The National Theatre, South Bank, London:

An Updated Archaeological and Geoarchaeological Investigation Report

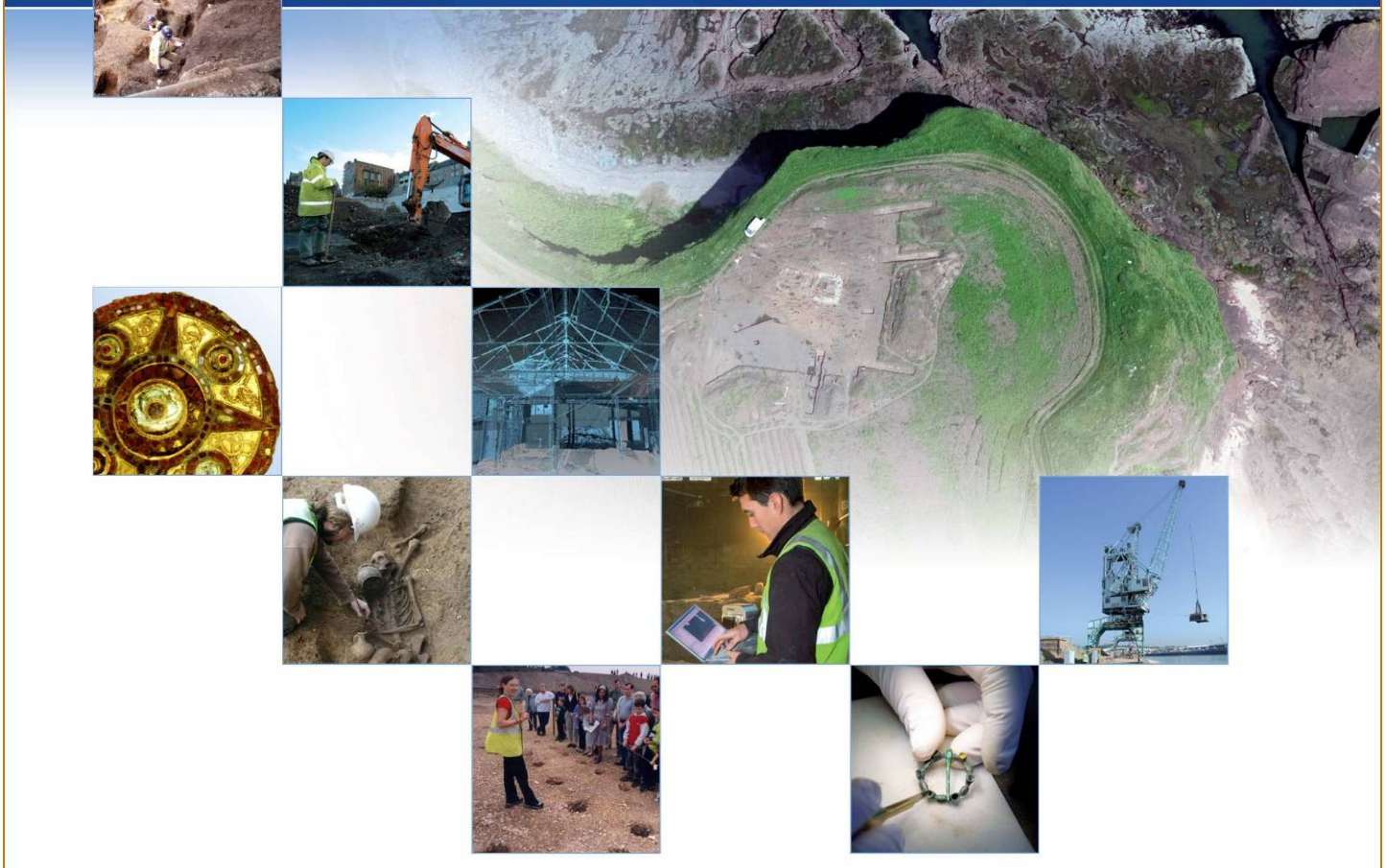
Planning Application Number: 10/02040/F

National Grid Reference Number: TQ 3101 8031

AOC Project No: 31046

Site Code: NTH11

Date: March 2014



AOC Archaeology Group

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The National Theatre, South Bank, London:

An Updated Archaeological and Geoarchaeological Investigation Report

On Behalf of:	**The National Theatre** South Bank London SE1 9PX
National Grid Reference (NGR):	**TQ 3101 8031**
AOC Project No:	**31046**
Prepared by:	**Paul Mason**
Illustration by:	**Lesley Davidson**
Date of Report: **Updated Report**	**September 2013** **March 2014**

This document has been prepared in accordance with AOC standard operating procedures.

Authors: Paul Mason **And Catherine Edwards**	**Date: September 2013**
Approved by: Tony Walsh	**Date: September 2013**
Final Report Stage:	**Date: March 2013**

Enquiries to: AOC Archaeology Group
Unit 7
St Margarets Business Centre
Moor Mead Road
Twickenham
TW1 1JS

Tel. 020 8843 7380
Fax. 020 8892 0549
e-mail. london@aocarchaeology.com

AOC Archaeology Group

www.aocarchaeology.com

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Non-Technical Summary

AOC Archaeology Group were commissioned by the National Theatre to undertake a watching brief during the development of a basemented extension to the rear of the theatre (National Grid Reference Number TQ3101 8031).

The work was carried out between October 2012 and March 2013, revealing a deep alluvial sequence overlying the river terrace gravels. A pollen monolith taken from this sequence indicated that the transition to dry land conditions in this part of the Thames floodplain began in the late Bronze Age/early Iron Age. Successive layers indicate that intermittent flood episodes probably occurred until the site was first occupied in the post-medieval period.

Further work, in the form of an additional radiocarbon determination, was carried out to provide an age for the cessation of the organic-rich horizon. The results indicate that the duration of organic-rich sedimentation was very short spanning a maximum of 290 years which correlates to the Late Bronze Age/Early Iron Age cultural periods.

The results of the watching brief and geoarchaeological investigation will be summarised for inclusion in the Local Archaeology Round-up and published via the Archaeological Data Service (ADS) website. On completion of the project, the archive, consisting of paper records and digital photographs, will be deposited with the Museum of London.

1. Introduction

1.1 This report presents the results of a programme of archaeological and geoarchaeological work associated with development at the National Theatre, South Bank, London, National Grid Reference Number TQ3101 8031 (Planning Application 10/3022/F; Figure 1).

1.2 The work comprised a watching brief whilst excavations were made for the foundations and basement of an extension to the rear of the existing theatre and services were diverted outside the footprint of the new build (Figure 2). The works exposed a sequence of made ground and alluvial deposits overlying river terrace gravels.

1.3 The fieldwork and subsequent analysis was undertaken accordance with a Written Scheme of Investigation (WSI) prepared by AOC Archaeology (AOC 2011) and approved by Greater London Archaeology Advisory Service (GLAAS). All tasks were undertaken by a team of suitably qualified archaeologists following local and national guidelines.

2. Planning Background

2.1 The local planning authority is the London Borough of Lambeth Council. Archaeological advice to the council is provided by Mark Stevenson of the Greater London Archaeological Advisory Service (GLAAS).

2.2 The site lies within the South Bank Conservation Area as defined by the London Borough of Lambeth. The National Theatre itself was built during the 1970's and is a Grade II* listed building.

2.3 Planning consent for the scheme (10/02040/F) was granted subject to the following condition:

'No development shall take place until the applicant has secured the implementation of a programme of archaeological work in accordance with a written scheme of investigation which has been submitted by the applicant and approved by the Local Planning Authority. The development shall only take place in accordance with the detailed scheme pursuant to this condition. The archaeological work shall be carried out by a suitably qualified investigating body acceptable to the Local Planning Authority'

Informative

The development of this site is likely to damage archaeological remains. The applicant should therefore submit detailed proposals in the form of an archaeological project design. The design should be in accordance with the appropriate English Heritage Guidelines.

2.4 The first stage of the process was the production of a Desk-Based-Assessment (AOC 2010). This document informed the scope of works for a programme of archaeological monitoring and recording which was detailed in a Written Scheme of Investigation prepared by AOC and approved by GLAAS (AOC 2011).

2.5 The fieldwork was conducted in accordance with the approved WSI and current best archaeological practice and local and national standards and guidelines:

- Department of Communities and Local Government – National Planning Policy Framework (DCLG 2012).
- English Heritage – Management of Research Projects in the Historic Environment (EH 2006).
- Institute for Archaeologists – Code of Conduct (IfA 2010).

2.6 Further work was requested by the archaeological advisor to determine the cessation date for the organic rich horizon. The report for which is added as an addendum to the geoarchaeological report, Appendix B.

3. Geology and Topography

3.1 The British Geological Survey Maps No 270 and 256 (BGS 1981 and 1984) indicate that the underlying geology of the site of the National Theatre comprises alluvium underlain by River Terrace Deposits over London Clay.

3.2 On-site geotechnical investigations were undertaken by Southern Testing Environmental and Geotechnical between the 9th November and the 16th November 2009 (Southern Testing 2010). The investigations included three light percussion boreholes; two 25m deep and one dug to 15m.

3.3 Extensive deposits of made ground were encountered in all three boreholes.

3.4 Alluvium was encountered across the site, underlying the made ground between 2.6m in the western part of the site and 3.8m in the east and extending to a maximum depth of 5.5m below the modern ground surface. Organic material was noted within the boreholes.

3.5 Prior to the commencement of the groundworks the site comprised a wide ramp giving access to the existing theatre basement from the north-east. To the south was a flat area of hard standing levelled at c.4mOD.

4. Archaeological and Historical Background

The following information is paraphrased from the Desk-Based Assessment (AOC 2010).

4.1 The Prehistoric Periods (Palaeolithic c. 500,000 – 10000 BC; Mesolithic c. 10000 to 4000 BC; Neolithic c. 4000-2200 BC; Bronze Age c. 2200-700 BC and Iron Age c. 700 BC - AD 43)

4.1.1 The area around the National Theatre is relatively rich in prehistoric archaeology; Mesolithic and Neolithic tools have been found in the Thames and also adjacent to the river. The site is likely to have stood on marshy ground during much of the prehistoric period.

