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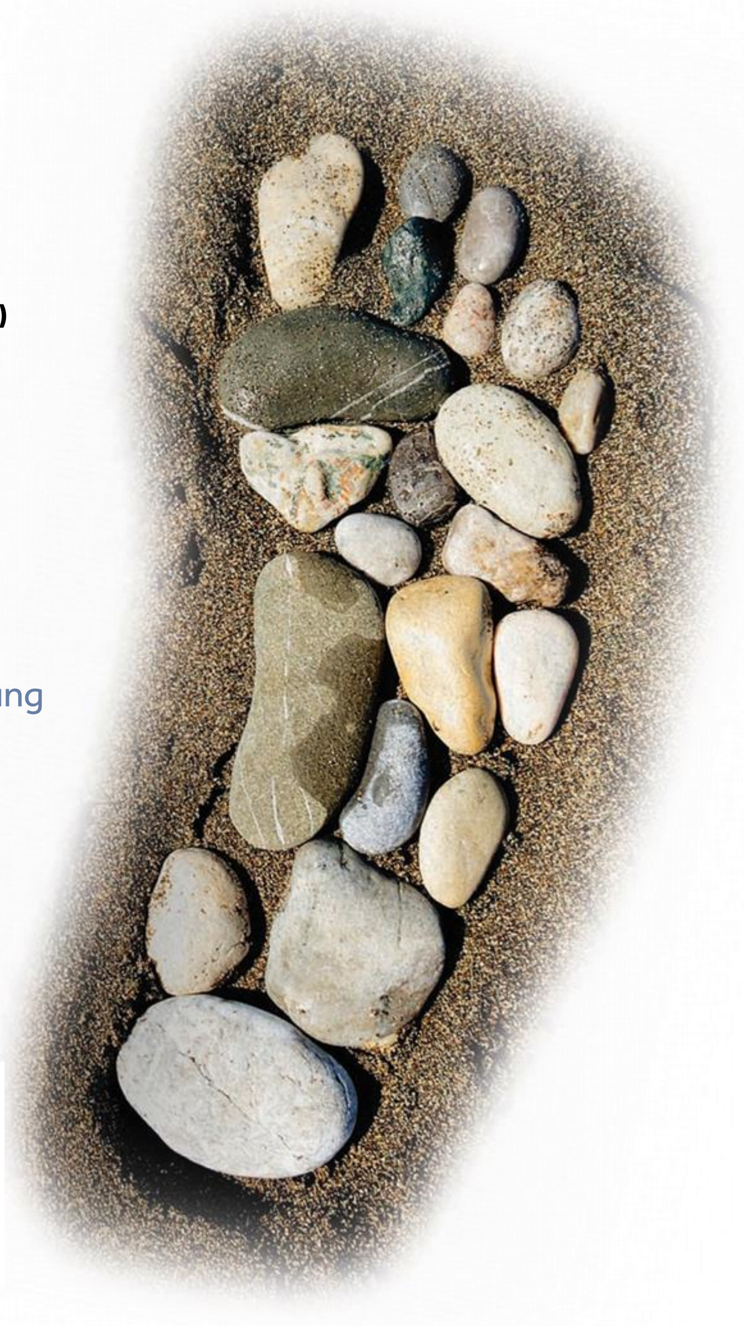
ALCHEMY PARK, CRABTREE MANORWAY NORTH, LONDON BOROUGH OF BEXLEY

Geoarchaeological Assessment Report

(Submission pursuant to Condition 5 of Outline Planning Permission 11/01932/OUTM)



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

QUEST, School of Archaeology, Geography and Environmental Science, Whiteknights, University of Reading, RG6 6AB

Tel: 0118 378 7978 / 8941
Email: c.r.batchelor@reading.ac.uk
http://www.reading.ac.uk/quest

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CONTENTS

1. NON-TECHNICAL SUMMARY 3
2. PLANNING CONTEXT 4
3. INTRODUCTION 4
   3.1 Site context 4
   3.2 Palaeoenvironmental and archaeological significance 5
   3.3 Aims and objectives 6
4. METHODS 9
   4.1 Geoarchaeological field investigations and deposit modelling 9
   4.2 Organic matter determinations 10
   4.3 Radiocarbon dating 10
   4.4 Pollen assessment 10
   4.5 Diatom assessment 11
   4.6 Macrofossil assessment 11
5. RESULTS AND INTERPRETATION OF THE DEPOSIT MODELLING, ORGANIC MATTER DETERMINATIONS & RADIOCARBON DATING 14
   5.1 Shepperton Gravel 14
   5.2 Lower Alluvium 14
   5.3 Peat 15
   5.4 Upper Alluvium 16
   5.5 Made Ground 16
6. RESULTS AND INTERPRETATION OF THE POLLEN ASSESSMENT 30
7. RESULTS AND INTERPRETATION OF THE DIATOM ASSESSMENT 34
8. RESULTS AND INTERPRETATION OF THE MACROFOSSIL ASSESSMENT 35
9. DISCUSSION 37
   9.1 Stratigraphic and hydrological history 37
   9.2 Vegetation history 39
10. CONCLUSIONS AND RECOMMENDATIONS 42
11. REFERENCES 43
12. APPENDIX 1: OASIS 47

1. NON-TECHNICAL SUMMARY

A geoarchaeological assessment was carried out by Quaternary Scientific (University of Reading) in connection with the proposed development of land at Alchemy Park, Crabtree Manorway North, London Borough of Bexley. The work was commissioned by Turley on behalf of Savills Investment Management. The aims of the investigation were to: (1) to investigate the age of the peat horizons at the site; (2) to provide a provisional reconstruction of the environmental history of the site, (3) to highlight any evidence of human activity, and (4) to make recommendations for further analysis (if required). In order to carry out the work, a program of radiocarbon dating and an assessment of the palaeobotanical (pollen, seeds, wood, diatoms) and palaeofaunal (insects, molluscs, ostracods and foraminifera) remains was undertaken.

The results have built upon the initial geoarchaeological fieldwork and deposit modelling exercise which confirmed a sequence of River Terrace Gravels (the Shepperton Gravel), overlain by floodplain deposits of Lower Alluvium (sands, silts, peat and plant remains), Peat and Upper Alluvium (silts and clays) beneath the site. However, the depth and thickness of these deposits changes from south (low gravel surface; thick floodplain deposits) to north (high gravel surface; thin floodplain deposits) suggesting that the site is located towards the interface of two different environments: the floodplain valley of the Lower Thames Valley (to the north) and a deep west-east orientated palaeochannel (to the south). The Lower Alluvium began accumulating during the late Mesolithic (middle Holocene) beyond the margins of the probable palaeochannel, and earlier within the channel itself. The rate of accumulation was relatively rapid (ca. 3m/1000 years). Peat formation commenced towards the very end of the Mesolithic and continued to the Bronze Age.

During the accumulation of the Lower Alluvium and Peat (Mesolithic to early Bronze Age) the floodplain environment was dominated by wetland woodland comprising alder and a ground flora of sedges, grasses, aquatics and ferns, whilst mixed deciduous woodland occupied the dryland. At the time of the transition from Peat to Upper Alluvium (Bronze Age), woodland declined on both surfaces as a consequence of relative sea level rise (floodplain) and human activity (dryland). The vegetation history of the Alchemy Park site is broadly similar to that indicated at nearby sites. There have however, been important discoveries which might also be recorded at Alchemy Park. These include: (1) the Neolithic colonisation and decline of yew (*Taxus*) woodland, and (2) the Neolithic decline and late Bronze Age expansion of elm (*Ulmus*) woodland.

The assessment has thus been successful in demonstrating that the sequences from Alchemy Park have the potential to address aims 3 to 5 of the project, and have provided preliminary interpretations. It is therefore recommended that a targeted program of analysis is carried out as outlined within the Written Scheme of Investigation for the site (Batchelor, 2015) focusing on: (1) radiocarbon dating to improve the chronological framework; (2) pollen analysis of additional samples likely to increase knowledge/understanding of the history of elm & yew woodland; both of which have affiliations with human activity.

2. PLANNING CONTEXT

This Geoarchaeological assessment report is submitted pursuant to the requirements of Planning Condition 5 of Outline Planning Permission 11/01932/OUTM granted by the London Borough of Bexley on 28 March 2012. Condition 5 states '*No development shall take place within the site 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 in writing by the Local Planning Authority*'. The fieldwork report has been undertaken in line with the Written Scheme of Investigation (dated 18 December 2015) approved by the London Borough of Bexley on 15 February 2016.

3. INTRODUCTION

3.1 Site context

This report summarises the findings arising out of the geoarchaeological assessment undertaken by Quaternary Scientific (University of Reading) in connection with the proposed development of land at Alchemy Park, Crabtree Manorway North, London Borough of Bexley (NGR centred on: TQ 500 801; site code: ALY16; Figures 1 & 2). Quaternary Scientific were commissioned by Turley on behalf of Savills Investment Management to undertake the geoarchaeological investigations. The site is located on the floodplain of the Estuarine Thames, less than 300m from the modern waterfront and *ca*. 1km north of the floodplain edge and the rising ground of the valley side. The site lies on the south side of the Thames, forming part of the Erith Marshes which occupies the eastern end of the area of floodplain enclosed by the river where it makes a broad northward loop between Woolwich in the west and Erith in the east. The whole of this area of valley floor, which has its most northerly point at Crossness, is underlain by Holocene Alluvium. The British Geological Survey (BGS) 1:50,000 Sheets 257 Romford (1996) and 271 Dartford (1998) show the Alluvium overlying bedrock Lower Tertiary Lambeth Group sediments in much of the eastern part of the area; and overlying Taplow Gravel in the western part and in the south, adjacent to the higher ground that forms the southern edge of the floodplain.

Recent geoarchaeological investigations at the site (Batchelor & Young, 2016) have in fact revealed that the northern part of the site is located on a Late Devensian Shepperton Gravel surface resting between -7.5 and -9m OD. On the southern part of the site however, a west-east or northwest-southeast orientated deep trough (probable palaeochannel) is recorded. The channel is cut into the Shepperton Gravel surface, estimated to measure between 100 and 200m in width and *ca*. 2.5 in depth. A tripartite sequence of Lower Alluvium, Peat and Upper Alluvium infills the potential palaeochannel, and surrounding higher gravel surface. The sequences represented in the Alchemy Park geoarchaeological boreholes have good potential to provide detailed reconstructions of landscape change, potentially including evidence of human activity. Currently, the date of these deposits is unknown, but on the basis of sequences recorded nearby, they are likely to have accumulated from the late Mesolithic to Bronze Age periods (spanning up to 4000 years).

3.2 Palaeoenvironmental and archaeological significance

The results of the geoarchaeological fieldwork and deposit modelling thus demonstrate considerable variation in the height of the Shepperton Gravel, and the type and thickness 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 substantial variations in the surface of the gravel recorded here appear to represent the edge of a palaeochannel; (2) the peat recorded represents a former semi-terrestrial landsurface, and (3) fine-medium sediments such as sands, silts and clays represent periods of flooding and/or colluvial in-wash. Thus studying the sub-surface deposits of the site has enabled us to start building our understanding of the former landscapes and environmental changes that took place over both space and time across the site.

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 structure) and palaeoenvironmental record (e.g. changes in vegetation composition). Prehistoric structures have been located in the peat locally to the site at Erith Spine Road / Bronze Age Way (Sidell, 1996) and on the Erith Foreshore (Sidell pers. comm.). However, due to the depth of the sediments on the Alchemy Park site, the archaeological potential of the site is considered to be low.

Even in the absence of the archaeological remains, the sediments have the potential to contain a wealth of further information on the past landscape, through the assessment/analysis of palaeoenvironmental remains (e.g. pollen, plant macrofossils and insects) and radiocarbon dating from peat and alluvial sediments. So called environmental archaeological or palaeoenvironmental investigations can identify the nature and timing of changes in the landscape, and the interaction of different processes (e.g. vegetation change, human activity, climate change, hydrological change) thereby increasing our knowledge and understanding of the site and nearby area. In the case of human activity, palaeoenvironmental evidence can include: (1) decreases in tree and shrub pollen suggestive of woodland clearance; (2) the presence of herbs indicative of disturbed ground, pastoral and/or arable agriculture; (3) charcoal/microcharcoal suggestive of anthropogenic or natural burning, and (4) insect taxa indicative of domesticated animals. Such investigations are routinely carried out where required as part of planning conditions across the Lower Thames Valley and its tributaries; locally, they have been undertaken on the sedimentary sequences from Crossness Sewage Works (Batchelor *et al*., 2007a, b), Norman Road (Batchelor *et al*., 2008a) and Imperial Gateway (Batchelor *et al*., 2008b).

3.3 Aims and objectives

Five significant research aims were originally proposed within the geoarchaeological Written Scheme of Investigation (WSI; Batchelor, 2015) for the site as follows:

1. To clarify the nature of the sub-surface stratigraphy across the site;
2. To clarify the nature, depth, extent and date of any alluvium 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

The initial geoarchaeological fieldwork and deposit modelling successfully achieved the first two of these aims and demonstrated the potential of aims 3-5 being addressed through further investigation.

In order to fully identify whether these aims can be achieved, a laboratory assessment must be undertaken; the results of this investigation are outlined within the following report. The following objectives were carried out in order to do this:

1. Radiocarbon dating of the base of the peat, to establish a chronological framework for the environmental archaeological assessment,
2. Organic matter determinations to aid identification of the sedimentary units,
3. Assessment of the palaeobotanical remains (pollen, waterlogged wood and seeds) to provide a provisional reconstruction of the vegetation history,
4. Assessment of the diatoms to provide an indication of the palaeohydrology (e.g. marine, brackish or freshwater) of the site.

