before Present (or B.P.) and can be then converted to A.D. or B.C. To avoid any confusion between calibrated and un-calibrated dates, we will use '^{14}C' prior to the nomenclature used (i.e. ^{14}C B.P., ^{14}C A.D. and ^{14}C B.C.) if the ages are un-calibrated, and use 'cal' prior to the term if calibrated (i.e. cal. B.P., cal. A.D. and cal. B.C.). Ages will be quoted with the measurement error only, and is typically given at 2 standard deviation (i.e. 95%) confidence limits. Calibration of radiocarbon dates, due to cosmic ray flux, solar

intensity and changes in the carbon cycle will be conducted on radiocarbon ages to 11,857 dendro (tree ring) years B.P (see Stuiver *et al.*, quoted in Branch *et al.,* 2005).

5.16 Reporting

Following completion of the laboratory-based assessment, a detailed report will be produced. This report will build upon the report produced in 5.8 and is likely to include some or more of the following sections:

- Introduction
  (inclusive of site location and borehole location figures)
- Methods
- Results and interpretation of the geoarchaeological investigations and deposit modelling
  (inclusive of borehole description tables and figures, topographic surface and thickness models and cross sections, organic matter content and radiocarbon tables)
- Results and interpretation of individual microfossil and macofossil assessment
  (inclusive of appropriate tables and figures)
- Discussion
  (inclusive of appropriate tables and figures)
- Conclusions and recommendations for analysis
- References
- Appendix

6. LABORATORY-BASED ANALYSIS, REPORTING & PUBLICATION

6.1 Based upon the assumption that further laboratory-based analysis will be required, QUEST will implement a targeted laboratory-based palaeoenvironmental analysis of a minimum of one borehole sequence. The work will consist of one or more of the following analytical techniques:

6.2 Pollen analysis

Quantification of the pollen assemblages in each sub-sample will be based upon a pollen sum of 300 total land pollen (trees, shrubs and herbs) with aquatic and spore taxa counted in addition. The results will be presented diagrammatically as percentages using Tilia and Tilia-Graph software.

6.3 Waterlogged plant macrofossil analysis

Quantification of the plant macrofossil assemblages in each bulk sample will be based on the identification of the entire assemblage. The results will be tabulated and presented diagrammatically as raw counts and percentages.

6.4 Waterlogged wood analysis

Quantification of the wood and charcoal assemblages in each bulk sample will be based on the identification of 100 specimens for both classes. The results will be tabulated and presented diagrammatically as raw counts and percentages.

6.5 Insect analysis

Quantification of the insect assemblages in each bulk sample will be based on the identification of the entire assemblage. The results will be tabulated and presented diagrammatically as raw counts and percentages.

6.6 Mollusca analysis

Quantification of the Mollusca assemblages in each bulk sample will be based on the identification of a minimum of 300 specimens. The results will be tabulated and presented diagrammatically as raw counts and percentages.

6.7 Radiocarbon dating

Further AMS radiocarbon dates will be obtained from targeted sedimentary units and archaeological contexts to enhance the provisional geochronological model and create an overarching spatial-temporal model for the site incorporating the geoarchaeological, zooarchaeological and archaeobotanical data.

6.8 Age-depth modelling

Bayesian statistical methods is employed, if necessary, to the ^{14}C measurements using the OxCal Calibration program, which allow the incorporation of other ages and stratigraphic information to identify statistical outliers and constrain the precision of individual radiocarbon ages for calibrating. So called, 'age-depth' models also enable the creation of a continuous chronology for a stratigraphic sequence, thus enabling age estimates for changes in the litho- and bio-stratigraphic record that were not possible to date directly. Age-depth models are constructed following the approach of Blockley *et al.* (2007), which uses a Bayesian approach in OxCal (Bronk Ramsey 1995, 2001, 2007). This method allows prior information to be incorporated into the calibration process, namely stratigraphical context and succession as age increases with depth (Blockley *et al.*, 2004).