4.1.2 Peat deposits and possible land surfaces dating to the Bronze Age and early Iron Age have been noted in the area of the site as well as the discovery of an Iron Age horned helmet near Waterloo Bridge.

4.2 The Roman Period (AD 43 – AD 410)

4.2.1 There is little previously recorded evidence for Roman activity within 500m of the site; the only entry of this date recorded on the greater London Sites and Monuments Record (GLSMR) database being the findspot of a Roman coin, from the site of the Royal Festival Hall.

4.2.2 The main concentrations of Roman settlement were focused on the modern day areas of The City, Southwark and Thorney Island (Westminster). The low-lying Lambeth area was likely marshy and unsuitable for any substantial form of development or activity. The route of a Roman road has been identified running from Southwark across Lambeth to a ferry crossing towards Thorney Island in the area of modern day Stangate Street, *c.* 600m to the south-west of the National Theatre site.

4.2.3 During the Roman period the site occupied an area characterised by a network of creeks, inlets and small streams, including the River Neckinger which joins the River Thames under the present Waterloo Bridge, to the west of the National Theatre.

4.3 The Early Medieval (AD 410 – AD 1066) and Medieval Periods (AD 1066 – AD 1538)

4.3.1 This area of the Thames most likely remained marshland into the early medieval period. It is thought the name Lambeth derives from *Lambhythe*, possibly meaning landing place for sheep, and it is here, along the route of the crossing to Thorny Island / Westminster on the opposite bank, that the early medieval activity was first focused.

4.3.2 The Southbank area east of modern day Waterloo Bridge Road, lay within the northern part of the Manor of Kennington, also of early medieval origin. This area was still likely low-lying marshland and unlikely to have been an area of significant settlement activity.

4.3.3 Earlier medieval archaeology recorded on the GLSMR in the vicinity of the site is limited to two findspots in the vicinity of Waterloo and Hungerford Bridges to the west of the site and timber features associated with Saxo-Norman pottery found during excavations at No. 1-6 Barge House (*c.*350m to the east of the site).

4.3.4 Later medieval evidence is more notable, though not indicative of significant activity. A number of medieval finds have been noted within the foreshore area between Waterloo Bridge and Blackfriars Bridge, with further evidence including a medieval road and water channel named 'Great Dyke' situated along the area of modern day Belvedere Road to the west of Waterloo Road. In addition, medieval ditches were found at Barge House Street *c*. 350m to the east of the site, and at 99 – 101 Waterloo Road *c.* 400m to the south. Evidence of peat deposits of medieval date was discovered at 10 -11a Theed Street, *c.* 260m to the south-east; indicating this area was still wetland at some point during this period.

4.3.5 Land reclamation over the area of Lambeth Marsh was first attempted in the 14th century, though the area is still thought to have periodically flooded into the post-medieval period. Some evidence of reclaimed land during the late medieval period was suggested by dump deposits encountered at Cornwall House to the south of the National Theatre site, although there is thought to have been little development until the 17th century.

4.4 The Post-Medieval (AD 1538 – AD 1900) and Modern Period (AD 1900 to present)

4.4.1 The northern part of the Manor of Kennington, east / north-east of Waterloo Bridge Road, was named Princes' Mead or Princes Meadow and comprised demesne land lying between the site of modern day Waterloo Road and Broadwall to the north-east / east. This area of marshland was formed by a riverside route way identified as 'The 'banke' on a 17th century map and later called Narrow Wall, the route of which runs through the area of the National Theatre site.

4.4.2 The main focus of post-medieval settlement on Princes Meadow appears to have been first concentrated east of the site, toward the western end of Narrow Wall, and early post-medieval evidence is noted in this area; however as land reclamation continued, development expanded west wards along Narrow Wall and into the area of the National Theatre site in the 18th century.

4.4.3 The GLSMR identifies the sites of The Feathers Inn adjacent or partly within the curtilage of the National Theatre site, which is identified as medieval / post-medieval date. This area later became part of Cuppers Garden pleasure garden in 1738.

4.4.4 More substantial development occurred through the late 18th and early 19th century, with a survey of 1785 recording 70 dwellings on Prince's Mead, including light industrial riverside activities warehouses, storehouses, wharves, yards. This type of activity defined the area of the National Theatre site until the mid 20th century

5. Aims of the Investigation

5.1 The aims of the project were defined as being:

- To establish the presence/absence of archaeological remains within the site.
- To determine the extent, condition, nature, character, quality and date of any archaeological remains encountered.
- To record and sample excavate any archaeological remains encountered.
- To assess the ecofactual and environmental potential of any archaeological features and deposits.
- To determine the extent of previous truncations of the archaeological deposits.
- To enable GLAAS to make an informed decision on the status of the condition, and any possible requirement for further work in order to satisfy that condition.

5.2 The specific aims of the project were defined as being:

- To determine the presence or absence of evidence of prehistoric date.
- To inform on the geomorphology of the area during the Bronze Age and Iron Age.

5.3 The final aim was to make public the results of the investigation, subject to any confidentiality restrictions.

6. Scope of Works and Strategy

6.1 The works comprised the archaeological monitoring of the removal of the basement ramp and machine excavation for the foundations and basement of the theatre extension with limited ground reduction and service diversion in an area of open space to the south of the new build's footprint.

6.2 The watching brief principally focused on the area of the site formerly occupied by the basement access ramp and a heavy concrete retaining wall to the south, both of which were aligned north-east (ground level) to south-west (basement level) against the rear of the theatre. Thus, the original ground level in this area had been previously truncated to a depth of up to c. 4m in line with the fall of the ramp. The footprint of the new basement extension roughly corresponded with that of the ramp and retaining wall (Figure 2; Plate 1). Sheet piling was used to retain the ground to the south of the new build whilst the modern ramp foundations and pockets of earlier made ground were removed by mechanical excavator to the basement formation level. Access issues (compounded by rapidly rising ground water) precluded close monitoring of this stage of work, but most of the excavated material was noted to be modern backfill associated with the construction of the ramp and retaining wall.

6.3 The formation level of the basement corresponded loosely with the mid-sequence level of alluvium (where preserved behind the ramp retaining wall along the southern periphery of the reduced level dig). Once safe access was created to this level, a number of localised interventions (for a lift pit, sump and deeper ring beams) were made through the lower levels of alluvium and into the underlying river terrace gravels (Figure 2). These works were also archaeologically monitored.

6.4 In addition, once made safe, a single column sample was taken from the alluvial/made ground sequence, which had been exposed in section behind the ramp retaining wall, at the southern edge of the basement excavation (Figure 3).

Plate 1: The formation level for the new basement, looking east, showing the scar of the access ramp on the existing rear wall of the theatre

6.5 The recording and reporting conform with current best archaeological practice and local and national standards and guidelines:

- English Heritage – Archaeological Guidance Paper 3: Standards and Practices in Archaeological Fieldwork (EH 1998).
- English Heritage – Environmental Archaeology: A Guide to the Theory and Practice of Methods, from Sampling and Recovery to Post-excavation (second edition) (EH 2011)
- Institute for Archaeologists – Standard and guidance for an archaeological watching brief (IfA 2008)
- Museum of London – Archaeological Site Manual (Third Edition) (MoL 1994).

6.6 A unique site code (NTH11) has been created in consultation with LAARC as the site identifier, and was used on all records.

6.7 The fieldwork was undertaken by Catherine Edwards, Chris Clarke and Paul Mason and was monitored by Mark Stevenson on behalf of the local planning authority. The project was managed by Paul Mason for AOC Archaeology.

7. Results

7.1 The earliest of the observed deposits was river terrace gravel (13) comprising gravel suspended in a fine, greenish brown sand, exposed by only the very deepest of the intrusive groundworks (Plate 2). The surface of the gravel lay some 6.6m below the existing ground level at c. -2.6mOD.

Plate 2: River terrace gravel (13) observed in the base of a sump pit

7.2 The gravel was overlain by an alluvial sequence comprising a number of different deposits (Figure 2; Section 1; Plate 3). No finds were recovered from this sequence but a monolith sample <1> was taken; a summary of the assessment of the sample is presented below and the full report can be found in Appendix B.

7.3 The lowest deposit in the sequence was a firm dark blue-grey clay (12) with occasional inclusions of plant fibres and fragmented twigs, lying to a depth in excess of 1m. This was overlain by a 0.35m thick layer of dark brown clay (11) which also contained organic material including alder catkins, which were extracted from near to the base of the deposit and radiocarbon dated to 2780-2710 cal BP (830-760 cal BC). A second sample was extracted from the upper levels of (11), in the form of a twig wood. The results of radiocarbon dating indicated a date of 2750-2490 cal BP (800-540 cal BC). This indicates a period of accumulation spanning a maximum of 290 years and correlates to the Late Bronze Age/Early Iron Age cultural periods.

7.4 Overlying this was a firm blue-brown clay (10), 0.22m thick, in turn sealed by a 0.50m thick layer of blue-grey gleyed clay, the uppermost deposit of the alluvial sequence, whose surface lay at c. 0.50mOD.

7.5 Where preserved to its full depth (to the south of the ramp retaining wall), the alluvial sequence was overlain by a 0.13m thick layer of heavy dark grey clay loam (8) containing occasional flecks of charcoal and mortar. This undated layer, perhaps a buried topsoil, was the earliest deposit to contain evidence for nearby occupation. It was overlain by a similar depth of firm dark grey clay (7), alluvial in character and perhaps the result of a prolonged flooding episode.

7.6 This layer was overlain by a thin band of dark grey brown clay loam (6) flecked with CBM and mortar but without dating evidence. This was sealed by a 0.18m thick layer of sterile grey clay (3), perhaps alluvial and either lain *in situ* or deliberately re-deposited.

7.7 A feature with near vertical sides and a flat base [4] was cut from the top of layer (3). Only part of it was visible in section; it was filled with greyish brown clay loam (5) containing flecks of CBM and mortar but no dating evidence.

7.8 A 0.30m thick deposit of similar greyish brown clay loam (2) sealed the underlying sequence. It contained frequent fragments and flecks of CBM and mortar; dating evidence was again absent. Its surface lay at c. 1.25mOD.