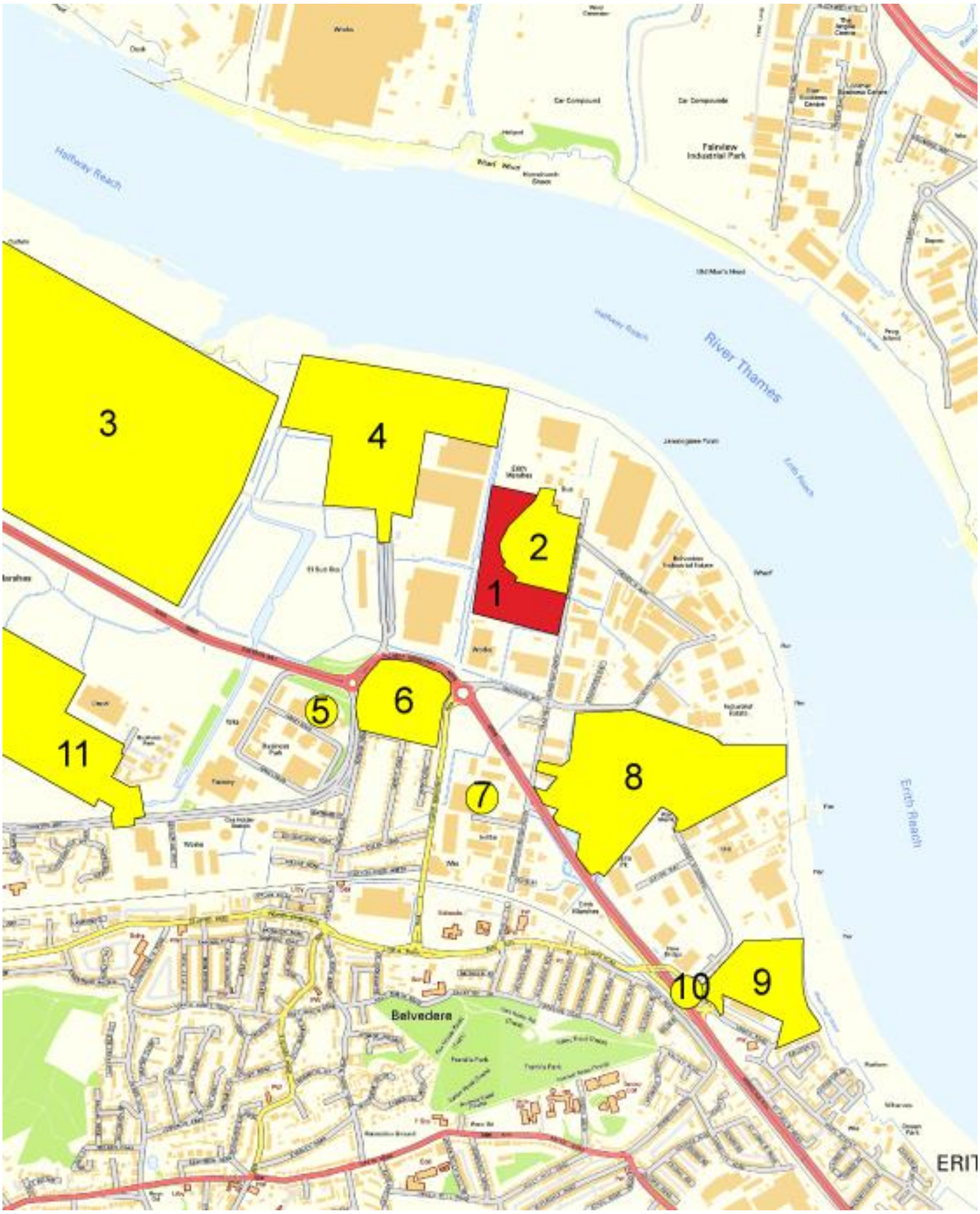

Figure 1: Location of (1) the Alchemy Park site (1) and other selected local sites: (2) Former NuFarm Site (Young *et al.*, 2008a); (3) Crossness (Devoy, 1979) / Crossness Sewage Works (EAW06 - Batchelor *et al.*, 2007a; CXS07 - Batchelor *et al.*, 2007b; CRO11 - Green *et al.*, 2011); (4) Norman Road (NNB06; Batchelor *et al.*, 2008a); (5) North Bexley Drainage Improvements (EWY01; Branch *et al.*, 2004); (6) Imperial Gateway (Batchelor *et al.*, 2008b); (7) Crabtree Manorway South (CXN05; Askew and Spurr, 2006); (8) Pirelli Works (PWR12; Young et al., 2012); (9) Erith Spine Road / Bronze Age Way (Sidell *et al.*, 1996); (10) Corinthian Quay (Corcoran & Lam, 2002); (11) Veridion Park (Green & Batchelor, 2013) *Contains Ordnance Survey data © Crown copyright and database right [2015]*

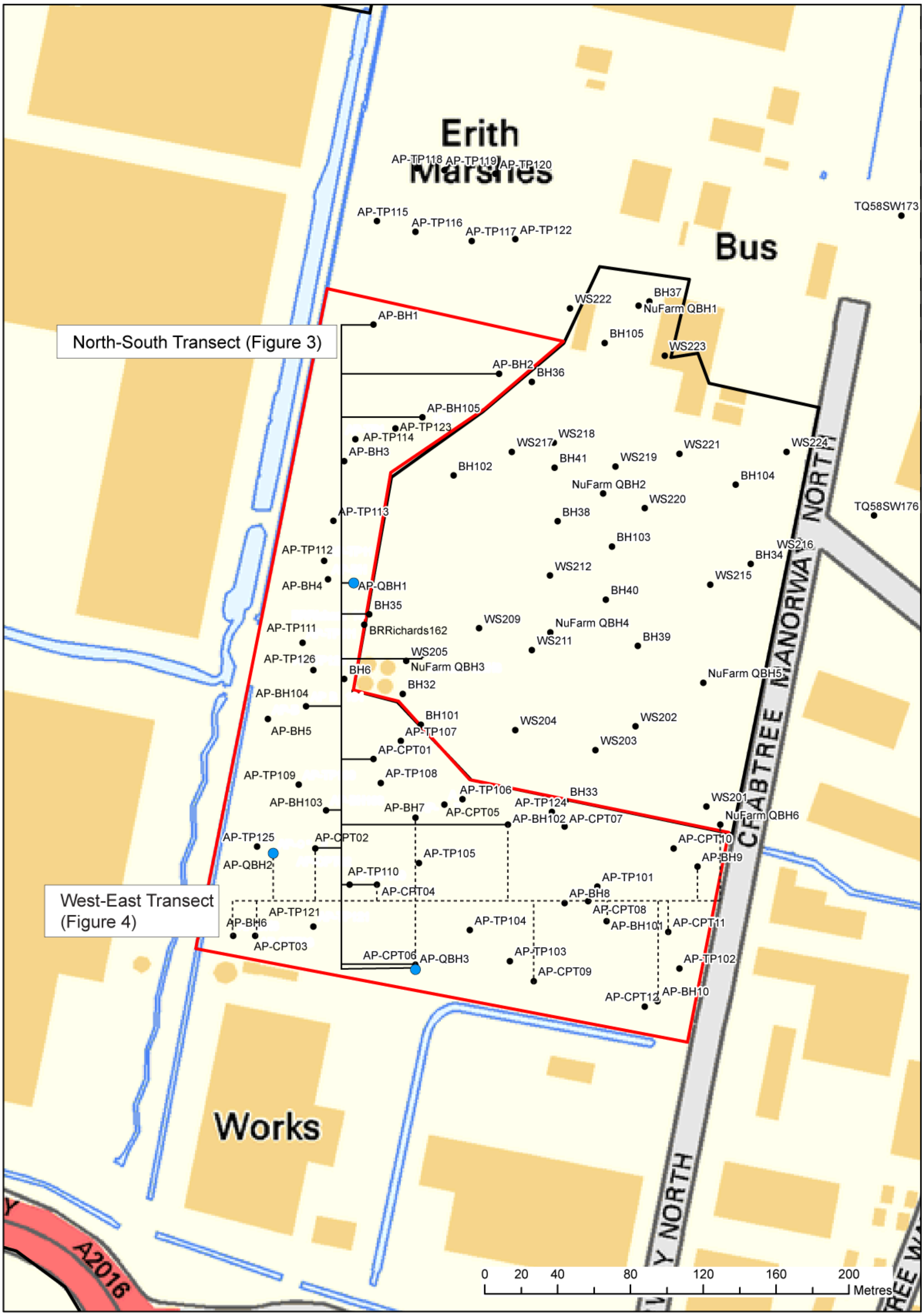

Figure 2: Location of the geoarchaeological boreholes and select recent/historical geotechnical boreholes and test-pits across the Alchemy Park and NuFarm sites, London Borough of Bexley

4. METHODS

4.1 Geoarchaeological field investigations and deposit modelling

Three geoarchaeological boreholes (boreholes AP-QBH1 to QBH3) were put down at the site in February 2016 (Figure 2) by Quaternary Scientific. The borehole core samples were recovered using an Eijkelkamp window sampler and gouge set using an Atlas Copco TT 2-stroke percussion engine. This coring technique is a suitable method for the recovery of continuous, undisturbed core samples and provides sub-samples suitable for not only sedimentary and microfossil assessment and analysis, but also macrofossil analysis. The new and historic borehole locations were obtained with reference to site maps and recent topographic surveys (Table 1).

The lithostratigraphy of the retained core samples was 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 sample using a scalpel; (2) recording the physical properties, most notably colour using a Munsell Soil Colour Chart; (3) recording the composition; gravel (Grana glareosa; Gg), fine sand (Grana arenosa; Ga), silt (Argilla granosa; Ag) and clay (Argilla steatoides); (4) recording the degree of peat humification and (5) recording the unit boundaries e.g. sharp or diffuse.

The deposit model generated during the previous phase of work was based on a review of 105 borehole and test-pit records, incorporating those from both Alchemy Park, NuFarm, and historical records from around the site (Figure 2; Table 1). West-east and north-south borehole transects were compiled (Figures 3 & 4). Sedimentary units from the boreholes were classified into five groupings: (1) Gravel, (2) Lower Alluvium; (3) Peat; (4) Upper Alluvium and (5) Made Ground. The classified data for groups 1-5 were then input into a database with the RockWorks geological utilities software. Models of surface height were generated for the Gravel, Lower Alluvium, Peat and Upper Alluvium (Figures 5, 6, 8 & 10). Thickness of the Lower Alluvium, Peat, Upper Alluvium, Total Alluvium and Made Ground (Figures 7, 9, 11, 12 & 13) was also modelled (also using a nearest neighbour routine).

How effectively Rockworks portrays the relief features of stratigraphic contacts or the thickness of sediment bodies depends on the number of data points (boreholes/test pits) per unit area, and the extent to which these points are evenly distributed across the area of interest. The portrayal is also affected by the significance assigned to these data points, in terms of the extent of the area around the point to which the data are deemed to apply. This can be predetermined for each data set, and in the present case the value chosen for each data point (borehole) is equivalent to an area of 25m radius for all models. The boreholes are relatively well distributed over the area of investigation. In general, reliability improves towards the core area of boreholes where mutually supportive data are likely to be available from several adjacent data points. Reliability is also affected by the quality of the stratigraphic records, which in turn are affected by the nature of the sediments and/or their post-depositional disturbance during previous stages of land-use on the site. Quality is also affected where boreholes have been put down at different times and recorded using different descriptive terms and subject to differing technical constraints in terms of recorded detail including the exact levels of the stratigraphic boundaries. Of the records used in the deposit model, the cores from the geoarchaeological boreholes put down by Quaternary Scientific represent the most detailed record of the sediment sequences. Finally, because of the 'smoothing' effect of the modelling procedure, the modelled levels of stratigraphic contacts may differ slightly from the levels recorded in borehole logs.

4.2 Organic matter determinations

A total of 30 subsamples from borehole AP-QBH1 and 12 from AP-QBH2 were taken for determination of the organic matter content (Table 5; Figure 12). 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^{0}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. The samples were then re-weighed after 2 hours at 950°C for determination of the calcium carbonate content (see Bengtsson and Enell, 1986).

4.3 Radiocarbon dating

Two subsamples of unidentified twig wood (<2-3 years old) were extracted from the base of the peat in borehole AP-QBH1 and AP-QBH2 for radiocarbon dating; a further sample was taken from a thin peat unit within the Lower Alluvium. The samples were submitted for AMS radiocarbon dating to the BETA Analytic Radiocarbon Dating Facility, Miami, Florida. The results have been calibrated using OxCal v4.2 (Bronk Ramsey, 1995; 2001 and 2007) and the IntCal13 atmospheric curve (Reimer *et al*., 2013). The results are displayed in Figure 12 and in Table 6.

4.4 Pollen assessment

Eleven subsamples from borehole AP-QBH1 and eight from AP-QBH2 were extracted for an assessment of pollen content. 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) (Tables 7 & 8).

4.5 Diatom assessment

Four samples from AP-QBH1 and two from AP-QBH2 were sampled for assessment of the diatom content. Samples AP-QBH1 -1.47m and -1.51m have been sampled from either side of the Upper Alluvium / Peat boundary, whereas samples BH1 -4.08, -4.13 and BH2 -4.73m, -4.77m have been sampled from either side of the Peat / Lower Alluvium boundary.

0.5g of sediment was required for the diatom sample preparation. Depending on the dominance of either minerogenics of organics within each sample, samples chosen for analysis were first treated with sodium hexametaphosphate and left overnight, to assist in minerogenic deflocculation. Samples were then treated with hydrogen peroxide (30% solution). Samples were finally sieved using a 10μm mesh to remove fine minerogenic sediments. The residue was transferred to a plastic vial, from which a slide was prepared for subsequent assessment. A minimum of four slide traverses were undertaken across each slide sample. When encountered, diatom species ware identified with reference to van der Werff and Huls (1958-74), Hendy (1964) and Krammer & Lange-Bertalot (1986-1991). Due to the nature of the assessment, many taxa were only identified to genera level. The results are displayed in Table 9.