6.9 Reporting

Following completion of the laboratory-based analysis, a detailed report will be produced. This report will build upon the report produced in 4.5 and 5.9 and is likely to include some or more of the following sections:

- Introduction
  (inclusive of site location, borehole, geophysical and pile location figures)
- Methods
- Results and interpretation of the geoarchaeological investigations and deposit modelling

(inclusive of borehole description tables and figures, topographic surface and thickness models and cross sections, organic matter content and radiocarbon tables)

- Results and interpretation of each individual microfossil and macofossil assessment (pollen, diatoms, waterlogged plant macrofossils etc)
  (inclusive of appropriate tables and figures)
- Discussion
  (inclusive of appropriate tables and figures)
- Conclusions and recommendations for publication
- References
- Appendix

6.10 Following the results of the analysis, a publication text will be prepared for submission to an appropriate high-ranking peer-reviewed academic journal (if appropriate)

7. ARCHIVE DEPOSITION

The local museum will be contacted in advance to ensure they have the capacity to receive the geoarchaeological / palaeoenvironmental archive. The archiving of the processed samples (ecofacts) and text will follow local museum guidelines. In summary:

- Order components according to size, material and series, ensuring that they are appropriately identified, linked and packaged
- Arrange for microfilming
- Document the records by completing a proforma checklist (where available)
- Ensure that digital files, images, file names and metadata are in specified formats
- Ensure any file relationships are documented
- Transfer all digital records to optical media then virus check, label and pack as specified and in a separate box
- Pack all materials into records boxes and tubes for protection during transportation; the boxes may contain records from more than one site; Mark identification of boxes in soft pencil
- Ensure that all the ecofacts (environmental samples) are accounted for, including large items
- All the tubes/phials of plant macrofossils are accounted for
- Tubes are appropriately marked and packed in bags
- Bags/tube holders of flots and residues and insects are placed in standard box in sample number order
- Microfossils mounted on slides are in a labelled slide carrier or box and the carrier placed in Stewart box in context order
- Timber samples bagged, labelled and boxed
- Dried radiometric samples are in bags in standard box in sample number order; frozen samples in a Stewart box
- Box contents list is provided (digital and hard copy)

- Arrange delivery to local museum.

8. POLICIES, GUIDELINES & RESEARCH FRAMEWORKS

This document has been prepared in accordance the guidelines set out by the Chartered Institute for Archaeologists (CIfA), Historic England and the Greater London Archaeological Advisory Service (GLAAS), as described below:

National Guidance:

1. DCLG 2014, Planning Practice Guidance, Conserving and enhancing the historic environment
2. DCMS 2013, Scheduled Monuments & nationally important but non-scheduled monuments
3. Department of Communities and Local Government National Planning Policy Framework 2012
4. Historic England, 2016, Preserving Archaeological Remains. Decision-taking for Sites under Development
5. Historic England, 2015, Piling and Archaeology. Guidelines and Best Practice
6. Historic England, 2015, Historic Environment Good Practice Advice in Planning. Note 1, The Historic Environment in Local Plans
7. Historic England, 2015, Historic Environment Good Practice Advice in Planning. Note 2, Managing Significance in Decision taking in the Historic Environment
8. Historic England, 2015, Historic Environment Good Practice Advice in Planning. Note 3. The Setting of Heritage Assets

Chartered Institute for Archaeologists Guidelines:

1. The Chartered Institute for Archaeologists Code of Conduct, published December 2014 http://www.archaeologists.net/sites/default/files/CodesofConduct.pdf
2. The Chartered Institute for Archaeologists Standard and guidance for archaeological excavation, published December 2014 http://www.archaeologists.net/sites/default/files/CIfAS&GExcavation_1.pdf

Historic England Guidelines:

1. MAP2 Management of Archaeological Projects (Second Edition) 1991
2. MoRPHE Management of Research Projects in the Historic Environment The MoRPHE Project Managers' Guide 2009
3. MoRPHE Management of Research Projects in the Historic Environment PPN 3: Archaeological Excavation January 2008
4. Environmental Archaeology: A Guide to the Theory and Practice of Methods, from Sampling and Recovery to Post-excavation (second edition). English Heritage, 2011.
5. Geoarchaeology: Using Earth Sciences to Understand the Archaeological Record. Revised and reprinted by English Heritage 2015.
6. Animal Bones and Archaeology: Guidelines for Best Practice. Historic England, 2014.
7. Research and Conservation Framework for the British Palaeolithic. Historic England, 2008.
8. Identifying and protecting Palaeolithic remains. Archaeological guidance for planning authorities and developers. English Heritage, May 1998.
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Research Frameworks