Plate 3: Alluvial sequence and monolith sample <1>

7.9 From this level to ground surface (c. 4mOD) lay a deep deposit of modern made ground (1) comprising a large amount of 20th century building debris. Ground reduction to the south of the new basement exposed the upper level of this made ground. Short sections of brick wall foundation, heavily truncated by a morass of services, were noted (Plate 4).

Plate 4: Ground reduction through modern made ground to the south of the basement, looking south-east

8. Finds and environmental samples

8.1 No finds were collected during the course of the archaeological investigation.

8.2 The results of the assessment of the monolith sample <1> indicate that alluvial sequence consisted mainly of silty clay sediments, indicative of a fluvial/estuarine environment. Although no peat was recorded in the sequence, the silty clay became more organic between -0.59 and -0.24m OD (context 11), representing a transition towards semi-terrestrial conditions and the growth of wetland vegetation during the Late Bronze Age/Early Iron Age (2750-2490 cal BP to 2780-2710 cal BP).

8.3 The combined results of the palaeobotanical assessments (pollen, wood and seeds) correlate well with the lithostratigraphic record, indicating that the sequence can be divided into two sections. During the accumulation of contexts (12) and (11) the assemblage is indicative of a floodplain environment dominated by alder and willow fen carr woodland with a ground flora including grasses, sedges and aquatic plants. No palynological indicators of human activity were recorded, and the concentration of microcharcoal was minimal. The dryland appears to have been composed of mixed deciduous woodland dominated by oak with lime and hazel. Considering the late prehistoric date of the sequence, the apparent dominance of woodland in the local environment is considered slightly surprising; a more open environment consequent of woodland clearance might be anticipated.

8.4 During the accumulation of contexts (3) to (10), the recorded assemblage is indicative of large changes in the vegetation community on both the wetland and dryland. On the wetland, a decline of alder-dominated fen carr woodland in response to wetter conditions is indicated by the increase of grasses, sedges and buttercups. On the dryland, the decline of mixed deciduous woodland is indicated, whilst the herbaceous assemblage of cereals and weed taxa is suggestive of clearance for agricultural and possibly settlement purposes.

9. Conclusion

9.1 The watching brief has shown that much of the current development area at the rear of the National Theatre has been subject to previous truncation, largely caused by the construction of a ramp that provided access to the existing theatre basement.

9.2 Despite this truncation, a sequence of deposits from river terrace gravel to modern ground surface was exposed, recorded and sampled for environmental evidence.

9.3 A sequence of alluvium, lying approximately 3m thick over the gravels, was found to comprise a number of separate layers, some with high organic content. Organic material from the lowest of the accessible alluvial deposits (11) was radiocarbon dated to 2770-2620 cal BP (820-670 cal BC), whilst a sample from the upper deposits indicated a date of 2750-2490 cal BP (800-540 cal BC) which corresponds to the late Bronze Age/early Iron Age. This layer represents a transition towards semi-terrestrial conditions and the growth of wetland vegetation within the floodplain of the Thames.

9.4 Cereal pollen first occurs in the uppermost layer of the alluvial sequence (10), corresponding with a decline in pollen from deciduous woodland species.

9.5 Overlying layers appear to indicate the establishment of dryer land conditions, interspersed with episodes of intermittent flooding.

9.6 Although no artefactual dating evidence was recovered from the layers sealing the alluvium, nearby occupation was indicated throughout the stratigraphic sequence by the presence of highly fragmented CBM and mortar.

9.7 The first clear evidence for occupation on the site were the highly truncated footings of 19th/20th century structures exposed by limited ground reduction to the south of the new basement footprint.

10. Publication and Archive Deposition

10.1 Copies of this report will be issued to the client, Lambeth Borough Council, Mark Stevenson (GLAAS), the appropriate Historic Environment Record and the local studies library on the understanding that it will become a public document after an appropriate period of time.

10.2 If deemed appropriate, a synthesised report detailing the findings of the environmental analysis will be submitted to a relevant academic journal for publication.

10.3 The site archive will comprise all environmental samples and written and drawn records. It is to be consolidated after completion of the whole project, with records and finds collated and ordered as a permanent record. The archive will be prepared in accordance with Guidelines for the preparation of excavation archives for long-term storage (UKIC 1990)

10.4 On completion of the project AOC will liaise with the developer/landowner and discuss arrangements for the archive to be deposited with LAARC. Following completion of the fieldwork (as appropriate) the site archive will be security copied and a copy deposited with the National Archaeological Record (NAR).

10.5 An OASIS form has been completed (Appendix C) and an electronic copy of this report will be deposited with the Archaeological Data Service (ADS).

11. Bibliography

AOC Archaeology Group (2010). *The National Theatre, London Borough of Lambeth: Archaeological Desk Based Assessment.*

AOC Archaeology Group (2011). *The National Theatre, South Bank, London Borough of Lambeth: A Written Scheme of Investigation for a Programme of Archaeological Observation and Recording*

British Geological Survey (1981). *Sheet 270: South London.*

British Geological Survey (1984). *Sheet 256: North London.*

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

English Heritage (1998). *Archaeological Guidance Paper 3: Standards and Practices in Archaeological Fieldwork. (English Heritage London Region).*

English Heritage (2006). *Management of Research Projects in the Historic Environment (MoRPHE).*

English Heritage (2011). *Environmental Archaeology: A guide to the theory and practice of methods, from sampling and recovery to post-excavation.*

Institute for Archaeologists (2008). *Standard and Guidance for an Archaeological Watching Brief*.

Institute for Archaeologists (2012). *Code of Conduct.*

Museum of London Archaeology Service (MoLAS) (1994). *Archaeological Site Manual (3rd ed).*

Southern Testing (2010). *Site Investigation Report at The National Theatre, London* (Unpublished Report).

United Kingdom Institute for Conservation (1990). *Guidance for Archaeological Conservation Practice.*

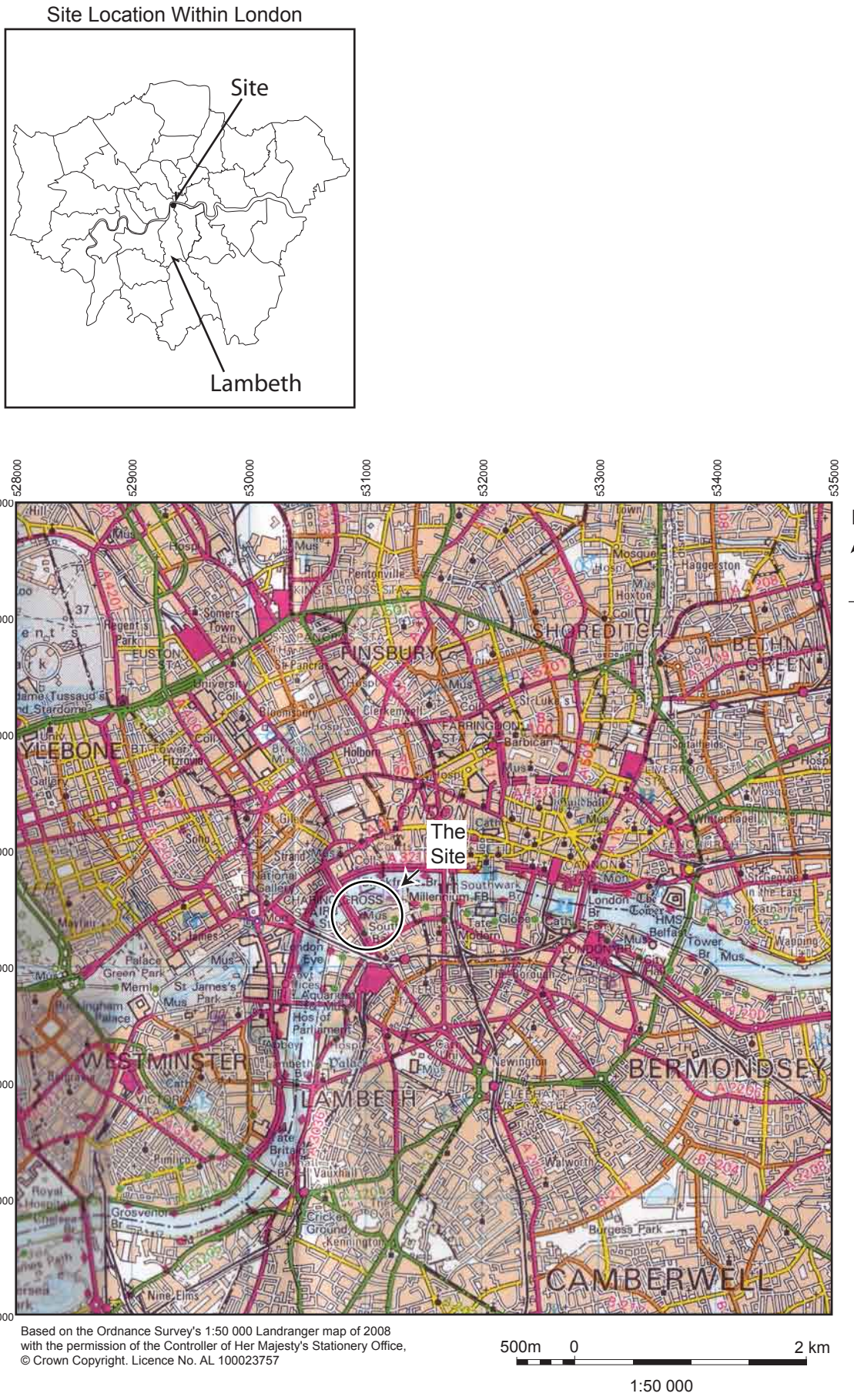


Figure 1: Site Location

Figure 2: Plan of Observed Areas and Section through Alluvial Sequence

Appendices

Appendix A – Context Register

Context	Context Description	Depth
1	Modern rubble	2m +
2	Clay loam layer	0.30m
3	Clay layer	0.18m
4	Pit?	0.24m
5	Clay loam fill of pit [4]	0.24m
6	Clay loam layer	0.05m
7	Clay layer	0.14m
8	Clay loam layer	0.13m
9	Alluvial clay	0.50m
10	Alluvial clay	0.22m
11	Alluvial clay	0.36m
12	Alluvial clay	0.95m +
13	River terrace gravels	NFE

Appendix B – Geoarchaeological report

THE NATIONAL THEATRE, SOUTH BANK, LONDON BOROUGH OF LAMBETH (SITE CODE: NTH11): ENVIRONMENTAL ARCHAEOLOGICAL ASSESSMENT REPORT AND ADDENDUM

C.R. Batchelor & D.S. Young

Quaternary Scientific (QUEST)

INTRODUCTION

This report summarises the findings arising out of the environmental archaeological assessment undertaken by Quaternary Scientific (QUEST) in connection with the proposed development at The National Theatre, South Bank, London Borough of Lambeth (Site Code: NTH11; National Grid Reference: TQ 3101 8031; Figures 1 & 2). The site is on the floodplain of the River Thames, *ca*. 150m from the waterfront on the south bank of the river on the eastern side of Waterloo Bridge. The ground surface at the site is between 4 and 5m OD, but these levels only reflect the presence of Made Ground. The natural level of the floodplain surface can be inferred from a general knowledge of the historic floodplain topography and from borehole records (e.g. Gibbard 1985 Fig. 43) and was probably between 1.0 and 2.0m OD.