4.6 Macrofossil assessment

A total of seven small bulk samples (five from borehole AP-QBH1 and two from AP-QBH2) were extracted for the recovery of macrofossil remains including waterlogged plant macrofossils, wood, insects and Mollusca. The extraction process involved the following procedures: (1) removing a sample of either 5 or 10cm in thickness; (2) measuring the sample volume by water displacement, and (3) 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 10 & 11). Preliminary identifications of the waterlogged seeds have been made using modern comparative material and reference atlases (Cappers *et al.,* 2006). Nomenclature used follows Stace (2005).

Table 1: Borehole and select Test-Pit attributes for those records used in the deposit model, Alchemy Park, Crabtree Manorway North, London Borough of Bexley (all depths metres below ground level (bgl))

Name	Easting	Northing	Elevation	Total depth	Top of Upper Alluvium	Top of Peat	Top of Lower Alluvium	Top of Shepperton Gravel	Top of Bedrock	Notes
AP-QBH1	549994	180223	0.9	8	2.37	2.41	5.00			SG not reached; Peat in LA
AP-QBH2	549950	180074	1.5	10	1.1	2.9	6.26			SG not reached
AP-QBH3	550028	180011	1.8	10	1.35	3.15	3.54			SG not reached
AP-BH1	550005	180365	1.6	15	1.6	4.4	6.5	10.3		UA organic rich/peaty 3.4-4.4; 50cm horizon of organic clay within peat (5.3-5.8); LA organic-rich & peaty throughout
AP-BH2	550074	180338	1.35	25	1.5	2.6	4.1	9.4	14.3	LA organic-rich and peaty throughout
AP-BH3	549989	180290	1.2	20	1.3	2.8	4.9	9.4	13.4	LA organic-rich and peaty throughout
AP-BH4	549980	180225	1	15		2.4	6.5	9.3	13.5	UA truncated; 50cm horizon of organic clay within peat (4.3-4.8); LA organic-rich and peaty throughout
AP-BH5	549947	180148	1.3	25	1.3	3.5	4.3	9.3	13.4	LA organic-rich and peaty throughout
AP-BH6	549928	180029	1.5	24	1.2	2.3	3.9	11.9	15.5	LA organic-rich and peaty throughout
AP-BH7	550028	180094	1.59	15	1.2	4.65	6.2	11.6		UA organic rich/peaty 4-4.65; LA organic-rich & peaty throughout; occasional gravel from 9.9m
AP-BH8	550110	180047	1.8	15	1.4	4.5	6.6	11.8		LA organic-rich & peaty throughout; occasional gravel from 9.9m
AP-BH9	550183	180067	1.4	25	0.7	3	5.4	10.8	14.5	UA organic rich/peaty 2.45-3; LA organic-rich & peaty throughout
AP-BH10	550161	179993	1.5	20	1.5		3	12.1		No peat; LA organic-rich/peaty throughout
AP-BH101	550133	180037	1.82	16.7	2.5	5.3	7	11		Peat within LA between 8.8 & 9.5m
AP-BH102	550079	180090	2.13	25	1.9	6.95	8.5	11	19	Peat within LA between 9.2 & 10.10m
AP-BH103	549979	180098	1.52	20	1.55	4.5	6.8	12	16.5	LA contains wood
AP-BH104	549968	180155	1.14	17	0.5	5.45	8.45	9.95	15	
AP-BH105	550032	180314	1.48	21.2	1.4	4	5.5	9.5	14.2	Peat within LA between 8.8 & 9.5m
AP-CPT01	550005	180126	1.15	13				9.8		Gravel surface only reliable height
AP-CPT02	549973	180077	1.5	13				12.7		Gravel surface only reliable height
AP-CPT03	549940	180029	1.3	13				11.6		Gravel surface only reliable height
AP-CPT04	550007	180057	1.6	13				11.9		Gravel surface only reliable height
AP-CPT05	550044	180101	1.4	13				9.8		Gravel surface only reliable height
AP-CPT06	550028	180013	1.8	13				13		Gravel surface only reliable height
AP-CPT07	550110	180089	1.7	13				11.1		Gravel surface only reliable height

Name	Easting	Northing	Elevation	Total depth	Top of Upper Alluvium	Top of Peat	Top of Lower Alluvium	Top of Shepperton Gravel	Top of Bedrock	Notes
AP-CPT08	550123	180048	1.7	13				11.2		Gravel surface only reliable height
AP-CPT09	550093	180004	1.7	13				12.6		Gravel surface only reliable height
AP-CPT10	550170	180077	1.7	13				10.5		Gravel surface only reliable height
AP-CPT11	550167	180031	1.6	13				12		Gravel surface only reliable height
AP-CPT12	550154	179990	1.66	13				12		Gravel surface only reliable height
AP-TP101	550128	180056	1.91	4	1.8	4				
AP-TP102	550173	180011	1.36	5	1	3.05	4.4			
AP-TP103	550080	180015	2.08	5	3.4					
AP-TP104	550058	180032	3.07	2						
AP-TP105	550030	180069	1.65	5	1.2					
AP-TP106	550054	180104	1.49	5	2.8					
AP-TP107	550020	180136	1.29	2.2	2					
AP-TP108	550009	180113	1.36	4.8		3.8				
AP-TP109	549964	180112	1.62	4.7	1.1	4.3				
AP-TP110	549992	180057	1.51	5	1.6	2.7	4.3			
AP-TP111	549966	180190	3.11	3.1						
AP-TP112	549978	180235	4.47	4.5						
AP-TP113	549983	180257	4.6	4.4						
AP-TP114	549995	180302	4.7	4.3						
AP-TP115	550007	180422	11.65	5						
AP-TP116	550028	180416	12.15	5						
AP-TP117	550059	180411	10.1	5						
AP-TP118	550029	180451	15.45	5						
AP-TP119	550044	180450	13.95	4						
AP-TP120	550072	180448	11.85	4.4						
AP-TP121	549972	180034	1.55	5.1		2.3	3.05			
AP-TP122	550083	180412	9.85	5						
AP-TP123	550017	180308	3.4	4	3.7					
AP-TP124	550103	180097	1.7	3.8	1.4					
AP-TP125	549941	180078	1.49	4	1.4	2.6				
AP-TP126	549972	180175	2.1	4	2.2					

5. RESULTS AND INTERPRETATION OF THE DEPOSIT MODELLING, ORGANIC MATTER DETERMINATIONS & RADIOCARBON DATING

The results of the geoarchaeological borehole descriptions are shown in Tables 2-4. The results of the deposit modelling are displayed in Figures 3 to 11; Figures 3 and 4 are 2-dimensional transects through the two sites from north to south, and west to east, respectively. Figures 5 to 11 are surface elevation and thickness models for each of the main stratigraphic units. Finally, the results of the organic-matter determinations and radiocarbon dating are shown in Figure 12 & Tables 5 and 6. The results of the deposit modelling indicate that the number and spread of the logs is sufficient to permit modelling with a high level across the entire area under investigation.

The full sequence of sediments recorded in the boreholes comprises:

Made Ground
Upper Alluvium – widely present
Peat – widely present
Lower Alluvium – widely present, frequently peaty
Gravel (Shepperton Gravel)

5.1 Shepperton Gravel

The Shepperton Gravel was present in all the boreholes that penetrated to the bottom of the Holocene sequence. It was deposited during the Late Glacial (15,000 to 10,000 years before present) and comprises the sands and gravels of a high-energy braided river system which, while it was active would have been characterised by longitudinal gravel bars and intervening low-water channels in which finer-grained sediments might have been deposited. Such a relief pattern would have been present on the valley floor at the beginning of the Holocene when a lower-energy fluvial regime was being established.

The surface of the Shepperton Gravel across the area (Figures 3-5) display significant relief between -7.5 (AP-BH6) and -11.2m OD (AP-CPT02; AP-CPT06). However, the results suggest a surface that is relatively even across much of the former NuFarm site, and northern part of the Alchemy Park site, ranging between *ca*. -7.5 and -9.0m OD. It is on the southern part of the Alchemy Park site that the gravel surface drops to below -10.5m OD (e.g. AP-BH103; AP-CPT09; AP-BH10) and reaches -11.2m in AP-CPT02 and AP-CPT06 (Figure 2). This is a pattern suggestive of a trough (likely palaeochannel) in this area of the site. The precise orientation and dimensions of this channel are unclear, but it appears to be aligned approximately west-east or northwest-southeast, and measured at least 100m in width and up to 2.2m in depth.

5.2 Lower Alluvium

The Lower Alluvium rests directly on the Shepperton Gravel and was recorded in all records both within and beyond the confines of the channel (Figures 3, 4 and 6). The deposits of the Lower Alluvium are described as a predominantly silty or clayey unit tending to become increasingly sandy downward in most sequences. The Lower Alluvium frequently contains detrital wood or plant remains, and in many cases is described as organic, sometimes including peat lenses and occasional Mollusca remains. The variable content of the Lower Alluvium is reflected in the organic-matter content values which tend to range between 10% and 60% (Table 5; Figure 12). The surface of the Lower Alluvium (Figure 7) is highly variable, generally lying at between *ca*. -3m and -1m. The thicker occurrences of the Lower Alluvium are present where the surface of the Shepperton Gravel lies at a lower level.

The sediments of the Lower Alluvium are indicative of deposition during the Early to Mid-Holocene, when the main course of the Thames was probably confined to a single meandering channel. This is confirmed by the radiocarbon date on a peat lens within the Lower Alluvium of AP-QBH1, which provided an age of 7410-7170 cal BP (late Mesolithic age). During this period, the surface of the Shepperton Gravel was progressively buried beneath the sandy and silty flood deposits of the river. The richly-organic nature of the Lower Alluvium suggests that this was a period during which the valley floor was occupied by a network of actively shifting channels, with a drainage pattern on the floodplain that was still largely determined by the relief on the surface of the underlying Shepperton Gravel.

5.3 Peat

Overlying the Lower Alluvium across the whole site is a bed of peat, varying in thickness from 0.4m (AP-QBH3) to 5.6m (AP-BH6), but generally between 1.0m and 4.0m thick (Figure 8). The thickest horizons of peat (>2.5m) all occur beyond the confines of the former channel on the NuFarm and northern part of the Alchemy Park site; within the channel, the peat rarely exceeds 2.5m in thickness (AP-QBH2 being the only case – 3.4m of peat recorded). The surface of the peat (Figure 7) is fairly level between -1.0m and -3.0m OD; only in a couple of cases is it recorded at a lower elevation (>-4m OD in AP-BH102, AP-BH104 and NuFarm-QBH4).

The widespread occurrence of this peat horizon indicates a general transition to a more stable valley floor, possibly associated with falling relative sea level and slight incision of the main channel of the Thames, encouraging the development of semi-terrestrial conditions across most of the floodplain. The peat is composed of wood and herbaceous remains indicating that during its accumulation the floodplain supported the growth of sedge fen/reed swamp and woodland communities. Radiocarbon dating carried out on the base of the peat in both AP-QBH1 & AP-QBH2 indicate that accumulation commenced from 6600-6410 and 6300 to 6200 cal BP respectively (Figure 12; Table 6). No radiocarbon dates were attempted on the top of the peat, but on the NuFarm and northern part of the Alchemy Park site, the thicker peat horizons suggest accumulation may have continued for a period of 3000 to 4000 years (on the basis that 1m of peat is approximately equal to 1000 years of accumulation). The radiocarbon dating program has also demonstrated that peat formation commenced at least marginally later within the confines of the channel, and probably for a shorter period of time. This is because of the higher surface elevation of the Lower Alluvium recorded here (Figure 6), indicating that the channel was still active at the time when peat began to accumulate beyond its margins. The thinner nature of the peat also suggests it accumulated for a much shorter period of time.

Finally, the organic matter content of the peat is highly variable (>20% to 80%; Figure 12, Table 5). This suggests that the peat surface was not consistently dry and 'stable' throughout its accumulation. Low organic matter values indicate the influx of mineral-rich material, most likely as a consequence of flooding. There is also the suggestion that there may be a synchronous event with low values recorded in each borehole at approximately -3.20m OD; this could only be confirmed by further radiocarbon dating.

5.4 Upper Alluvium

The uppermost unit in the Holocene alluvial sequence is the Upper Alluvium, the deposits of which comprise largely sterile clays and silty clays. The Upper Alluvium generally ranges between 1 and 3m in thickness, but occasional reach up to 5m (e.g. AP-BH102 and AP-BH105). The deposition of the Upper Alluvium had the effect of infilling the remaining inequalities in the relief of the floodplain, so that the surface of the Upper Alluvium (Figure 9) is remarkably level between +0.5m and -0.1m OD.

The Upper Alluvium is typical of the mineral-rich sediments that are present as the uppermost element of the Holocene sequence beneath most floodplains in southern and south-east England. It is generally considered to reflect increased sediment loads resulting from intensification of agricultural land use from the later prehistoric period onward, combined with the effects of rising sea level.

5.5 Made Ground

Between 1 and 5m of Made Ground caps the Holocene alluvial sequence (Figure 11).