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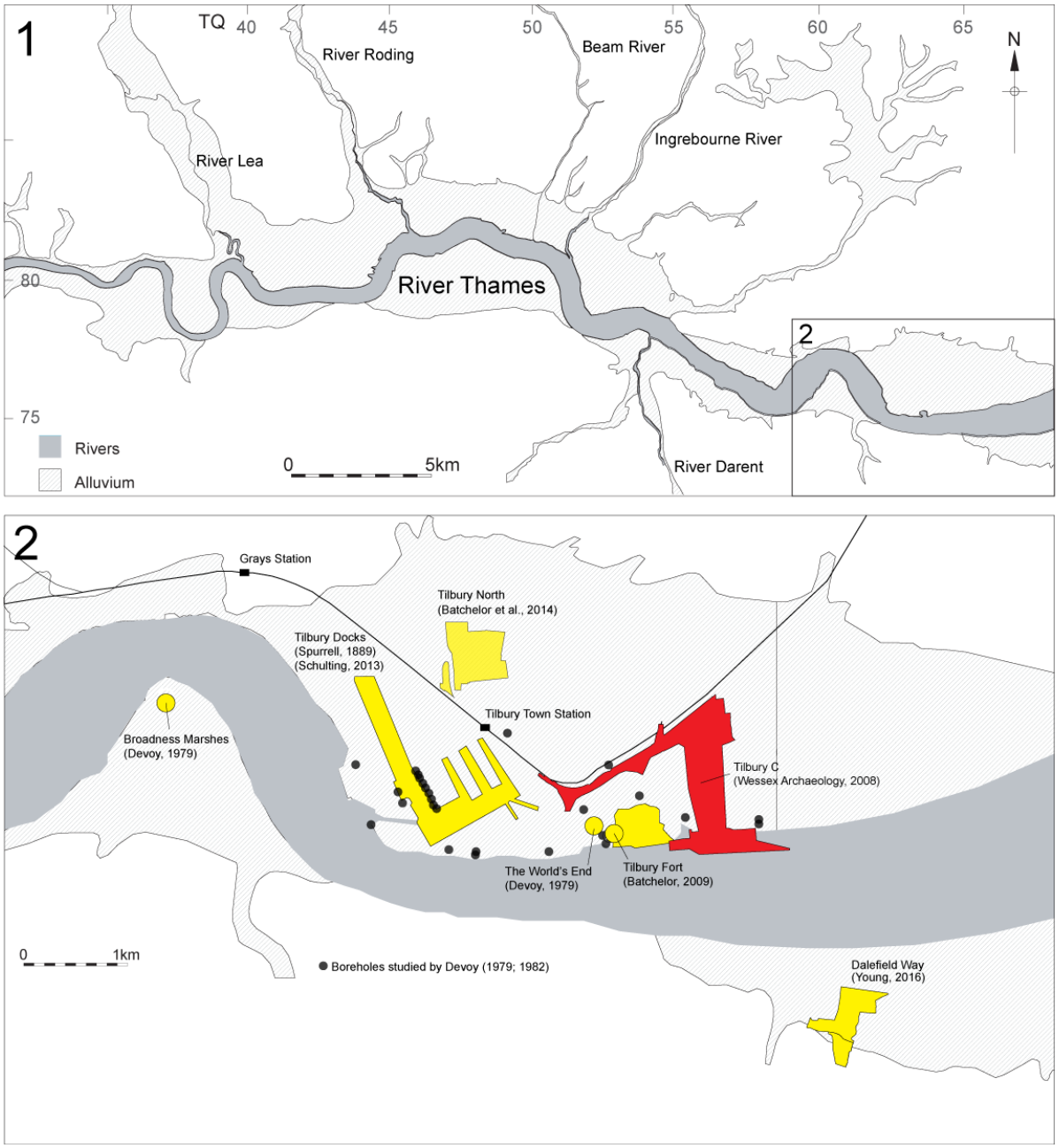

Figure 1: Location of the Tilbury 2 site, Tilbury, South Essex site and other sites of geoarchaeological and palaeoenvironmental interest, showing the extent of the floodplain alluvium.