The British Geological Survey (1:50,000 Sheet 270 South London 1998) shows the site underlain by Alluvium resting on bedrock London Clay. In reality the floodplain alluvium is immediately underlain by sand and gravel which can be assigned to the Shepperton Gravel of Gibbard (1985) of Late Devensian Late Glacial age. A borehole transect illustrated by Gibbard (1985 Fig. 43) from Whitehall across the Thames into Lambeth suggests that in Lambeth, from the modern waterfront for a distance of about 200m away from the river, the surface of the Shepperton Gravel is *ca*. 3m below OD. The gravel surface is then shown rising away from the river to levels close to or slightly above OD. This sub-surface arrangement is borne out by geotechnical and BGS borehole records from the National Theatre site where gravel is present at -2.80m OD in borehole TQ38SE770 and rises south/south-eastwards to between -0.43 and -1.43m OD in boreholes BH1, BH2, BH3 and TQ38SW632/G (Figure 2; Hogg, 2011).

These previous borehole investigations also reveal that the Alluvium overlying the Shepperton Gravel consists of fine-grained inorganic sediments and peat deposits of geoarchaeological interest. As a consequence of this, a sequence of column samples was

collected from the south-eastern corner of the site during the course of recent archaeological excavations carried out by AOC Archaeology.

The overarching aim of the environmental archaeological assessment was: (1) to evaluate the potential of this sedimentary sequence for reconstructing the environmental history of the site and its environs, and (2) to detect evidence for human activity. In order to achieve these aims, the assessment consisted of:

1. Recording the lithostratigraphy to provide a preliminary reconstruction of the sedimentary history
2. Radiocarbon dating of plant macrofossils to provide a provisional geochronological framework for the natural stratigraphic sequence
3. Assessment of the preservation and concentration of pollen grains and spores to provide a preliminary reconstruction of the vegetation history, and to detect evidence for human activities e.g. woodland clearance and cultivation
4. Assessment of the preservation and concentration of diatom frustules to provide a preliminary reconstruction of the hydrological history e.g. water quality and depth
5. Assessment of the preservation and concentration of macroscopic plant, insect and Mollusca remains from a single bulk sample to provide a preliminary reconstruction of the vegetation history and general environmental context of the site.

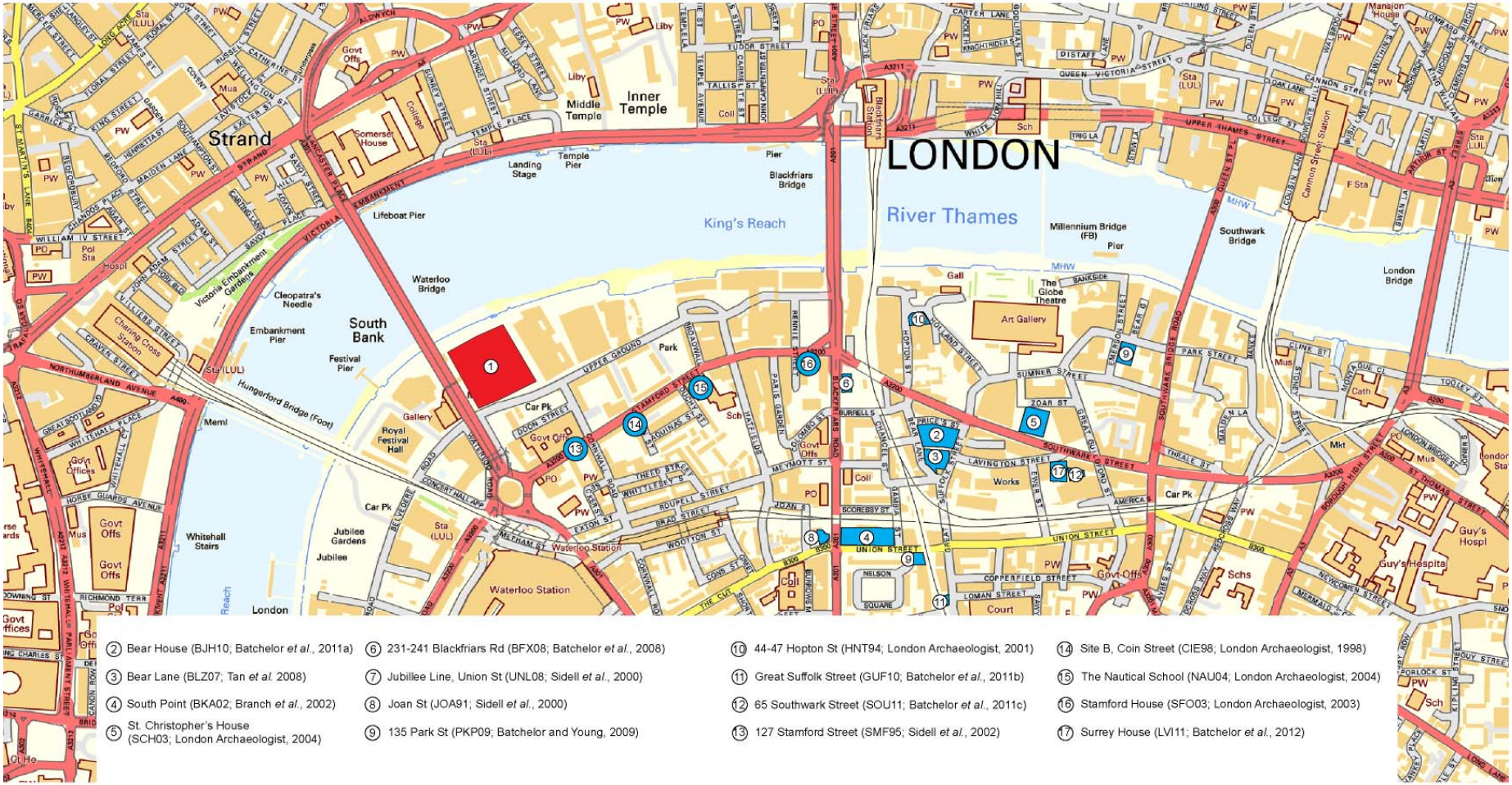


Figure 1: Location of the National Theatre, South Bank, London Borough of Lambeth and other nearby sites

Figure 2: Detailed Site Location Plan (modified from Hogg, 2011)

METHODS

Lithostratigraphic descriptions

The lithostratigraphy of column samples <1> to <4> were described in the laboratory using standard procedures for recording unconsolidated sediment and organic sediments, noting the physical properties (colour), composition (gravel, sand, clay, silt and organic matter) and inclusions (e.g. artefacts) (Tröels-Smith, 1955). The procedure involved: (1) cleaning the samples with a spatula or scalpel blade and distilled water to remove surface contaminants; (2) recording the physical properties, most notably colour using a Munsell Soil Colour Chart; (3) recording the composition; gravel, fine sand, silt, clay and organic material; (4) recording the degree of peat humification and (5) recording the unit boundaries e.g. sharp or diffuse. The results of the lithostratigraphic descriptions are displayed in Table 1 and Figure 3.

Organic matter content determinations

A total of 24 sub-samples were taken for determination of the organic matter content through column samples <1> to <4> (Table 2; Figure 3). These records were important as they can identify increases in organic matter possibly associated with more terrestrial conditions. The organic matter content was determined by standard procedures involving: (1) drying the sub-sample at 110^{o}C for 12 hours to remove excess moisture; (2) placing the sub-sample in a muffle furnace at 550°C for 2 hours to remove organic matter (thermal oxidation), and (3) re-weighing the sub-sample obtain the 'loss-on-ignition' value (see Bengtsson and Enell, 1986).

Radiocarbon dating

One sub-sample was extracted for radiocarbon dating from near the base of the organic-rich horizon in column sample <3> (Context (11); -0.53 to -0.58m OD). The sample was submitted for AMS radiocarbon dating to the SUERC Radiocarbon Dating Facility, East Kilbride. The results have been calibrated using OxCal v4.10 Bronk Ramsey (1995; 2001; 2007) and the IntCal04 atmospheric curve (Reimer et al., 2004). The results of the radiocarbon dating are displayed in Table 3 and in Figure 3.

Pollen assessment

A total of eight sub-samples were extracted for an assessment of pollen content from column samples <1> to <4>. The pollen was extracted as follows: (1) sampling a standard volume of sediment (1ml); (2) adding two tablets of the exotic clubmoss *Lycopodium clavatum* to provide a measure of pollen concentration in each sample; (3) deflocculation of the sample in 1% Sodium pyrophosphate; (4) sieving of the sample to remove coarse mineral and organic fractions (>125µ); (5) acetolysis; (6) removal of finer minerogenic fraction using Sodium polytungstate (specific gravity of 2.0g/cm^{3}); (7) mounting of the sample in glycerol jelly. Each

stage of the procedure was preceded and followed by thorough sample cleaning in filtered distilled water. Quality control is maintained by periodic checking of residues, and assembling sample batches from various depths to test for systematic laboratory effects. Pollen grains and spores were identified using the University of Reading pollen type collection and the following sources of keys and photographs: Moore *et al.,* (1991); Reille (1992). The assessment procedure consisted of scanning the prepared slides, and recording the concentration and preservation of pollen grains and spores, and the principal taxa on four transects (10% of the slide) (Table 4). A semi-quantitative estimate of the microscopic charcoal with at least one axis exceeting 40µm in length was also made.