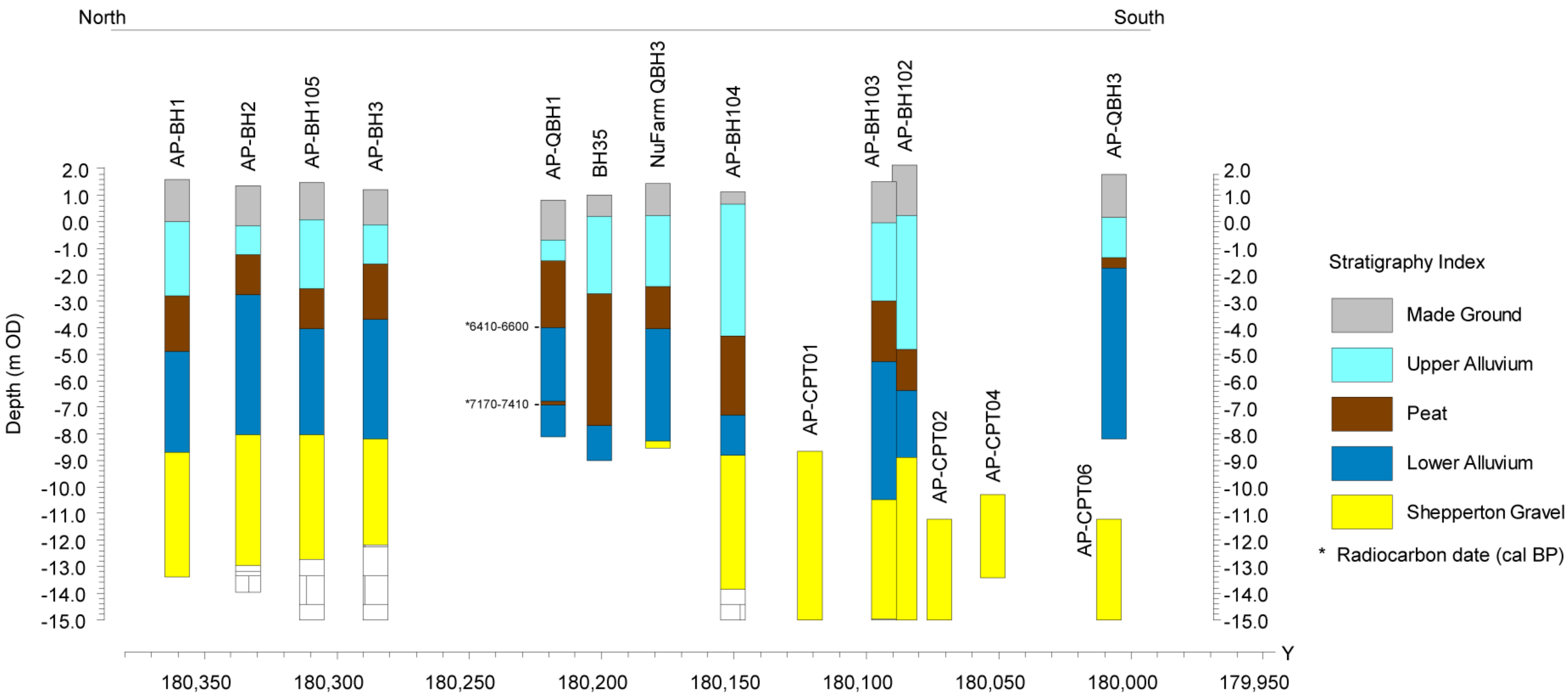

Figure 3: North-South transect of selected boreholes across Alchemy Park, Crabtree Manorway North, London Borough of Bexley, inclusive of radiocarbon dates.

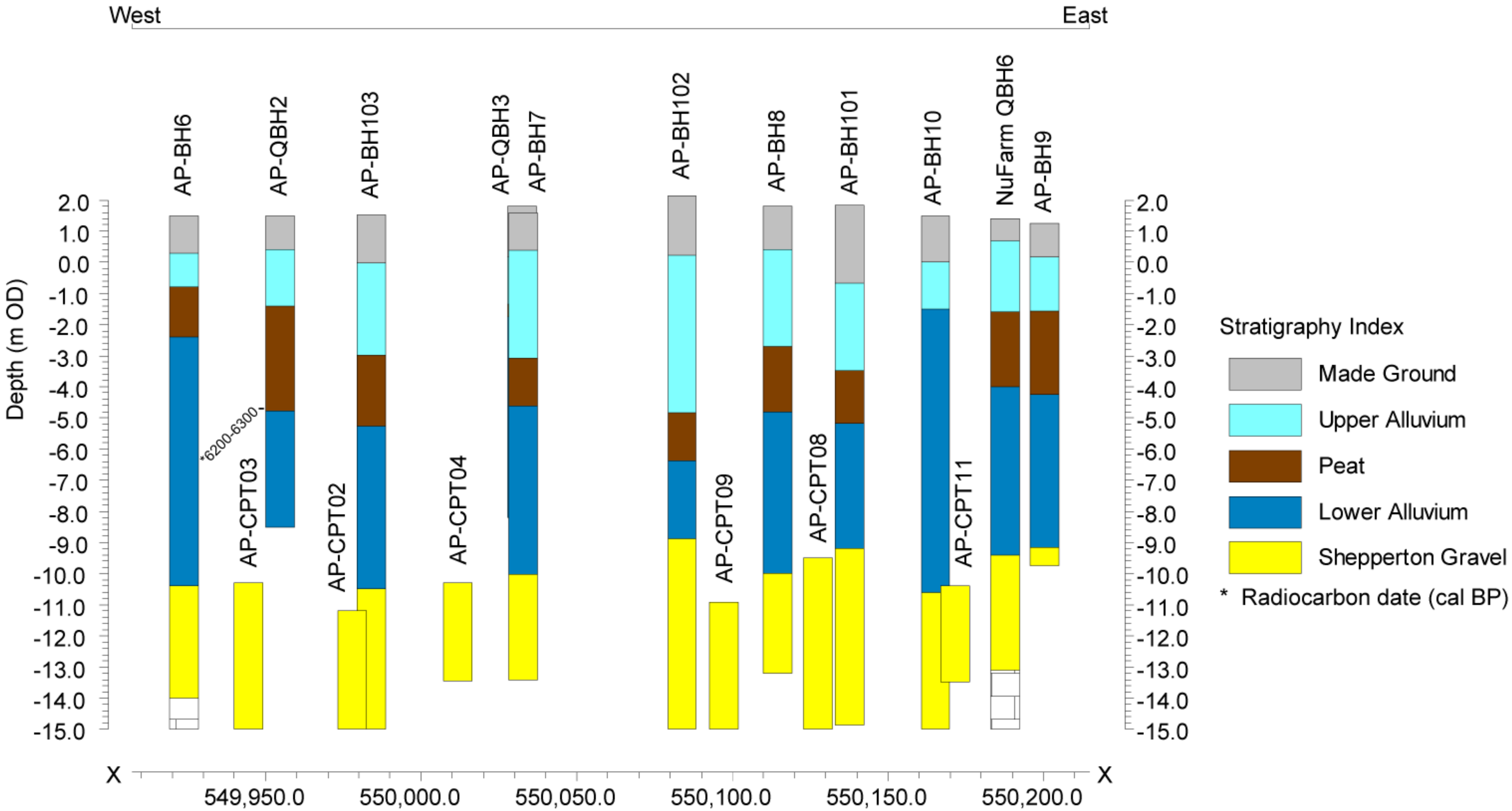

Figure 4: West-East transect of selected boreholes along the potential palaeochannel on the southern half of Alchemy Park, Crabtree Manorway North, London Borough of Bexley, inclusive of radiocarbon dates.

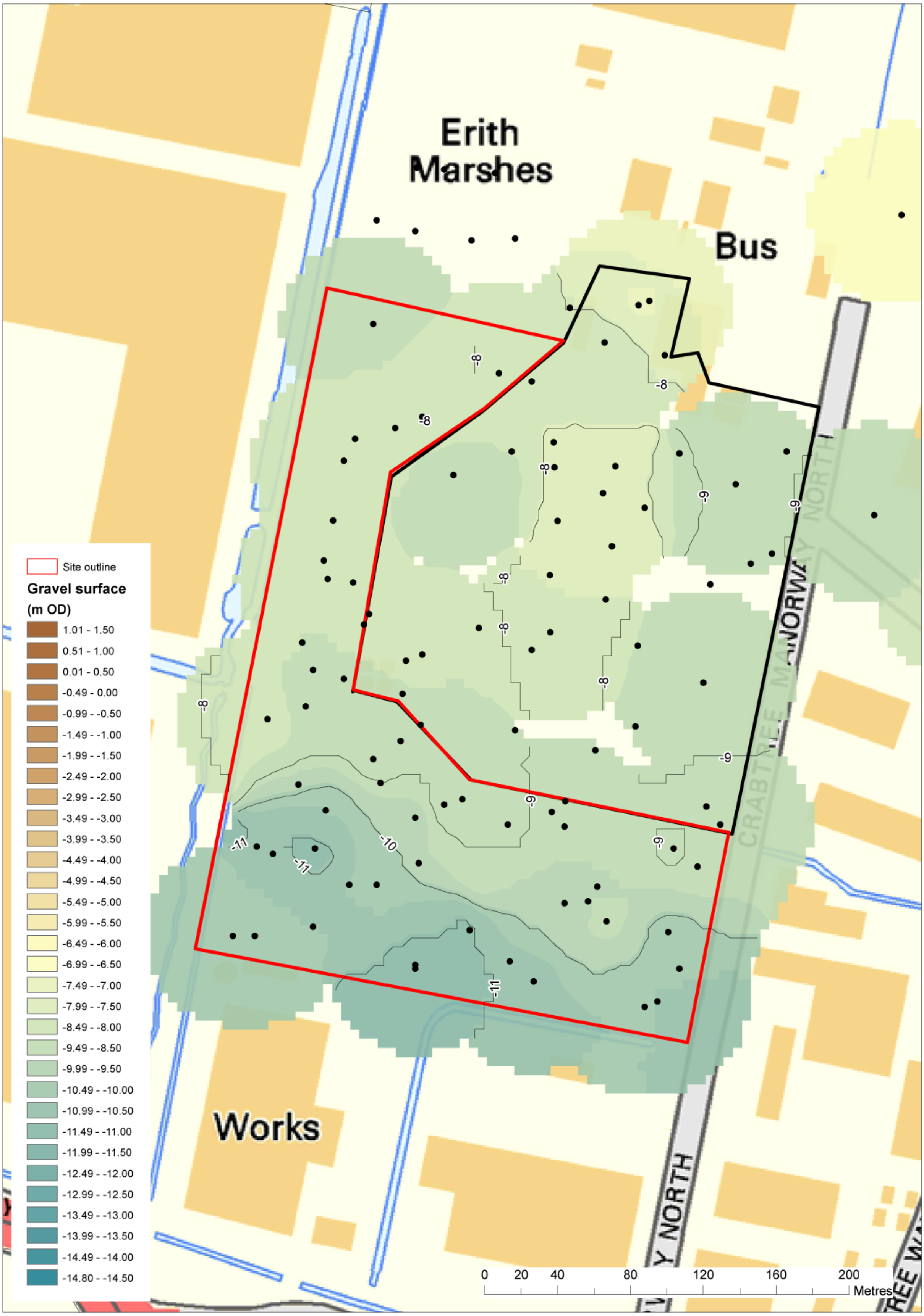

Figure 5: Top of the Shepperton Gravel (m OD) (site outline in red)

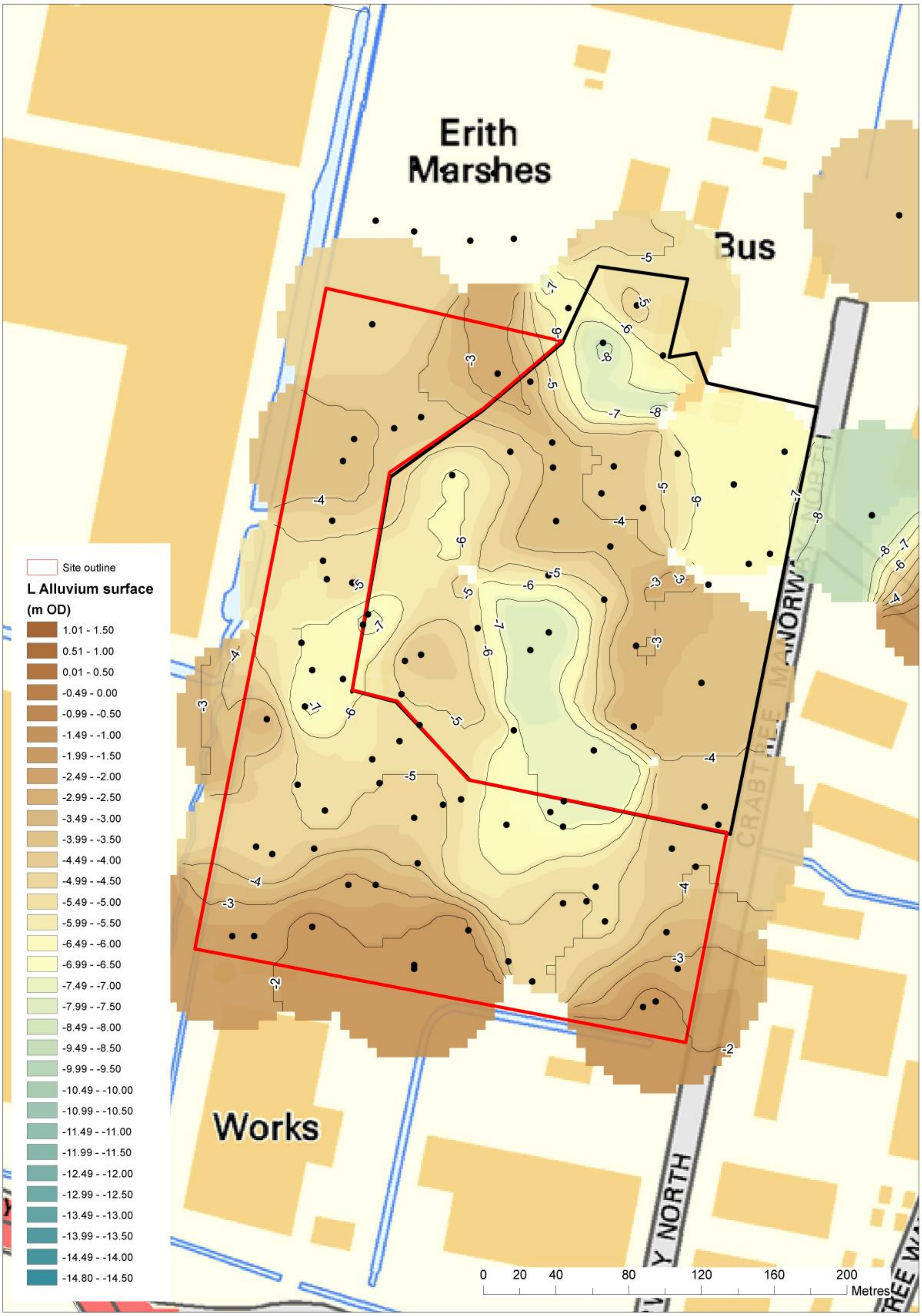

Figure 6: Top of the Lower Alluvium (m OD) (site outline in red)