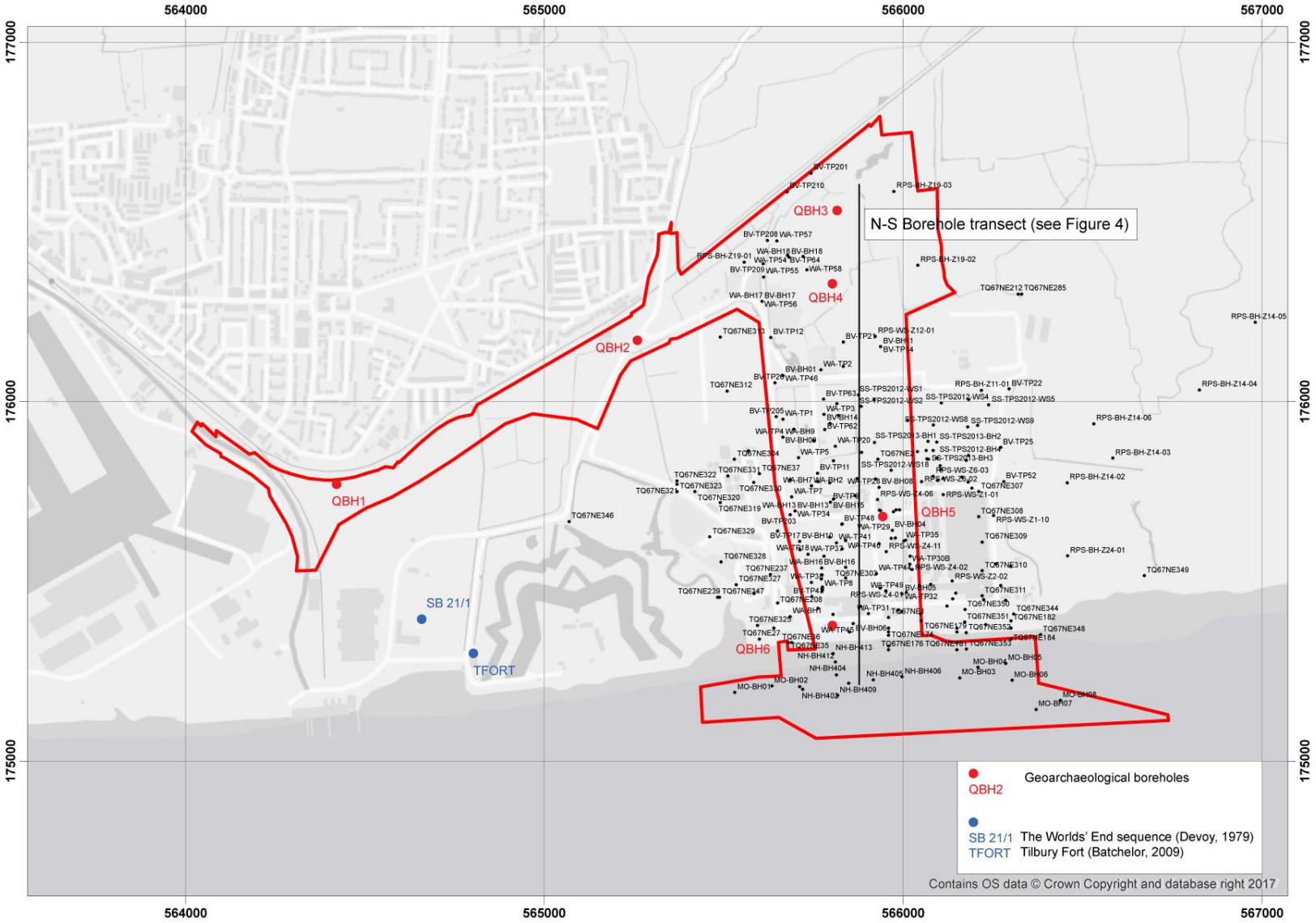

Figure 2: Location of the geotechnical borehole sequences used in the deposit model at Tilbury 2, Tilbury, South Essex.