Diatom assessment

Six sub-samples from the column samples were extracted for the assessment of diatoms. The diatom extraction involved the following procedures (Battarbee *et al.,* 2001):

(1) Treatment of the sub-sample (0.2g) with Hydrogen peroxide (30%) to remove organic material and Hydrochloric acid (50%) to remove remaining carbonates
(2) Centrifuging the sub-sample at 1200 for 5 minutes and washing with distilled water (4 washes)
(3) Removal of clay from the sub-samples in the last wash by adding a few drops of Ammonia (1%)
(4) Two slides prepared, each of a different concentration of the cleaned solution, were fixed in mounting medium of suitable refractive index for diatoms (Naphrax)

Duplicate slides each having two coverslips were made from each sample and fixed in Naphrax for diatom microscopy. The coverslip with the most suitable concentration of the sample preparation was selected for diatom evaluation. A large area of this coverslip was scanned for diatoms at magnifications of x400 and x1000 under phase contrast illumination using a Leica microscope. The concentration and preservation of remains was recorded; the results are displayed in Table 5.

Macrofossil assessment

Seven small bulk samples from the column samples were processed for the recovery of macrofossil remains including waterlogged plant macrofossils, waterlogged wood, Mollusca, Ostracoda, Foraminifera, insects and small faunal remains. These samples were focussed on the organic-rich part of the sequence. The extraction process involved the following procedures: (1) measuring the sample volume by water displacement and (2) processing the sample by wet sieving using 300µm and 1mm mesh sizes. Each sample was scanned under a stereozoom microscope at x7-45 magnifications, and sorted into the different macrofossil

classes. The concentration and preservation of remains was estimated for each class of macrofossil (Table 6).

Identifications of the waterlogged seeds have been made using modern comparative material and reference atlases (e.g. Cappers *et al.,* 2006, NIAB, 2004; Martin & Barkley, 2000). Nomenclature used follows Stace (2005). The quantities of waterlogged seeds and wood were recorded for each sample, with identifications of the main taxa (Table 7).

RESULTS AND INTERPRETATION OF THE LITHOSTRATIGRAPHIC DESCRIPTIONS AND ORGANIC MATTER CONTENT

The results of the lithostratigraphic descriptions and organic matter determinations from column samples <1> to <4> are displayed in Table 1 and in Figure 3.

Sand and Gravel sediments consistent with the Shepperton Gravel were not recorded in the column sample sequence. However, whilst water ingress prevented the collection of column samples below -1.03m OD, Sand and Gravel was recorded at -1.35m OD at the base of the section, consistent with the Shepperton Gravel recorded below -1.24m OD in geotechnical borehole BH2, less than 10m to the north (see Figure 2).

The lowermost unit consisted of silty clay with traces of detrital plant remains and organic matter, recorded between -1.03 and -0.59m OD (context (12); 13% organic content). These sediments are consistent with deposition in a low energy fluvial/estuarine environment during the Early to Middle Holocene. Overlying this between -0.59 and -0.24m OD (context (11)), the organic content of the silty clay increases to approximately 20%; large wood macrofossils were also recorded in this unit. These sediments are suggestive of a transition towards semi-terrestrial conditions, and the growth of woodland. From -0.24 to 0.56m OD (contexts (10) to (9)), the organic matter content of the silty clay declines to <10% (on average); this is indicative of inundation of the semi-terrestrial environment and a return to deposition in a fluvial/estuarine environment.

From 0.56 to 0.82m OD (contexts (8) to (3)), the presence of burnt flint and brick fragments may suggest the dominantly silty clay alluvium has been reworked. This interpretation is enhanced by the recognition of charcoal and possible mortar fragments in the field in context (8). Furthermore, context (3) was described in the field as a redeposited horizon.

Table 1: Lithostratigraphic description of column samples <1> to <4>, The National Theatre, South Bank, London Borough of Lambeth

Depth (m OD)	Context number	Column sample	Composition
0.82 to 0.63	(3)/(6)	<1>	10YR 5/1; Ag2 As2 Dl+ Dh+ Sh+; grey silt and clay with traces of detrital wood, herbaceous material and organic matter. Some calcareous nodules. Sharp contact in to:
0.63 to 0.56	(7)/(8)	<1>	10YR 2/1; Ag2 As1 Sh1 Gg+; black clayey organic silt with occasional gravel clasts. Burnt flint and brick inclusions. Sharp contact in to:
0.56 to 0.32	(9)	<1>	Gley1 5/1; Ag2 As2; grey silt and clay with some calcareous nodules.
0.32 to -0.13	(9)/(10)	<2>	Gley1 5/1; As3 Ag1; grey silty clay with some calcareous nodules.
-0.13 to -0.24	(10)	<3>	10YR 5/1; Ag2 As2 Dh+; grey silt and clay with traces of detrital herbaceous material. Diffuse contact in to:
-0.24 to -0.59	(11)	<3>	10YR 4/1; Ag2 As1 Sh1 Dl+ Dh+; dark grey organic clayey silt with traces of detrital herbaceous material and wood. Large wood macrofossil at 1.63 to 1.56m OD.
-0.59 to -1.03	(12)	<4>	10YR 4/1; Ag2 As2 Sh+ Dh+ Dl+; dark grey silt and clay with traces of organic matter, detrital herbaceous material and detrital wood.

Table 2: Results of the organic matter determinations of column samples <1> to <4>, The National Theatre, South Bank, London Borough of Lambeth

Depth (m OD)		Context number	Organic matter content (%)
From	To		
0.81	0.82	(3)	9.44
0.74	0.75	(3)	11.38
0.66	0.67	(6)	10.15
0.58	0.59	(7)	21.01
0.5	0.51	(8)	13.07
0.42	0.43	(9)	11.54
0.34	0.35	(9)	6.61
0.26	0.27	(9)	9.07
0.18	0.19	(9)	7.83
0.1	0.11	(9)	6.90
0.02	0.03	(10)	6.90
-0.07	-0.06	(10)	6.52
-0.13	-0.14	(10)	13.99
-0.21	-0.22	(10)	17.68
-0.29	-0.3	(11)	21.62
-0.37	-0.38	(11)	19.56
-0.45	-0.46	(11)	22.73
-0.53	-0.54	(11)	17.64
-0.61	-0.62	(12)	13.66
-0.69	-0.7	(12)	14.19
-0.77	-0.78	(12)	25.08
-0.85	-0.86	(12)	11.31
-0.93	-0.94	(12)	12.35

RESULTS AND INTERPRETATION OF THE RADIOCARBON DATING

The results of the radiocarbon dating of the organic alluvium are displayed in Table 3 and Figure 3. *Alnus glutinosa* (alder) catkins were extracted from a small bulk sample towards the base of the organic rich sediment (context (11); -0.53 to -0.58m OD) and were radiocarbon dated to 2770-2620 cal BP (820-670 cal BC). The δ13C (‰) values are consistent with that expected for organic sediment, and there is no evidence for mineral or biogenic carbonate contamination. The date indicates that the formation of the organic alluvium began during the Late Bronze Age/Early Iron Age cultural periods.

Table 3: Results of the radiocarbon dating of the base of the organic-rich horizon in column sample <3>, The National Theatre, South Bank, London Borough of Lambeth

Laboratory code / Method	**Material and location**	**Sample (m OD)**	**Uncalibrated radiocarbon years before present (yr BP)**	**Calibrated age BC/AD (BP) (2-sigma, 95.4% probability)**	**δ13C (‰)**
SUERC-47032 (GU30583)	*Alnus glutinosa* (alder) catkins at base of organic-rich horizon (context (11))	-0.53 to -0.58	2596 ± 29	820-670 cal BC (2770-2620 cal BP)	-29.2