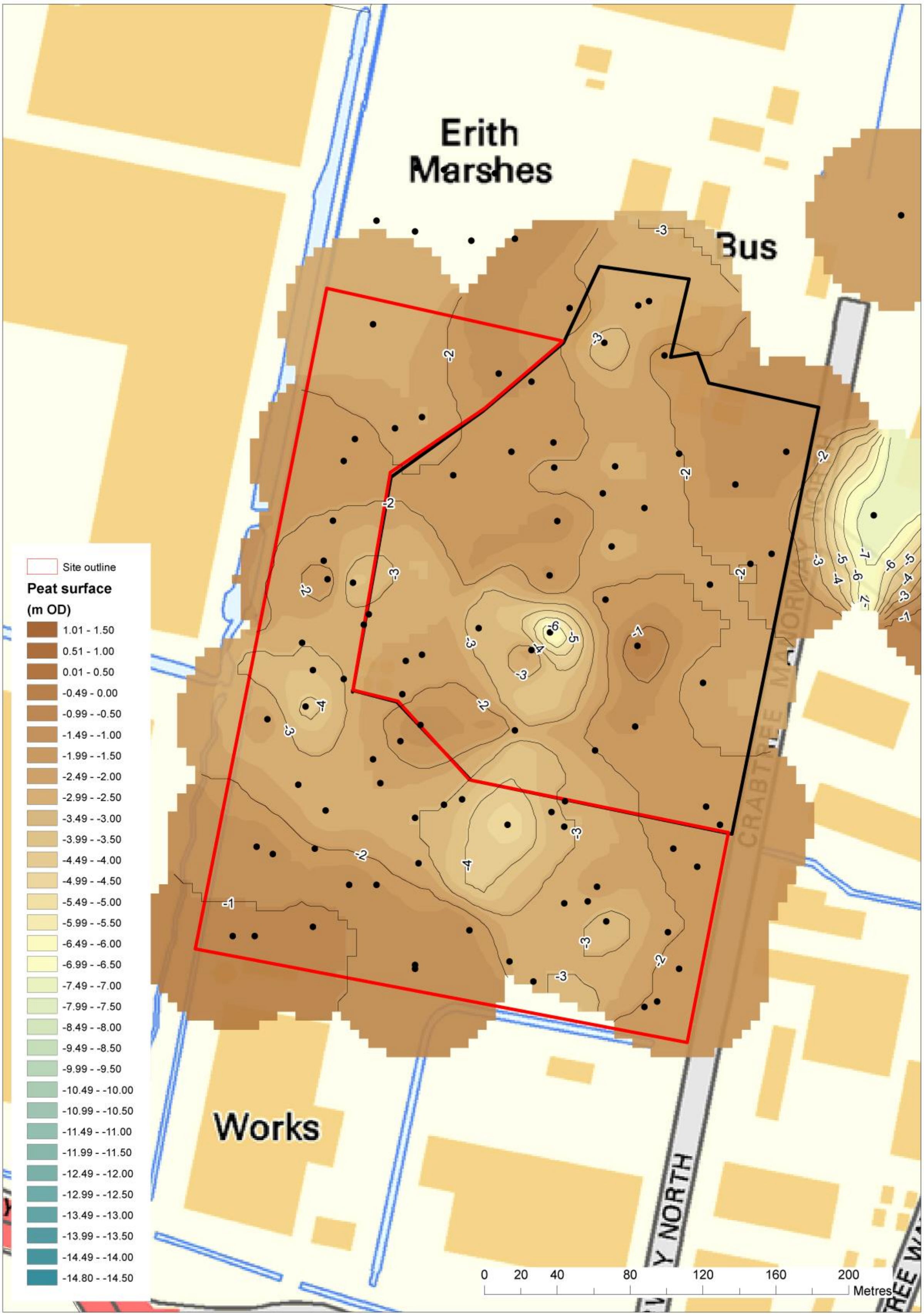

Figure 7: Top of Peat (m OD) (site outline in red)

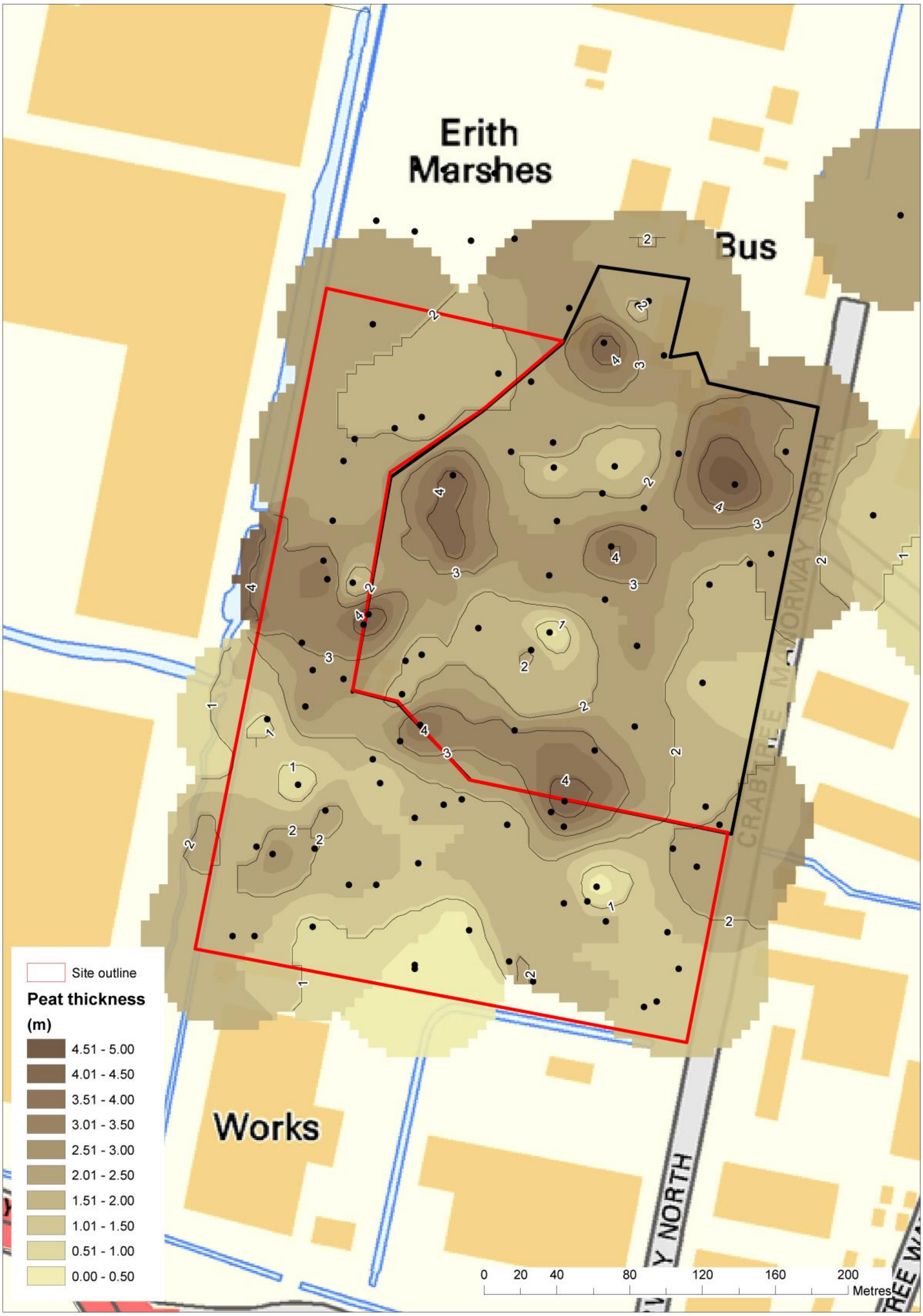

Figure 8: Thickness of Peat (m) (site outline in red)

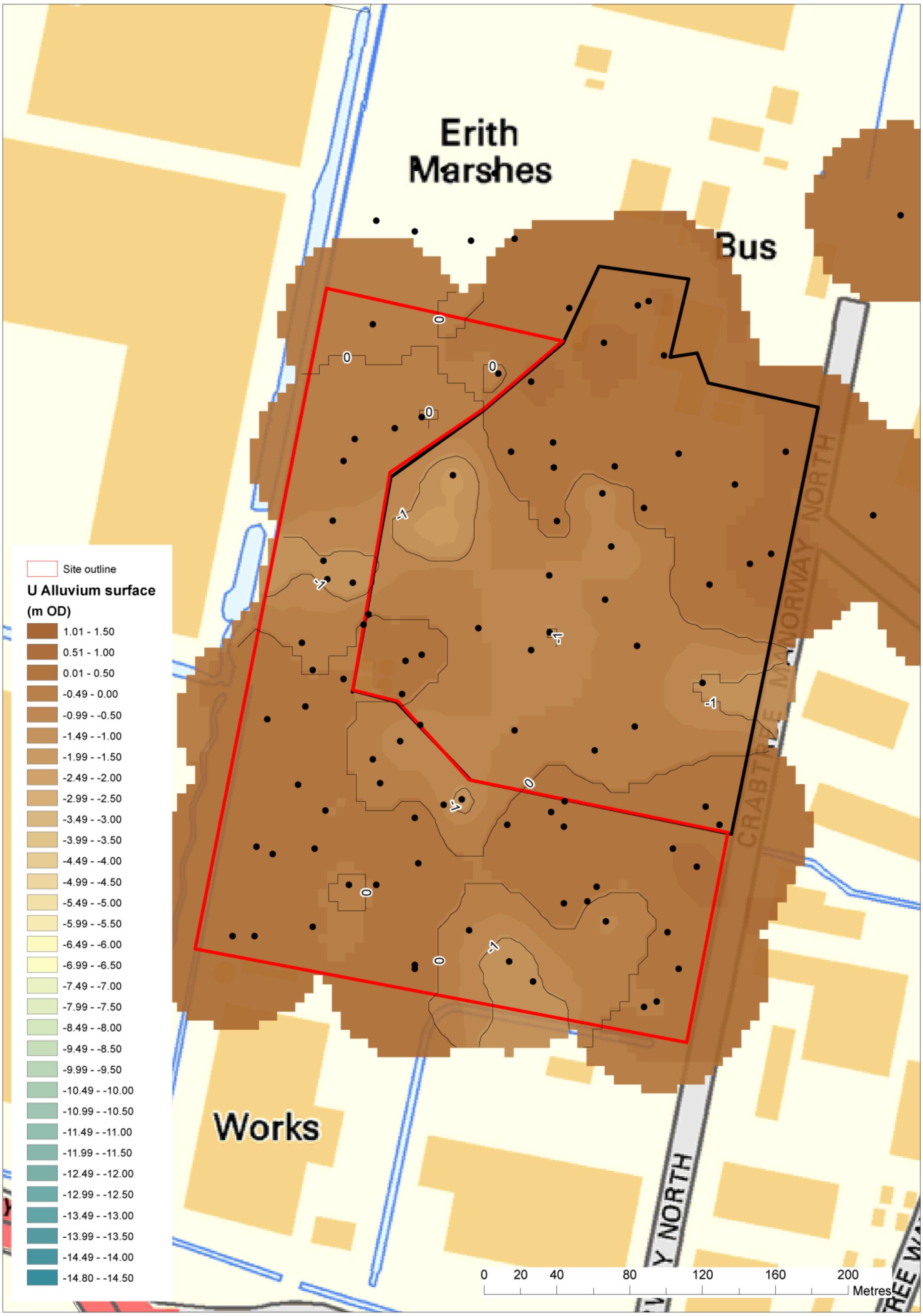

Figure 9: Top of the Upper Alluvium (m OD) (site outline in red)