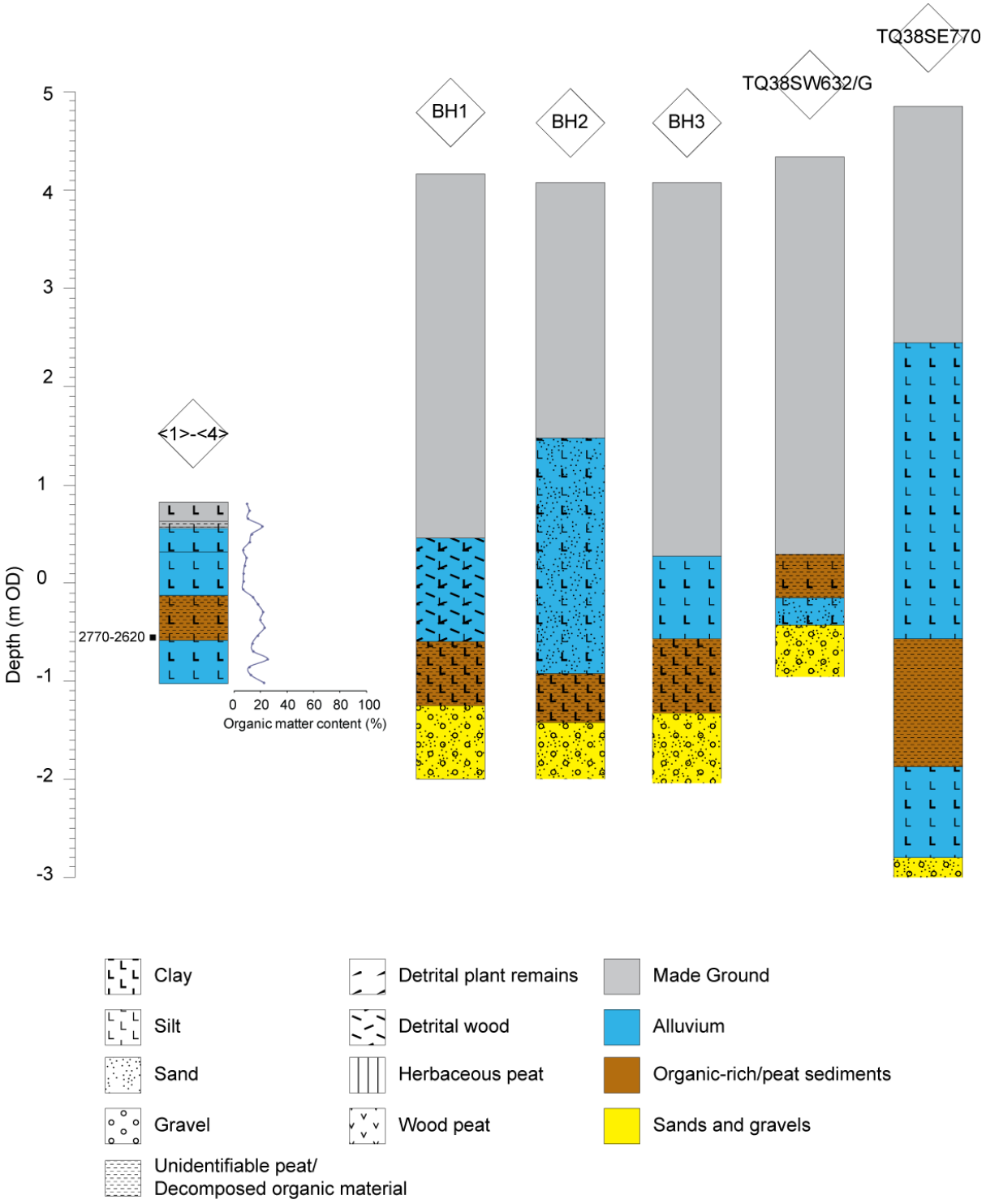


Figure 3: Lithostratigraphic description of column samples <1> to <4>, incorporating organic matter determinations, and the radiocarbon date (cal BP).

RESULTS AND INTERPRETATION OF THE POLLEN ASSESSMENT

Eight sub-samples were extracted from the lithostratigraphic sequence for assessment of the pollen and spore content (Table 4). The results of the assessment indicate that the samples can be divided into two groups.

The three samples from lowermost contexts (11) and (12) all contain a very high concentration of remains in a good to excellent state of preservation. Each sample is dominated by tree and shrub taxa including *Alnus* (alder), *Quercus* (oak), *Tilia* (lime) and *Corylus* type (e.g. hazel), with individual occurrences of *Salix* (willow) and possibly *Sambucas nigra* (elder). The concentration and diversity of herb, aquatic and spore taxa was relatively limited, including Poaceae (grasses), Cyperaceae (sedges), Asteraceae (daisies), *Plantago* (plantain), *Sparganium* type (bur-reed), *Filicales* (buckler ferns) and *Polypodium vulgare* (polypody ferns). This assemblage is indicative of a floodplain environment dominated by alder and willow fen carr woodland with a ground flora including grasses, sedges and aquatic plants. The presence of *Chenopodium* type may represent the growth of saltmarsh plants such as *Suaeda maritima* (annual seablite), in which case the wetland may be subject to a brackish water influence. However, *Chenopodium* type can also include non-saline plants such as *Chenopodium album* which are indicative of disturbed ground. The dryland appears to have been composed of mixed deciduous woodland dominated by oak with lime and hazel. No palynological indicators of human activity were recorded in the three samples, and the concentration of microcharcoal was minimal.

The five samples from contexts (3) to (10) are dominated by herbaceous and spore taxa including Poaceae, Cyperaceae, *Chenopodium* type, Lactuceae (dandelion family) and *Sinapis* type (e.g. charlock), with more sporadic occurrences of *Cereale* type (cereals), *Centaurea nigra* (black knapweed), *Cirsium* type (thistles), *Ranunculus* type (buttercup) and *Pteridium aquilinum* (bracken). Aquatic taxa include individual occurrences of *Sparganium* type and *Typha latifolia* (bulrush). Tree and shrub taxa are also present but in reduced concentrations, including *Alnus*, *Quercus*, *Pinus*, *Tilia* and *Corylus* type. Microcharcoal concentrations are abundant. This assemblage is indicative of large changes in vegetation community on both the wetland and dryland. On the wetland, a decline of alder-dominated fen carr woodland in response to wetter conditions is indicated by the increase of grasses, sedges and buttercups. On the dryland, the decline of mixed deciduous woodland is indicated, whilst the herbaceous assemblage of cereals and weed taxa is suggestive of clearance for agricultural and possibly settlement purposes.

Table 4: Results of the pollen assessment of column samples <1> to <4>, The National Theatre, South Bank, London Borough of Lambeth

	Context number	**(3)**	**(7)**	**(9)**	**(9)**	**(10)**	**(11)**	**(12)**	**(12)**
	Depth (m OD)	**0.82**	**0.58**	**0.34**	**0.10**	**-0.14**	**-0.38**	**-0.62**	**-0.86**
Latin name	**Common name**								
Trees									
Alnus	alder	3		3	5	5	9	11	7
Quercus	oak			1	3	1	6	6	11
Pinus	pine	2		1			1	1	
Tilia	lime	1		1	1		1	1	2
Shrubs									
Corylus type	e.g. hazel	2		1	4	7	4	4	1
Salix	willow								1
cf *Sambucas nigra*	elder						1		
Herbs									
Cyperaceae	sedge family	13		4	4	6	1	3	1
Poaceae	grass family	12	3	1	4	9	1		3
cf *Cereale* type	cereal				2	1			
Asteraceae	daisy family				1			3	2
Cirsium type	thistle	1			1				
Centaurea nigra	black knapweed		1						
Artemisia	mugwort								
Lactuceae	dandelion	2	4	3	3	2	2		
Plantago	plantain	1						1	1
Rumex undifferentiated	dock/sorrel				3				
Chenopodium type	goosefoot family	2	1	6	5		3		2
Sinapis type	e.g. charlock			10		1			
Filipendula type	meadowsweet					1			
Apiaceae	carrot family		1						
Ranunculus type	buttercup		1		1				
Rosaceae	rose family								1
Aquatics									
Potamogeton type	pondweed								1
Typha latifolia	bulrush				4				
Sparganium type	bur-reed	1						1	1
Spores									
Pteridium aquilinum	bracken	4	0	1	6	6			
Sphagnum	peat moss						1		
Filicales	ferns						1		
Polypodium vulgare	polypody	1					2		
Unidentifiable		23		7	3	5			
Total Land Pollen (grains counted)		**37**	**11**	**31**	**37**	**33**	**31**	**29**	**32**
Concentration*		**5**	**3**	**5**	**5**	**5**	**5**	**4**	**5**
Preservation**		**3**	**3**	**3**	**3**	**3**	**3-4**	**4**	**4-5**

Microcharcoal Concentration* **	**5**	**5**	**4**	**4**	**4**	**2**	**2**	**1-2**

Key:

**Concentration: 0 = 0 grains; 1 =1-75 grains, 2 = 76-150 grains, 3 =151-225 grains, 4 = 226-300, 5 =300+ grains per slide*

***Preservation: 0 = none, 1 = very poor, 2 = poor, 3 = moderate, 4 = good, 5 = excellent*

****Microcharcoal Concentration: 0 = none, 1= negligible, 2 = occasional, 3 = moderate, 4 = frequent, 5 = abundant*

RESULTS AND INTERPRETATION OF THE DIATOM ASSESSMENT

Six sub-samples from the column samples were extracted for the assessment of diatoms (Table 5). The results of the assessment indicate that diatom remains are present in the samples from context (12), but are only sporadically present, and poorly preserved in the samples from contexts (9) and (10). Thus, the hydrological conditions are only likely to be reconstructed in the samples from context (12).

Table 5: Results of the diatom assessment of column samples <1> to <4>, The National Theatre, South Bank, London Borough of Lambeth

Depth (m OD)		Context number	Diatom concentration	Quality of preservation	Diversity
From	To				
0.34	0.33	(9)	Very low	Very poor	Very low
0.39	0.38	(9)	Very low	Very poor	Very low
0.10	0.09	(9)	None	-	-
-0.14	-0.15	(10)	Very low	Very poor	Very low
-0.62	-0.63	(12)	Low	Very poor	Very low
-0.86	-0.87	(12)	Very high	Good	High

RESULTS AND INTERPRETATION OF THE MACROFOSSIL ASSESSMENT

Seven small bulk samples were extracted from column samples <1> to <4> for the recovery of macrofossil remains including charred and waterlogged remains (seeds and wood), insects, Mollusca, Ostracoda, Foraminifera, insects and faunal remains.

The results of an initial assessment (Table 6) indicated that the samples from contexts (11) and (12) contained low quantities of waterlogged wood and seeds, but no other macrofossil remains. By contrast, the samples from contexts (7), (8) and (9) contained no waterlogged seeds and a minimal amount of waterlogged wood in the sample taken between 0.30 and 0.20m OD. These samples also contained low quantities of charcoal and moderate numbers of Mollusca. An abundance of artefact remains (slag?) were recorded in uppermost sample 0.50 to 0.40m OD.

Waterlogged seeds

Waterlogged seeds were identified in four samples, and underwent a more detailed assessment (Table 7). The assemblage was dominated by *Alnus glutinosa* catkins (alder), *Ranunculus* sp. (buttercup) and *Rumex*/*Polygonum* sp. (dock/sorrel/knotgrass). The assemblage is limited, and thus a full interpretation of the seed assemblage cannot be made; however, the presence of these species is indicative of a damp environment supporting alder woodland and mixed herbs during the accumulation of contexts (12) and (11).