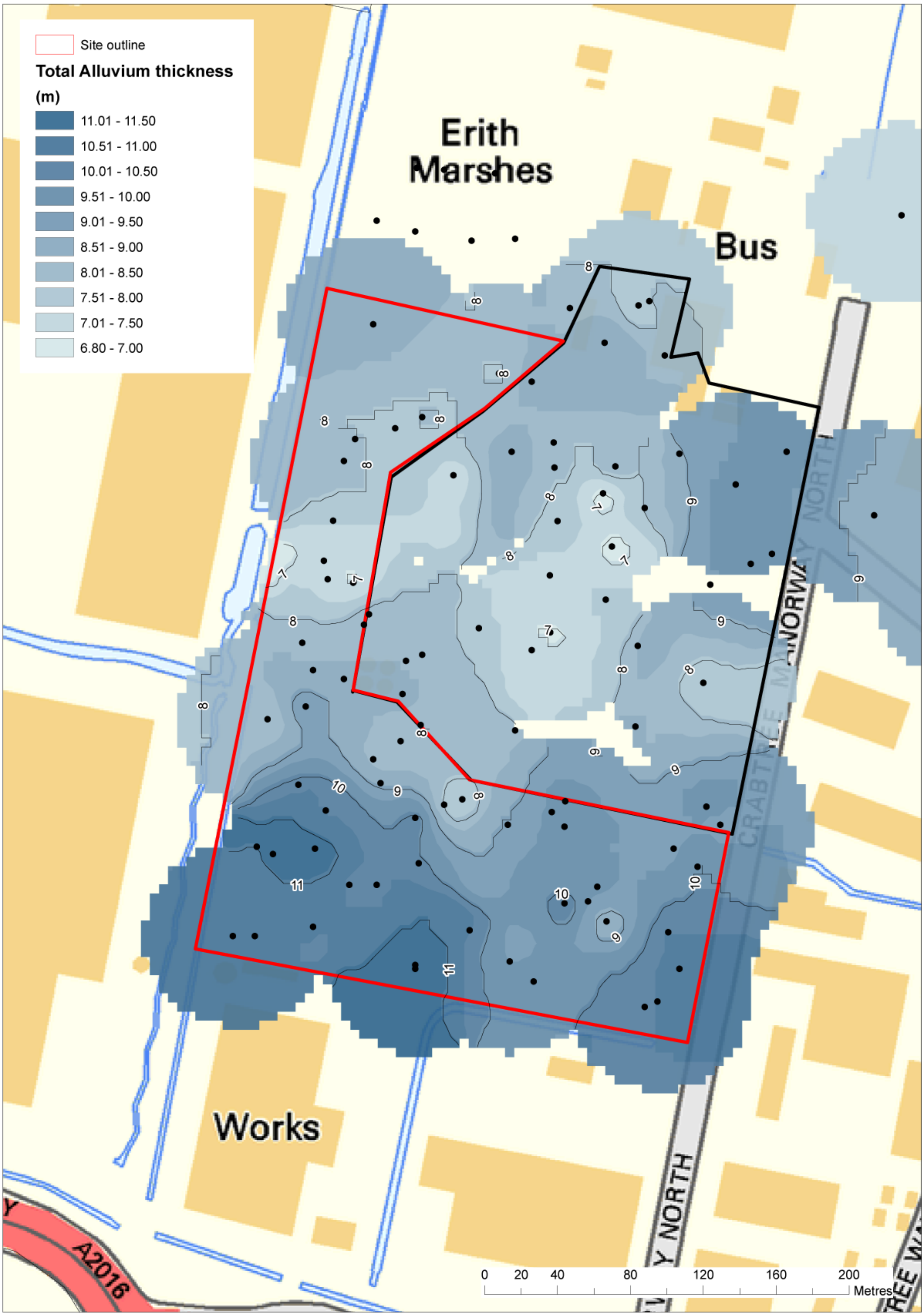

Figure 10: Thickness of Total Alluvium (m) (site outline in red)

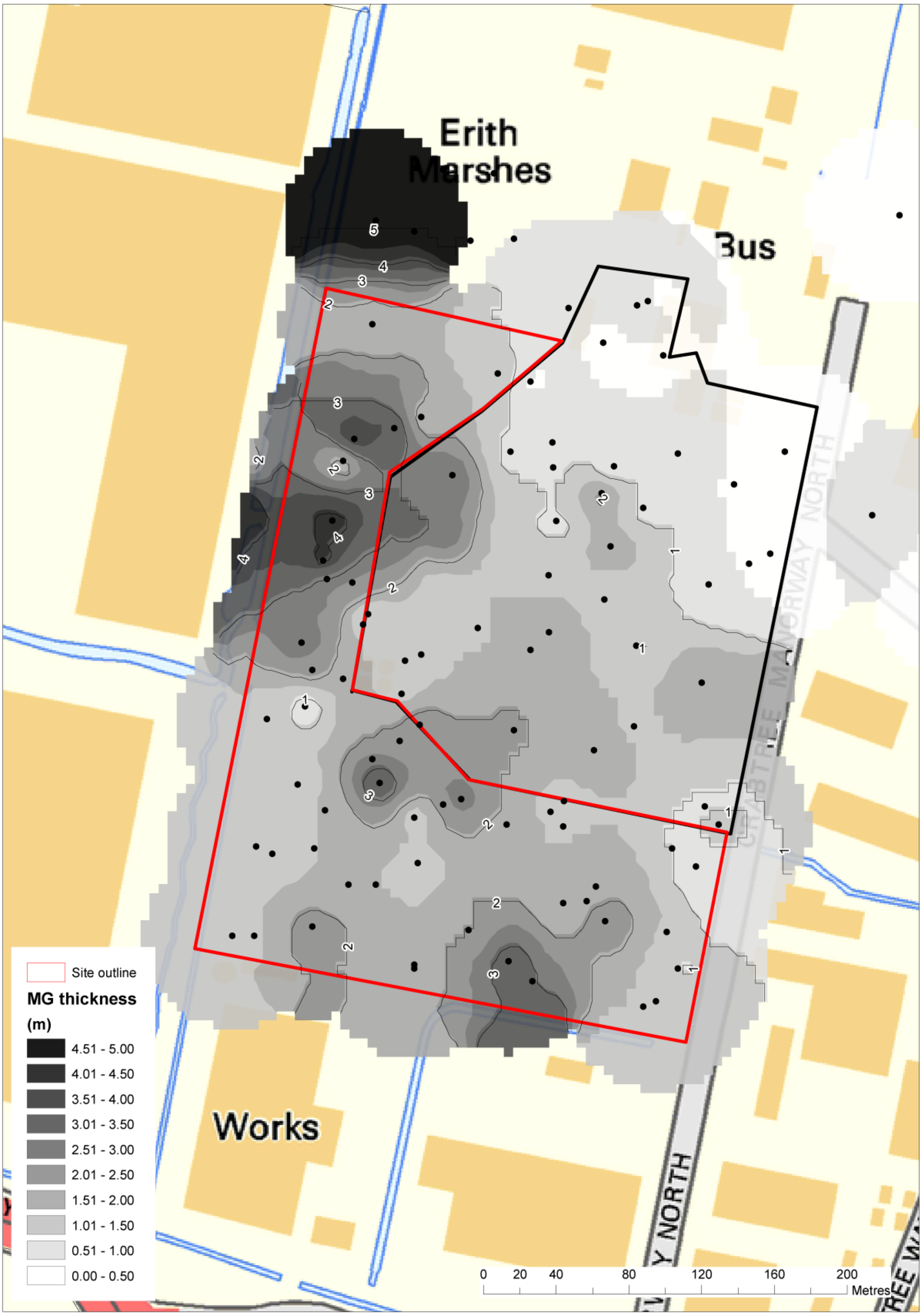

Figure 11: Thickness of Made Ground (m) (site outline in red)

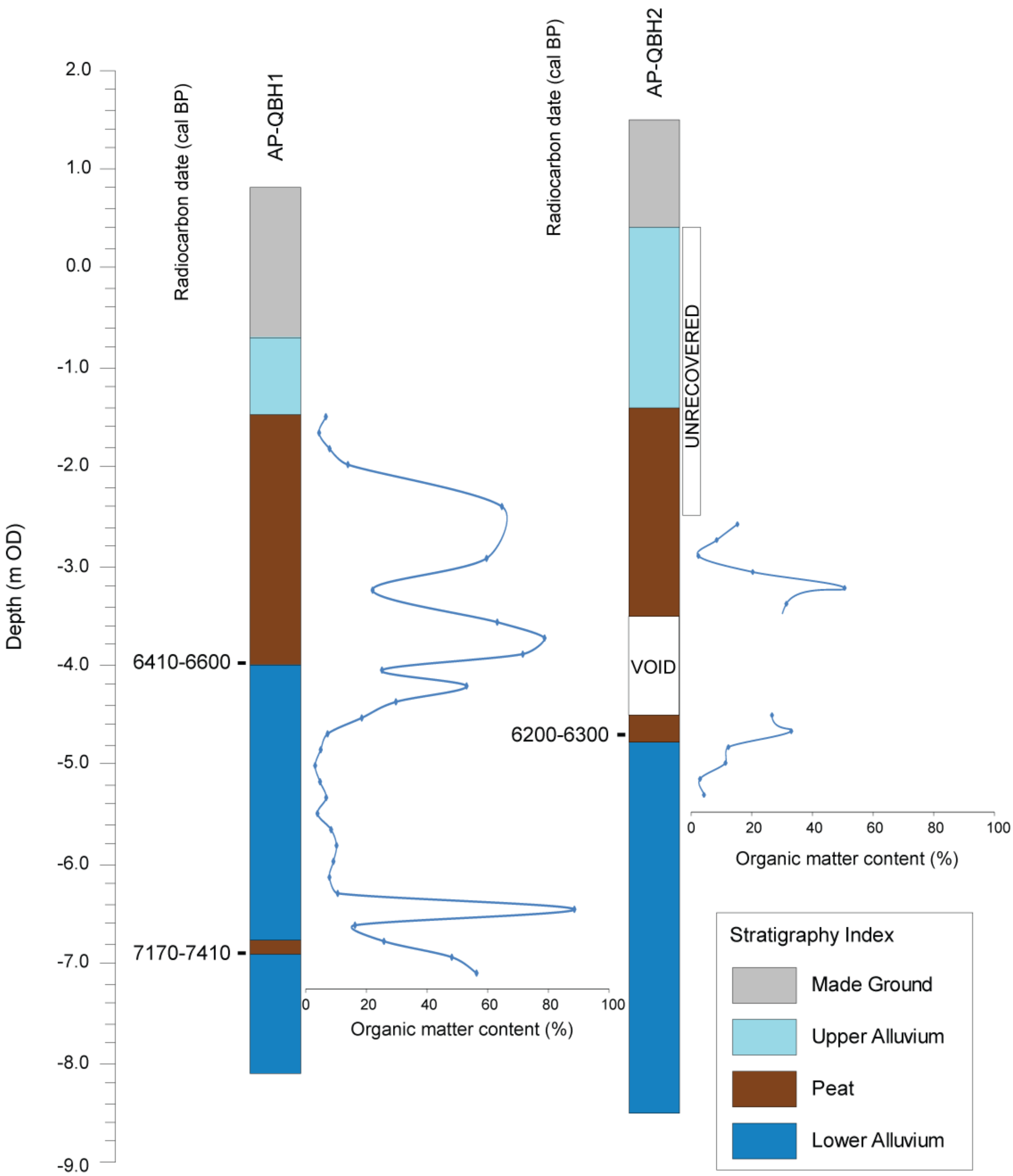

Figure 12: Detailed lithostratigraphy of AP-QBH1 & AP-QBH2, Alchemy Park, Crabtree Manorway North, London Borough of Bexley

Table 2: Lithostratigraphic description of borehole AP-QBH1, Alchemy Park, Crabtree Manorway North, London Borough of Bexley

Depth (m OD)	Depth (m bgs)	Description	Stratigraphic group
0.90 to -0.70	0 to 1.60	Made ground	MADE GROUND
-0.70 to -1.10	1.60 to 2.00	Gley 2 6/1; As3, Ag1; Bluish grey silty clay	UPPER ALLUVIUM
-1.10 to -1.51	2.00 to 2.41	10YR 4/1; As3, Ag1; Dark grey silty clay with traces of organic matter; sharp contact into:	
-1.51 to -2.01	2.41 to 2.91	10YR 2/1; Sh2, Tl^{1}1, Ag1; Humo 2-3; Black moderately humified silty wood peat; diffuse contact into:	PEAT
-2.01 to -2.81	2.91 to 3.71	UNRECOVERED	
-2.81 to -2.95	3.71 to 3.85	10YR 3/2; Ag2, Sh1, Tl^{1}1; Humo 2; Very dark greyish brown moderately humified silty wood peat; sharp contact into:	
-2.95 to -3.86	3.85 to 4.76	10YR 2/1; Sh2, Tl^{1}1, Ag1; Humo 2-3; Black moderately humified silty wood peat; diffuse contact into:	
-3.86 to -3.96	4.76 to 4.86	10YR 4/1; Ag3, Sh1; Dark grey organic-rich silt with traces of detrital plant remains; sharp contact into:	
-3.96 to -4.10	4.86 to 5.00	10YR 3/2; Sh2, Tl^{2}1, Th^{2}1; Humo 2; Dark grey moderately humified wood and herbaceous peat;	
-4.10 to -5.10	5.00 to 6.00	Gley 1 4/10Y; Ag2, As2; Dark greenish grey silty clay with traces of detrital plant remains and sand; diffuse contact into:	LOWER ALLUVIUM
-5.10 to -6.78	6.00 to 7.68	Gley 1 4/10Y; Ag2, As1, Dl1; Dark greenish grey silty clay with detrital wood and traces of Mollusca; large fragment of wood recorded between 7.25 and 7.36m bgl; diffuse contact into:	
-6.78 to -6.91	7.68 to 7.81	Gley 1 5/10Y; Ag2, Sh1, Dh1; Greenish grey organic-rich silt with detrital plant remains; sharp contact into:	
-6.91 to -7.10	7.81 to 8.00	10YR 2/1; Ag2, Sh2; Black organic-rich silt with traces of wood and herbaceous peat.	