Table 6: Results of the macrofossil assessment of column samples <1> to <4>, The National Theatre, South Bank, London Borough of Lambeth

				Charred					Waterlogged		Mollusca		Bone					
Depth (m OD)	Context number	Volume processed (l)	Fraction (e.g. flot, residue, >300µm)	Charcoal (>4mm)	Charcoal (2-4mm)	Charcoal (<2mm)	Seeds	Chaff	Wood	Seeds	Whole	Fragments	Large	Small	Fragments	Insects	Ostracoda/Foraminifera	Artefact remains
0.50 to 0.40	(7) / (8)	0.2	>300µm	-	-	-	-	-	-	-	-	2	-	-	-	-	-	5
0.30 to 0.20	(9)	0.2	>300µm	-	1	1	-	-	1	-	-	-	-	-	-	-	-	-
0.10 to 0.00	(9)	0.3	>300µm	-	-	2	-	-	-	-	-	3	-	-	-	-	-	-
-0.30 to -0.40	(11)	0.3	>300µm	-	-	-	-	-	2	1	-	-	-	-	-	-	-	-
-0.53 to -0.58	(11)	0.15	>300µm	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
-0.60 to -0.70	(12)	0.3	>300µm	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-
-0.90 to -1.00	(12)	0.2	>300µm	-	-	-	-	-	2	1	-	-	-	-	-	-	-	-

Key: 0 = Estimated Minimum Number of Specimens (MNS) = 0; 1 = 1 to 25; 2 = 26 to 50; 3 = 51 to 75; 4 = 76 to 100; 5 = 101+

Table 7: Results of the waterlogged plant macrofossil (seeds and wood) assessment of column samples <1> to <4>, The National Theatre, South Bank, London Borough of Lambeth

Depth (m OD)	Context number	Species identification		Number
		Latin name	Common name	
0.50 to 0.40	(7) / (8)	-	-	-
0.30 to 0.20	(9)	-	-	-
0.10 to 0	(9)	-	-	-
-0.30 to -0.40	(11)	*Rumex/Polygonum* sp.	dock/sorrel/knotgrass	1
-0.53 to -0.58	(11)	*Alnus glutinosa* catkin	alder	4
-0.60 to -0.70	(12)	*Ranunculus sceleratus*	celery-leaved buttercup	1
-0.90 to -1.00	(12)	*Alnus glutinosa* catkin *Ranunculus* cf. *repens* *Rumex/Polygonum* sp.	alder creeping buttercup dock/sorrel/knotgrass	2 2 1

DISCUSSION AND CONCLUSIONS

The overarching aim of the environmental archaeological assessment was: (1) to evaluate the potential of this sedimentary sequence for reconstructing the environmental history of the site and its environs, and (2) to detect evidence for human activity.

The results of the assessment indicate a shallow sequence of alluvium overlying the Shepperton Gravel, the surface of which falls from south/southeast (-0.43 to -1.43) to north (-2.80) across the site. The alluvial sequence consisted mainly of silty clay sediments throughout, indicative of a fluvial/estuarine environment. Although no peat was recorded in the sequence, the silty clay became more organic between -0.59 and -0.24m OD (context (11)), representing a transition towards semi-terrestrial conditions and the growth of wetland vegetation. Accumulation of this more organic horizon began during the Late Bronze Age/Early Iron Age (2770-2620 cal BP), post-dating peat accumulation at nearby sites to the south-east such as 127 Stamford Street (3690-6400 to 3060-2760 cal BP; Sidell *et al*., 2002), Site B, Coin Street (3550-3160 to 2790-2370 cal BP; London Archaeologist, 1998), the Nautical School (from 4220-3890 cal BP; London Archaeologist, 2004) and Stamford House (from 3450-3260 cal BP; London Archaeologist, 2003) (Figure 2). It therefore appears that this sequence represents a later phase of organic accumulation than previously investigated in this area of Lambeth.

The combined results of the palaeobotanical assessments (pollen, wood and seeds) correlate well with the lithostratigraphic record, indicating that the sequence can be divided into two sections. During the accumulation of contexts (12) and (11) the assemblage is indicative of a floodplain environment dominated by alder and willow fen carr woodland with a ground flora including grasses, sedges and aquatic plants. No palynological indicators of human activity were recorded in the three samples, and the concentration of microcharcoal was minimal. The dryland appears to

have been composed of mixed deciduous woodland dominated by oak with lime and hazel. Considering the late prehistoric date of the sequence, the apparent dominance of woodland in the local environment is considered slightly surprising; a more open environment consequent of woodland clearance might be anticipated.

During the accumulation of contexts (3) to (10), the recorded assemblage is indicative of large changes in vegetation community on both the wetland and dryland. On the wetland, a decline of alder-dominated fen carr woodland in response to wetter conditions is indicated by the increase of grasses, sedges and buttercups. On the dryland, the decline of mixed deciduous woodland is indicated, whilst the herbaceous assemblage of cereals and weed taxa is suggestive of clearance for agricultural and possibly settlement purposes.

The results of the diatom assessment indicate there is potential to provide a reconstruction of the hydrological conditions (specifically salinity) during the accumulation of the silty clay in context (12). The presence of Mollusca in contexts (7) to (9) may offer a similar opportunity.

RECOMMENDATIONS

The preservation and concentration of pollen (all contexts), diatoms (context (12)) and waterlogged wood/charcoal (contexts (9), (11) and (12)) in the alluvial sequence from the National Theatre is sufficient to reconstruct the environmental history of the site and its environs. In addition, this sequence appears to represent a later phase of organic accumulation which has not previously been investigated in this area of the Lambeth. Should further work be required in order to satisfy the planning conditions for the site, a focussed programme of analysis is recommended. This analysis should consist of (1) a minimum of one additional radiocarbon date, to provide an age for the cessation of the organic-rich horizon (context (11)), and (2) analysis of the pollen, diatoms and waterlogged wood/charcoal as outlined above.

ADDENDUM

In January 2014, the recommendation to carry out an additional radiocarbon determination, to provide an age for the cessation of the organic-rich horizon was instigated. One sample of twig wood from between -0.30 and -0.40m OD was submitted for AMS radiocarbon dating to the SUERC laboratory in East Kilbride. The result has been calibrated using OxCal v4.2 Bronk Ramsey (1995, 2001) and IntCal13 atmospheric curve (Reimer *et al*., 2013); SUERC. Radiocarbon determination SUERC-47032 (GU30583) has also been recalibrated using the most recent calibration curve (IntCal13). The results of both determinations are displayed in Table 8.

Table 8: Results of the radiocarbon dating, The National Theatre, South Bank, London Borough of Lambeth

Laboratory code / Method	**Material and location**	**Sample (m OD)**	**Uncalibrated radiocarbon years before present (yr BP)**	**Calibrated age BC/AD (BP) (2-sigma, 95.4% probability)**	**δ13C (‰)**
SUERC-50755 (GU33057)	Twig wood from top of organic-rich horizon (context (11))	-0.30 to -0.40	2535 ± 29	800-540 cal BC (2750-2490 cal BP)	-28.6
SUERC-47032 (GU30583)	*Alnus glutinosa* (alder) catkins at base of organic-rich horizon (context (11))	-0.53 to -0.58	2596 ± 29	830-760 cal BC (2780-2710 cal BP)	-29.2

The results of the radiocarbon dating indicate that the duration of organic-rich sedimentation was very short, commencing shortly before 2780-2710 cal BP (830-760 cal BC) and continuing until shortly after 2780-2710 cal BP (830-760 cal BC). Thus, the period of accumulation spanned a maximum of 290 years and correlates to the Late Bronze Age/Early Iron Age cultural periods.

REFERENCES

Bengtsson, L. & Enell, M. (1986) Chemical Analysis. In (Berglund, B.E. ed.) *Handbook of Holocene palaeoecology and palaeohydrology,* 423-451. Chichester: John Wiley and Sons.

Batchelor, C.R. and Young, D.S. (2009) 135 Park Street, London Borough of Southwark (site code: PKP09): Environmental Archaeological Assessment. *Quaternary Scientific (QUEST) Unpublished Report October 2009; Project Number 080/09*

Batchelor, C.R., Branch, N.P., Green, C.P., Young, D., Elias, S., Austin, P. and Cameron, N. (2008) *231-241 Blackfriars Road, London Borough of Southwark: Environmental Archaeological Assessment (Site Code: BFX08).* ArchaeoScape Unpublished Report.

Batchelor, C.R., Cameron, N., Young, D.S., Green, C.P., Allott, L., Austin, P. & S. Elias (2011a) *Bear House, Bear Lane, Southwark, London, SE1 (site codes: BJH10 and BLZ07): Environmental archaeological analysis report*. Quaternary Scientific (QUEST) Unpublished Report July 2010; Project Number 028/10.

Batchelor, C.R., Green, C.P., D.S. Young and Cameron, N. (2011b) *70 Great Suffolk Street, London Borough of Southwark (Site Code: GUF10): Environmental archaeological analysis report.* Quaternary Scientific (Quest) Unpublished Report March 2011; Project Number 152/10.

Batchelor, C.R., Young, D.S. Cameron, N. Green, C.P. & Allott, L. (2011c) *65 Southwark Street, London Borough of Southwark (site code: SOU11): Geoarchaeological analysis report*. Quaternary Scientific (QUEST) Unpublished Report May 2011; Project Number 158/10.

Batchelor, C.R., Green, C.P., D.S. Young (2012) *Surrey House, 20 Lavington street, London Borough of Southwark, SE1 0NZ (Site Code: LVI11): Environmental archaeological Assessment report.* Quaternary Scientific (Quest) Unpublished Report March 2012; Project Number 018/11.

Battarbee, R.W., Jones, V.J., Flower, R.J., Cameron, N.G., Bennion, H.B., Carvalho, L. & Juggins, S. (2001) *Diatoms.* In (J.P. Smol, H.J.B. Birks & W.M. Last, eds.), *Tracking environmental change using lake sediments volume 3: terrestrial, algal, and siliceous indicators*, 155-202. Dordrecht: Kluwer Academic Publishers.

Branch, N.P., Swindle, G.E. and Williams, A.N. (2002) *Middle Holocene Environmental History of South Point, Blackfriars Road, Southwark, London.* ArchaeoScape Unpublished Report.

Bronk Ramsey C. (1995) Radiocarbon Calibration and Analysis of Stratigraphy: The OxCal Program, *Radiocarbon* **37 (2)**, 425-430.

Bronk Ramsey C. (2001) Development of the Radiocarbon Program OxCal, *Radiocarbon* **43 (2a)**, 355-363.

Bronk Ramsey, C. (2007) Deposition models for chronological records. *Quaternary Science Reviews* (INTIMATE special issue; **27(1-2)**, 42-60.

Cappers, R.T.J., Bekker R.M. & Jans J.E.A. (2006) Digital Seed Atlas of the Netherlands. Groningen Archaeological Series 4. Barkhuis, Netherlands

Gibbard, P. (1985) *The Pleistocene history of the Middle Thames Valley*. Cambridge: Cambridge University Press.

Hogg, I. (2011) The National Theatre, South Bank, London Borough of Lambeth: A Written Scheme of Investigation for a programme of Archaeological Observation and Recording. AOC Archaeology Unpublished Report.

Malony, C. (1998) London Fieldwork and Publication Round-up 1998. *London Archaeologist.*

Malony, C. (2001) London Fieldwork and Publication Round-up 2001. *London Archaeologist.*

Malony, C. (2003) London Fieldwork and Publication Round-up 2003. *London Archaeologist.*

Malony, C. (2004) London Fieldwork and Publication Round-up 2004. *London Archaeologist*.

Martin, A.C. and Barkley, W.D. (2000) *Seed Identification Manual*. University of California Press, Berkeley.

Moore, P.D., Webb, J.A. & Collinson, M.E. (1991) *Pollen Analysis*. Oxford: Blackwell Scientific.

NIAB (2004) *Seed Identification Handbook (2nd Edition): Agriculture, Horticulture and Weeds. NIAB Tag Publications.*

Reille, M. (1992) *Pollen et spores D'Europe et D'Afrique du Nord*. Laboratoire de Botanique historique et Palynologie, Marsaille.

Reimer, P. J., Baille, M. G. L., Bard, E., Bayliss, A., Beck, J. W., Bertrand, C. J. H., Blackwell, P.G., Buck, C.E., Burr, G.S., Cutler, K.B., Damon, P.E., Edwards, R. L., Fairbanks, R.G., Friedrich, M., Guilderson, T.P., Hogg, A.G., Hughen, K.A., Kromer, B., McCormac, G., Manning, S., Bronk Ramsey, C., Reimer, R.W., Remelle, S., Southon, J.R., Stuiver, M., Talamo, S., Taylor, F.W., Van der Plicht, J., Weyhenmeyer, C.E. (2004) IntCal04 terrestrial radiocarbon age calibration, 0-26 cal kyr BP. *Radiocarbon,* **46 (3)**, 1029-1058.

Sidell, J., Wilkinson, K., Scaife, R. & Cameron, N. (2000) *The Holocene Evolution of the London Thames*: MoLAS Unpublished Report.

Sidell, E.J., Cotton, J., Rayner, L. & Wheeler, L. (2002) *The prehistory of Southwark and Lambeth.* MoLAS Monograph 15. London.

Stace, C. (2005) *New Flora of the British Isles*. Cambridge: Cambridge University Press.

Tan, M., Branch, N.P., Batchelor, C.R., Young, D. (2008) *Bear Lane, London Borough of Southwark: environmental archaeological assessment (site code: BLZ07) ArchaeoScape* Unpublished Report.

Troels-Smith, J. (1955). Characterisation of unconsolidated sediments. *Danmarks Geologiske Undersøgelse,* Raekke IV**(3)**, 38-73.

Appendix C – OASIS Form

OASIS ID: aocarcha1-111407

Project details	
Project name	The National Theatre, Lambeth
Short description of the project	Programme of Archaeological watching brief was conducted during ground works. geoarchaeoklogical sampling was carried out on site to deteremine the date and sequence of alluvial deposits recorded during the site works. The results of the radiocarbon dating indicate that the duration of organic-rich sedimentation was very short, commencing shortly before 2780-2710 cal BP (830-760 cal BC) and continuing until shortly after 2780-2710 cal BP (830-760 cal BC). Thus, the period of accumulation spanned a maximum of 290 years and correlates to the Late Bronze Age/Early Iron Age cultural periods.
Project dates	Start: 10-10-2011 End: 04-03-2014
Previous/future work	Yes / No
Any associated project reference codes	31046 - Contracting Unit No.
Any associated project reference codes	30672 - Contracting Unit No.
Any associated project reference codes	NTH12 - Sitecode
Type of project	Recording project
Site status	Conservation Area
Current Land use	Community Service 2 - Leisure and recreational buildings
Investigation type	'"Recorded Observation"'
Prompt	Direction from Local Planning Authority - PPS

Project location	
Country	England
Site location	GREATER LONDON LAMBETH LAMBETH The National Theatre, South Bank
Postcode	SE1 9PX
Study area	1.90 Hectares
Site coordinates	TQ 3101 8301 51.5302842393 -0.111082802306 51 31 49 N 000 06 39 W Point

Project creators	
Name of Organisation	AOC Archaeology
Project brief originator	EH GLAAS
Project design originator	AOC Archaeology
Project director/manager	Paul Mason
Project supervisor	Paul Mason
Type of sponsor/funding body	developer
Name of sponsor/funding body	The National Theatre

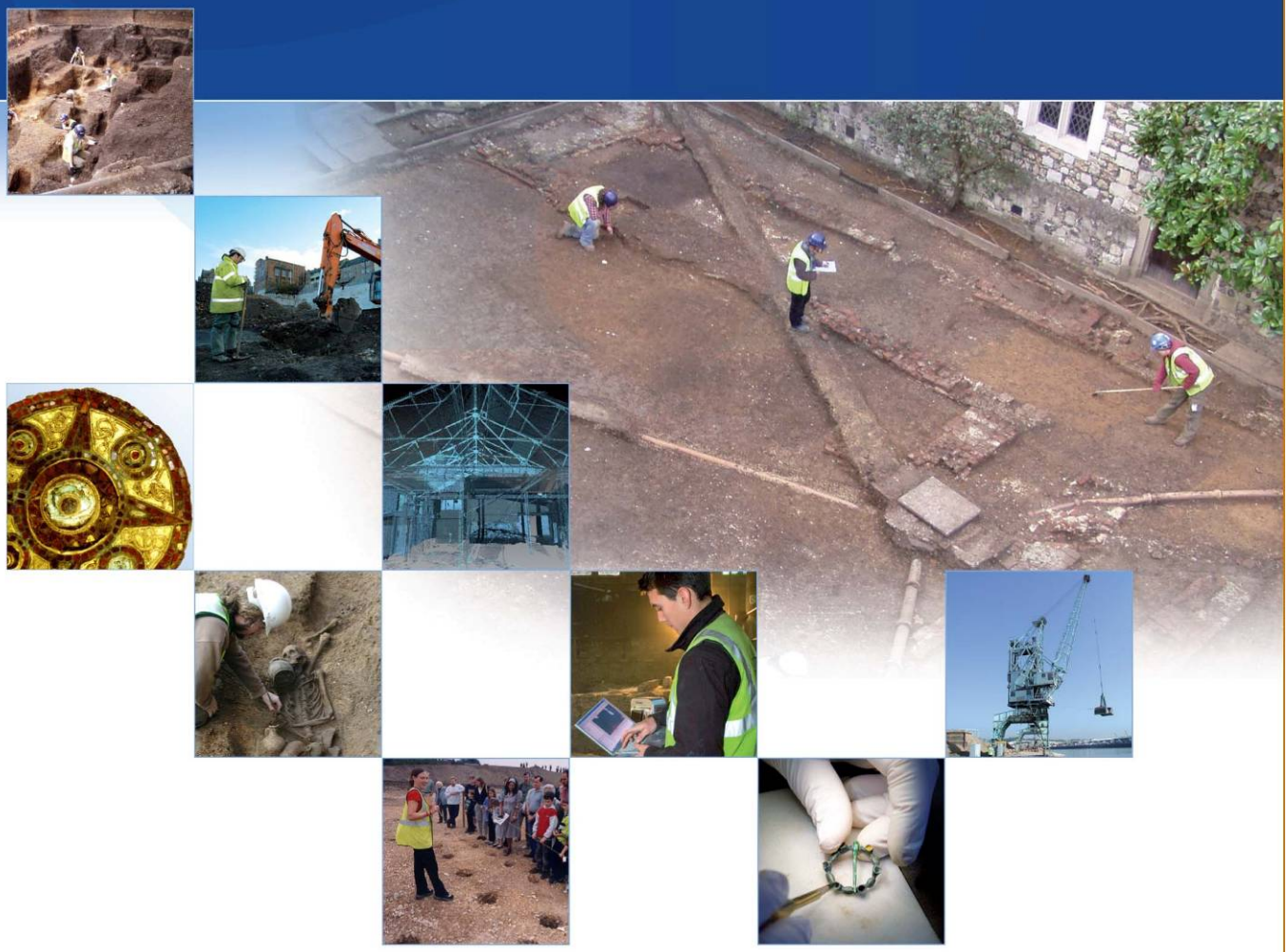
Project archives	
Physical Archive recipient	LAARC

Digital Archive recipient	LAARC
Digital Contents	"Environmental"
Digital Media available	"Images raster / digital photography","Text"
Paper Archive recipient	LAARC
Paper Contents	"Environmental"
Paper Media available	"Context sheet","Matrices","Microfilm","Photograph","Plan","Report","Section","Survey","Unpublished Text"

Project bibliography 1	
Publication type	Grey literature (unpublished document/manuscript)
Title	The National Theatre, Southbank, London: A archaeological and geoarchaeological investiogation report
Author(s)/Editor(s)	Paul Mason
Date	2013
Issuer or publisher	AOC Archaeology Group
Place of issue or publication	London
Description	Grey literature report

Project bibliography 2	
	Grey literature (unpublished document/manuscript)

Publication type	
Title	The National Theatre, South Bank, London: An Updated Archaeological and Geoarchaeological Investigation Report
Author(s)/Editor(s)	Mason, P
Author(s)/Editor(s)	Edwards, C
Date	2014
Issuer or publisher	AOC Archaeology
Place of issue or publication	London
Description	bound report with illsutrations, photos and geoarchaeological report
Entered by	catherine edwards (catherine.edwards@aocarchaeology.com)
Entered on	5 March 2014



AOC Archaeology Group, Unit 7, St Margarets Business Centre, Moor Mead Road, Twickenham TW1 1JS
tel: 020 8843 7380 | **fax:** 020 8892 0549 | **e-mail:** london@aocarchaeology.com