Table 3: Lithostratigraphic description of borehole AP-QBH2, Alchemy Park, Crabtree Manorway North, London Borough of Bexley

Depth (m OD)	Depth (m bgs)	Description	Stratigraphic group
1.50 to 0.40	0 to 1.10	Made Ground	MADE GROUND
0.40 to -0.50	1.10 to 2.00	Gley 2 6/1; As3, Ag1; Bluish grey silty clay; diffuse contact into:	UPPER ALLUVIUM
-0.50 to -0.90	2.00 to 2.40	10YR 5/1; As3, Ag1; Grey silty clay; sharp contact into:	
-0.90 to -1.40	2.40 to 2.90	10YR 5/2; Ag2, As1, Sh1; Greyish brown organic-rich clayey silt; unknown contact into:	
-1.40 to -2.50	2.90 to 4.00	2.5YR 2.5/1; Sh3, Th^{2}1; Humo 2-3; Reddish black well humified herbaceous peat; UNRECOVERED	PEAT
-2.50 to -3.09	4.00 to 4.59	10YR 4/1; Ag2, As1, Ga1; Dark grey sandy clayey silt with detrital wood inclusions; diffuse contact into:	
-3.09 to -3.50	4.59 to 5.00	10YR 3/1; Sh2, Ag1, Tl^{2}1; Humo 2; very dark grey silty moderately humified wood peat, with silty peat between 4.85 and 5.00m bgl;	

Depth (m OD)	Depth (m bgs)	Description	Stratigraphic group
-3.50 to -4.50	5.00 to 6.00	UNRECOVERED	
-4.50 to -4.76	6.00 to 6.26	10YR 3/1; Sh2, Ag1, Tl[2]1; Humo 2; very dark grey silty moderately humified wood peat, with silty peat between 4.85 and 5.00m bgl;	
-4.76 to -5.01	6.26 to 6.51	Gley 1 4/10Y; Ag3, Dl1; Dark greenish grey silt and detrital wood with traces of clay; diffuse contact into:	LOWER ALLUVIUM
-5.01 to -5.31	6.51 to 6.81	Gley 1 4/10Y; Ag3, As1; Dark greenish grey clayey silt with traces of sand; finely bedded; diffuse contact into:	
-5.31 to -6.50	6.81 to 8.00	Gley 1 3/10Y; Ga2, Ag2; Very dark greenish grey silty sand with traces of detrital plant remains; finely bedded; diffuse contact into:	
-6.50 to -8.50	8.00 to 10.00	Gley 1 4/10Y; Ga3, Ag1; Dark greenish grey silty sand with traces of detrital plant remains; finely bedded	

Table 4: Lithostratigraphic description of borehole AP-QBH3, Alchemy Park, Crabtree Manorway North, London Borough of Bexley

Depth (m OD)	Depth (m bgs)	Description	Stratigraphic group
1.80 to 0.45	0 to 1.35	Made Ground	MADE GROUND
0.45 to 0.15	1.35 to 1.65	10YR 5/3; As3, Ag1; Brown silty clay with iron staining; sharp contact into:	UPPER ALLUVIUM
0.15 to -0.20	1.65 to 2.00	Gley 2 6/1; As3, Ag1; Bluish grey silty clay	
-0.20 to -1.20	2.00 to 3.00	UNRECOVERED	
-1.20 to -1.74	3.00 to 3.54	10YR 2/1 Sh3, Th[2]2; Humo 2; Black well-humified herbaceous peat with traces of wood peat; sharp contact into:	PEAT
-1.74 to -2.20	3.54 to 4.00	Gley1 4/10Y; Ag3, As1; Dark greenish grey clayey silt with traces of detrital plant remains; diffuse contact into:	LOWER ALLUVIUM
-2.20 to -3.60	4.00 to 5.40	Gley 1 4/5GY; Ga2, Ag1, Dl1; Dark greenish grey silty sand and detrital wood with inclusions of detrital plant remains; sharp contact into:	
-3.60 to -5.54	5.40 to 7.34	Gley 1 3/10Y; Ga3, Ag1; Very dark greenish grey silty sand; diffuse contact into:	
-5.54 to -6.20	7.34 to 8.00	Gley1 4/10Y; Ga3. Dl1; sand with detrital wood and traces of silt; diffuse contact into:	
-6.20 to -7.20	8.00 to 9.00	UNRECOVERED	
-7.20 to -8.20	9.00 to 10.00	Gley1 4/10Y; Ga4; Dark greenish grey sand with traces of silt and detrital plant remains	

Table 5: Results of the organic matter determinations, Alchemy Park, Crabtree Manorway North, London Borough of Bexley

AP-QBH1		
Depth (m OD)		Organic matter content (%)
From	To	
-1.51	-1.52	7.40
-1.67	-1.68	5.17
-1.83	-1.84	8.61
-1.99	-2.00	14.59
-2.41	-2.42	65.01
-2.93	-2.94	59.97
-3.25	-3.26	22.68
-3.57	-3.58	63.48
-3.73	-3.74	78.95
-3.89	-3.90	71.82
-4.05	-4.06	25.75
-4.21	-4.22	53.44
-4.37	-4.38	30.30
-4.53	-4.54	19.14
-4.69	-4.70	7.97
-4.85	-4.86	5.70
-5.01	-5.02	3.91
-5.17	-5.18	5.47
-5.33	-5.34	7.48
-5.49	-5.50	4.66
-5.65	-5.66	9.11
-5.81	-5.82	10.87
-5.97	-5.98	9.87
-6.13	-6.14	8.55
-6.29	-6.30	11.27
-6.45	-6.46	88.73
-6.61	-6.62	16.91
-6.77	-6.78	26.40
-6.93	-6.94	48.62
-7.09	-7.10	56.70

AP-QBH2		
Depth (m OD)		Organic matter content (%)
From	To	
-2.58	-2.59	15.27
-2.74	-2.75	8.42
-2.90	-2.91	2.42
-3.06	-3.07	20.31
-3.22	-3.23	50.61
-3.38	-3.39	31.42
-4.50	-4.51	26.65
-4.66	-4.67	33.01
-4.82	-4.83	12.27
-4.98	-4.99	11.35
-5.14	-5.15	2.92
-5.30	-5.31	4.24

Table 6: Results of the radiocarbon dating, Alchemy Park, Crabtree Manorway North, London Borough of Bexley

Laboratory code / Method	Material and location	Depth (m OD)	Uncalibrated radiocarbon years before present (yr BP)	Calibrated age BC/AD (BP) (2-sigma, 95.4% probability)	**δ13C (‰)**
Beta-443558 AMS	QBH1 – base of peat; twig wood	-4.04	5700 ± 30 BP	4650-4450 6600-6400	-26.7
Beta-443559 AMS	QBH1 – peat lense in lower alluvium; twig wood	-4.71	6340 ± 30 BP	5460-5220 7410-7170	-27.0
Beta-443560 AMS	QBH2 – base of peat; twig wood	-7.05	5440 ± 30 BP	6300-6190 4350-4240	-26.3

6. RESULTS AND INTERPRETATION OF THE POLLEN ASSESSMENT

The pollen investigations focused on the peat sediments only. Whilst this did not permit investigation of the pollen through the complete sedimentary sequence, it did avoid a number of taphonomic issues that complicate the interpretation of palynological data from the mineral-rich sediments of low-energy fluvial and estuarine environments (e.g. Moore *et al.*, 1991; Scaife & Burrin, 1992; Cushing, 1967; Waller, 1993; Campbell, 1999).

The results of the assessment indicate a moderate to high concentration of pollen in the majority of samples from AP-QBH1 and AP-QBH2 (Tables 7 & 8). A similar assemblage is recorded in both sequences, characterised by high values of tree and shrub pollen. Alder (*Alnus*) and oak (*Quercus*) dominate with hazel (*Corylus* type), lime (*Tilia*), elm (*Ulmus*), ash (*Fraxinus*) and pine (*Pinus*). Herbs and aquatics were most commonly recorded in QBH2 and the top of the sequence in QBH1, where they are recorded in moderate to high concentrations, dominated by sedges (Cyperaceae), grasses (Poaceae), dandelions (Lactuceae), goosefoot (*Chenopodium* type), daisies (Asteraceae), pinks (Caryophyllaceae); cereals (*Cereale* type), black knapweed (*Centaurea nigra*) and plantain (*Plantago* type) were also recorded. Spores are dominated by ferns (*Filicales*), polypody (*Polypodium* vulgare) and occasional bracken (*Pteridium aquilinum*). Microcharcoal is generally recorded in negligible concentrations, but is higher at the top of AP-QBH1.

The results of the assessment indicate a floodplain environment dominated by wetland woodland comprising alder and a ground flora of sedges, grasses, aquatics and ferns. Towards the top of the sequence the decline of alder and increase of sedges and grasses is strongly suggestive of a transition towards sedge fen / reed swamp conditions in response to wetter conditions. The occurrence of saltmarsh taxa is also possible due to the presence of Chenopodiaceae pollen; Chenopodiaceae can either represent the growth of plants from saltmarsh (e.g. *Sueada maritima* – annual seablite) or disturbed ground (e.g. *Chenopodium album* – fat hen) environments. Finally, there are very tentative suggestions from the pollen assemblage that AP-QBH2 contains more herbaceous taxa indicative of damper conditions than that recorded in AP-QBH1. If so, this might reflect the position of AP-QBH2 within the former channel, and AP-QBH1 further away.

Oak, hazel and elm may have occupied the wetland woodland, but were equally likely to have formed mixed deciduous woodland on the dryland with lime. Towards the top of the sequence in QBH1, the contemporaneous decline of the woodland on the dryland is indicated, and reflected by an expansion of herbaceous taxa. The presence of cereal pollen, black knapweed and plantain suggests that this decline might be due to Bronze Age clearance for settlement and/or agricultural purposes; an interpretation enhanced by the raised values of microcharcoal.

Table 7: Results of the pollen assessment from AP-QBH1, Alchemy Park, Crabtree Manorway North, London Borough of Bexley

	Depth (m OD)	-1.68	-2.00	-2.98	-3.14	-3.30	-3.46	-3.78	-3.94	-4.08	-6.94	-7.10
Latin name	Common name											
Trees												
Alnus	alder	1	6	7	27	10	4	26	2	6	10	14
Quercus	oak		19	2	19	8	2	10	3	2	4	2
Pinus	pine	1	8				1			4	2	1
Ulmus	elm		1			2	1	1			3	
Tilia	lime		1		3	3		4	1			1
Betula	birch										1	
Fraxinus	ash		1			1				1		
Shrubs												
Calluna vulgaris	heather											
Corylus type	e.g. hazel		8		2	3		2	2	3	5	6
Hedera	ivy									1		
Prunus type	blackthorn		1									
Herbs												
Cyperaceae	sedge family	1	12	1	17					2		
Poaceae	grass family	7	28							2	1	
Cereale type	e.g. barley	5										
Asteraceae	daisy family	1								1		
Cirsium type	thistle		1									
Centaurea nigra	black knapweed		1									
Artemisia type	mugwort		1									
Lactuceae	dandelion family	10	1									
Plantago type	plantain		2									
Chenopodium type	goosefoot family	3	6	1			1			1		
Caryophyllaceae	pink family	3	1									
Rumex acetosa/acetosella	sorrel				1							
Rumex obtusifolius	dock		1									
Anenome nemorosa	wood anemone		2									
Polygonum persicaria	lady's thumb	1										
Mentha type	mint		1									
Galium type	bedstraw		1									
Aquatics												
Sparganium type	bur-reed					1						
Spores												
Pteridium aquilinum	bracken		4									
Filicales	ferns	1	2	3	5	8	3	5		1		

	Depth (m OD)	-1.68	-2.00	-2.98	-3.14	-3.30	-3.46	-3.78	-3.94	-4.08	-6.94	-7.10
Latin name	Common name											
Polypodium vulgare	polypody		1			1				1		
Unidentifiable			8		1							
Total Land Pollen (grains counted)		33	103	11	69	26	9	43	8	23	31	24
Concentration*		5	5	2	5	5	2	5	2	4	5	4
Preservation**		3	3-4	4	4	3-4	3	4	4	4	4	4
Microcharcoal Concentration***		4	1	1	0	1	0	0	0	0	1	0
Suitable for further analysis		YES	YES	YES	YES	YES	NO	YES	NO	YES	YES	YES

*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 = absent; 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*

Table 8: Results of the pollen assessment from AP-QBH2, Alchemy Park, Crabtree Manorway North, London Borough of Bexley

	Depth (m OD)	-2.58	-2.74	-2.90	-3.06	-3.22	-3.38	-4.50	-4.66
Latin name	Common name								
Trees									
Alnus	alder	17	5	10	43	10	43	11	13
Quercus	oak	23	7	15	53	8	25	17	21
Pinus	pine	9	2		1		3	2	
Ulmus	elm	2	1		5	2	3	3	2
Tilia	lime	1		2	4	3	2	2	2
Taxus	yew				1				
Betula	birch	1		1					
Fraxinus	ash				3	1	2		
Shrubs									
Calluna vulgaris	heather								
Corylus type	e.g. hazel	6	9	3	12	1	13	5	15
Salix	willow	1							
Hedera	ivy				2		1		
Ilex	holly		1						
cf *Sambucas nigra*	elder								1
Herbs									
Cyperaceae	sedge family	10	4		1		3		1
Poaceae	grass family	3	2	2	2				
Asteraceae	daisy family	1	1	1	1				
Artemisia type	mugwort	1					1		
Lactuceae	dandelion family				1				
Plantago lanceolata	ribwort plantain	1							
Chenopodium type	goosefoot family		4		3		3	1	2
Apiaceae	carrot family						2		
Rosaceae	rose family					1			
Aquatics									
Typha latifolia	bulrush						1		
Potamogeton type	pondweed								1
Spores									
Pteridium aquilinum	bracken	3	2						
Filicales	ferns	7	7	3	4	8	9	1	
Polypodium vulgare	polypody	2	1	1	5	1	2	6	2
Unidentifiable		5		10	4				2
Total Land Pollen (grains counted)		75	36	34	132	26	101	41	55
Concentration*		5	5	5	5	5	5	5	5
Preservation**		4	3	3	4	3-4	4	4	4
Microcharcoal Concentration***		2	1-2	2	1-2	1	1	1	0
Suitable for further analysis		YES	YES	YES	YES	YES	YES	YES	YES

*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 = absent; 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*

7. RESULTS AND INTERPRETATION OF THE DIATOM ASSESSMENT

A summary of the diatom assessment results is provided in Table 9. The most typical diatoms encountered in each sample are listed in order of abundance (most common at the top of each list). Diatoms were encountered in all samples submitted apart from AP-QBH1 at -1.51m OD. However, in AP-QBH1 at -1.47m and -4.13m OD, only a single diatom was encountered during the assessment, preventing any further comment in association to these samples. Similarly, the two samples from AP-QBH2 contained diatoms, but in relatively low abundance and diversity. When present, the species were of marine planktonic and brackish benthic origin. Diatoms were only encountered in high abundance in AP-QBH1 at -4.08m OD, where a mixture of marine and freshwater planktonic taxa and brackish benthic taxa were encountered.

Species of *Cyclotella* were encountered in the majority of samples, which are more often affiliated with more freshwater conditions. However the overriding majority of diatoms were from more open water and intertidal saline environments, indicating estuarine conditions are likely to have prevailed for much of the depositional history of the sequences under investigation. This is however based on a very limited assemblage.

Table 9: results of the diatom assessment, Alchemy Park, Crabtree Manorway North, London Borough of Bexley

Borehole	Depth	Diatoms encountered
AP-QBH1	-1.47m	*Paralia sulcata*
	-1.51m	n/a
	-4.08m	*Nitzschia navicularis* *Cyclotella sp.* *Paralia sulcata* *Pseudomelosira westii* *Synedra ulna* *Nitzschia punctata* *Rhaphoneis amphiceros*
	-4.13m	*Cyclotella sp.*
AP-QBH2	-4.73m	*Nitzschia punctata* *Pseudomelosira westii* *Cyclotella sp.* *Campylodiscus echeneis*
	-4.77m	*Paralia sulcata* *Campylodiscus echeneis* *Triceratum favus* *Cyclotella sp.* *Ellerbackia sp.*

8. RESULTS AND INTERPRETATION OF THE MACROFOSSIL ASSESSMENT

Five small bulk samples from borehole QBH1 and two from QBH2 were processed for the recovery of macrofossil remains, including waterlogged plant macrofossils, wood, insects and Mollusca (Tables 10 & 11). The samples were focussed on the peat horizons within both boreholes. The results of the macrofossil rapid assessment indicate that no charred plant remains, Mollusca, insects or bone were present in the samples. Waterlogged wood was recorded in moderate quantities in three samples from borehole QBH1 (-4.04 to -4.09, -7.00 to -7.05 and -7.05 to -7.10m OD), and in both samples from QBH2 (-4.66 to -4.71 and -4.71 to -4.76m OD). Waterlogged seeds were recorded in one sample from QBH1 (-7.00 to -7.05m OD); these were limited to catkins and a fruit of *Alnus glutinosa* (alder). The remains of sedges (culms and rhizomes) were recorded in three samples from QBH1, but no diagnostic epidermal tissues were found.

The assemblage represented in the samples from boreholes QBH1 and QBH2 is too small to attempt a full environmental interpretation; however, both alder and sedges are both typically found in alder carr/sedge fen environments.

Table 9: Results of the macrofossil assessment of borehole AP-QBH1, **Alchemy Park**

			Charred					Waterlogged			Mollusca		Bone				
Depth (m OD)	Volume processed (ml)	Fraction	Charcoal (>4mm)	Charcoal (2-4mm)	Charcoal (<2mm)	Seeds	Chaff	Wood	Seeds	Sedge remains	Whole	Fragments	Large	Small	Fragments	Insects	Artefacts
-1.56 to -1.61	<100ml	>300µm	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
-1.51 to -1.56	<100ml	>300µm	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
-4.04 to -4.09	<100ml	>300µm	-	-	-	-	-	3	-	1	-	-	-	-	-	-	-
-7.00 to -7.05	<100ml	>300µm	-	-	-	-	-	3	1	-	-	-	-	-	-	-	-
-7.05 to -7.10	<100ml	>300µm	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-

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 10: Results of the macrofossil assessment of borehole AP-QBH2, **Alchemy Park**

			Charred					Waterlogged			Mollusca		Bone				
Depth (m OD)	Volume processed (ml)	Fraction	Charcoal (>4mm)	Charcoal (2-4mm)	Charcoal (<2mm)	Seeds	Chaff	Wood	Seeds	Sedge remains	Whole	Fragments	Large	Small	Fragments	Insects	Artefacts
-4.66 to -4.71	<100ml	>300µm	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-
-4.71 to -4.76	<100ml	>300µm	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-

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+

9. DISCUSSION

The following section seeks to compare the current findings from Alchemy Park with those resulting from previous similar investigations undertaken in the local area. Thereby, placing the findings and their importance within a wider regional context.

9.1 Stratigraphic and hydrological history

The combined results of a wider deposit modelling exercise indicate that the sediments recorded at the Alchemy Park and NuFarm sites 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 two peat horizons, and buried beneath modern Made Ground. At the site and within its immediate vicinity, the principal relief feature of the Shepperton Gravel surface is a large linear depressions extending west to east or north-west to south-east on the southern part of the site, with the Shepperton Gravel surface recorded down to a level of -11.2m OD.

In order to place the findings of this investigation in a wider regional context, the modelling procedures carried out have been extended to cover a larger area of the local Thames floodplain (see Figure 1). The results of this wider-scale investigation are presented as a contour model of the Shepperton Gravel surface (Figure 13). The surface of the Shepperton Gravel is chosen as the basis for this wider regional evaluation as the relief features present on that surface are widely understood to be strongly influential in determining patterns of sedimentation on the Thames floodplain throughout the Holocene. It is highlighted that the larger area has been modelled at a coarser resolution (100m as opposed to 50m radius from each borehole) and due to the absence of records in certain areas, the coverage of the model is incomplete.

Whilst the deep palaeochannel and its northern bank were identified on the Alchemy Park site, its southern bank lay beyond the margins of the site, and thus its width could not be established. Unfortunately the coverage of the wider model is incomplete immediately south of Alchemy Park, however, the channel would appear to be a maximum of 100-200m wide on the basis that the Shepperton Gravel surface is recorded at above -9m OD on the Imperial Gateway (Batchelor *et al*., 2008b) and Pirelli Works (Young *et al*., 2008b). Extrapolating the orientation and origin of the channel is also restricted by the lack of coverage, however it would appear to be part of a wider pattern of probable drainage lines radiating from a more elevated part of the Shepperton Gravel surface identified during investigations of the Veridion Park site to the west (Batchelor and Green, 2013), whilst a deep embayment around Belvedere Industrial Estate suggest its confluence with the Thames at this point. Other deep depressions identified within the modelled area, include two which are orientated approximately north-south across the Pirelli Works site (Young *et al*., 2008b). The gravel surface at the base of these features however, is recorded at approximately -8m OD, indicating they are substantially less significant than the one recorded at Alchemy Park (-11.2m OD).

Beyond the margins of the channels, the Shepperton Gravel surface generally lies at around 7-8m OD, sloping downwards towards the Thames in a northern and eastern direction as might be expected. Two significantly high areas resting at -5m OD can be identified however, and such locations may have a greater potential to contain evidence of human activity. The first of these areas is located approximately 500m south of Imperial Gateway and most likely represents the edge of the Lower Thames Valley floodplain. The second is located approximately 400m north-west of the Alchemy Park site. In this case, the elevated surface is questionable as it is represented by a single borehole.

Following the deposition of the Shepperton Gravel, active fluvial processes dominated much of the Lower Thames Valley floodplain resulting in the deposition of the Lower Alluvium. In many places across the modelled area, peat formed either prior to, or during accumulation of the Lower Alluvium. When peat formed prior to the accumulation of the Lower Alluvium, it most frequently occurred in depressions in the Shepperton Gravel surface, but extending upward where gentle slopes afforded suitable conditions. The Lower Alluvium substantially infills the depressions in the surface of the Shepperton Gravel; but it also spreads, sometimes quite thickly, onto the higher areas of the gravel surface. It would appear therefore to have been an aggradational accumulation.

The results of the radiocarbon dating indicate that the Lower Alluvium began to accumulate beyond the channel on the northern part of the Alchemy Park site, sometime prior to 7410-7170 cal BP (during the late Mesolithic). This correlates well with the date produced at both Pirelli Works (7160-6750 cal BP; Young *et al*., 2012) and Imperial Gateway (7160-6900 cal BP; Batchelor *et al*., 2008b). In all three cases, the Lower Alluvium began accumulating above -8m OD, and the late Mesolithic date indicates that it accumulated rapidly (ca. 3m in 1000 years). Unfortunately the date that the Lower Alluvium began accumulating within the channel itself is unknown due to a lack of suitable datable material, but is likely to date earlier in the Mesolithic. The diatom assessment suggest that the Lower Alluvium was deposited under brackish water conditions.

There are relatively few localities where the Lower Alluvium is missing, and resting on it almost everywhere, is a bed of peat which is recorded in the vast majority of boreholes evaluated in the mapped area. The presence of peat represents evidence of a transition to a semi-terrestrial environment, and the records of detrital wood and *in situ* tree remains (Spurrell 1889; Whitaker 1889; Batchelor *et al*., 2007b, 2008a) indicate that wetland woodland was present at least locally on the floodplain. The thickness of the peat recorded at Alchemy Park and elsewhere across most of the mapped area, mainly between 1 and 3m indicates that the process of peat accumulation was taking place over a period of at least 3000 years (assuming accumulation occurs at a rate of approximately 1000 years per 1m of peat). At Alchemy Park, the results from both AP-QBH1 and AP-QBH2 indicate that this accumulation commenced towards the very end of the Mesolithic between 6600-6410 and 6300-6200 cal BP respectively. Here, the peat began accumulating on a surface between -5 and -4m OD. At Imperial Gateway (Batchelor *et al.,* 2008b), towards the eastern edge of the mapped area, peat accumulation was radiocarbon dated to 6290-6120 cal BP at a level of -3.80m OD. A similar range of dates is recorded at the Crossness Sewage Works (Batchelor *et al*., 2007a), Norman Road (Batchelor *et al.*, 2008a) and Pirelli Works (Young *et al*., 2008b) sites. Peat cessation was not dated at Alchemy Park during the assessment, but its elevation (ca. -1.5m OD), corresponds to a date of 3840-3640 cal BP at Imperial Gateway and 3210-2970 cal BP at Pirelli Works, indicative of a Bronze Age date.

The Upper Alluvium which overlies the Peat across the whole of the mapped area represents a transition from semi-terrestrial to alluvial/estuarine conditions, and was most likely brought about by a regional increase in the rate of relative sea level rise (Sidell, 2003); the assessment results from Alchemy Park do not provide data to confirm this however. Figure 11 represents the very low relief surface of the Upper Alluvium across the Alchemy Park and NuFarm sites and by comparison with Figure 10 indicates the way in which Holocene alluviation has very effectively masked the inequalities that were present on the surface of the Shepperton Gravel at the beginning of the Holocene period.

9.2 Vegetation history

The results of the pollen and plant macrofossil assessment from Alchemy Park indicate a floodplain environment dominated by wetland woodland comprising alder and a ground flora of sedges, grasses, aquatics and ferns. There are however, suggestions of damper conditions in the vicinity of AP-QBH2 throughout the period of peat formation, perhaps as a consequence of its position within the former channel. Oak, hazel and elm may have occupied the wetland woodland, but were equally likely to have formed mixed deciduous woodland on the dryland with lime.

Towards the top of the sequence a decline of woodland on both the floodplain and dryland is indicated. On the floodplain, a transition from wetland woodland to sedge fen / reed swamp and possibly saltmarsh conditions is indicated. This occurs towards the contact between the peat and Upper Alluvium and most likely reflects the well-documented increase in the rate of relative sea level that occurred during the Bronze Age (Sidell, 2003). On the dryland, the decline of woodland is reflected by an increase of microcharcoal and herbaceous taxa including cereal pollen, black knapweed and plantain. The timing of the event and taxa recorded suggests that the decline is due to Bronze Age clearance for settlement and/or agricultural purposes. Indeed, Bronze Age trackway structures at Erith Spine Road / Bronze Age Way (Sidell *et al*., 1996) and on the Erith foreshore (Sidell, pers. comm.) clearly demonstrate that human activity was taking place nearby around this time.

The vegetation history of the Alchemy Park site is broadly similar to that indicated at the Norman Road (Batchelor *et al*., 2008a), Crossness Sewage Works (Batchelor *et al*., 2007a) and Imperial Gateway (Batchelor *et al*., 2008b) sites. There have however, been important discoveries at these sites, evidence for which might also be recorded at Alchemy Park. These include: (1) the Neolithic colonisation and decline of yew (*Taxus*) woodland, and (2) the Neolithic decline and late Bronze Age expansion of elm (*Ulmus*) woodland.

The Neolithic colonisation and decline of yew woodland is now a well-documented phenomenon in the Lower Thames Valley, and the timing/causes are discussed elsewhere (e.g. Batchelor, 2009; Branch *et al*., 2012; Batchelor *et al*., in prep). Yew is well-represented in the records from Norman

Road, Crossness Sewage Works and the Erith Foreshore (Seel, 2001). It is not well recorded however at Imperial Gateway and apparently Alchemy Park, suggesting important and unexplained local variations in its distribution.

The early Neolithic decline of elm is also a well-documented phenomenon across north-west Europe and the Lower Thames Valley (e.g. Parker *et al*., 2002; Batchelor *et al*., 2014). Often, sequences from the Lower Thames Valley do not record this event because peat accumulation commences at, or just after the time that it occurs (6347 and 5281 cal BP). At Alchemy Park however, there is greater potential to consider the local timing/nature of the decline because peat accumulation commences prior to this date in AP-QBH1 (6600-6400 cal BP). Of even greater interest however, is the late Bronze Age expansion of elm on the peat surface. This is a relatively new and as yet unpublished phenomenon recorded in an increasing number of sequences in the Lower Thames Valley, including the nearby Norman Road (Batchelor *et al*., 2007a) and Erith Foreshore (Seel, 2001) sites. The Alchemy Park site has the potential to add to this growing number of sites and is therefore important for this reason.

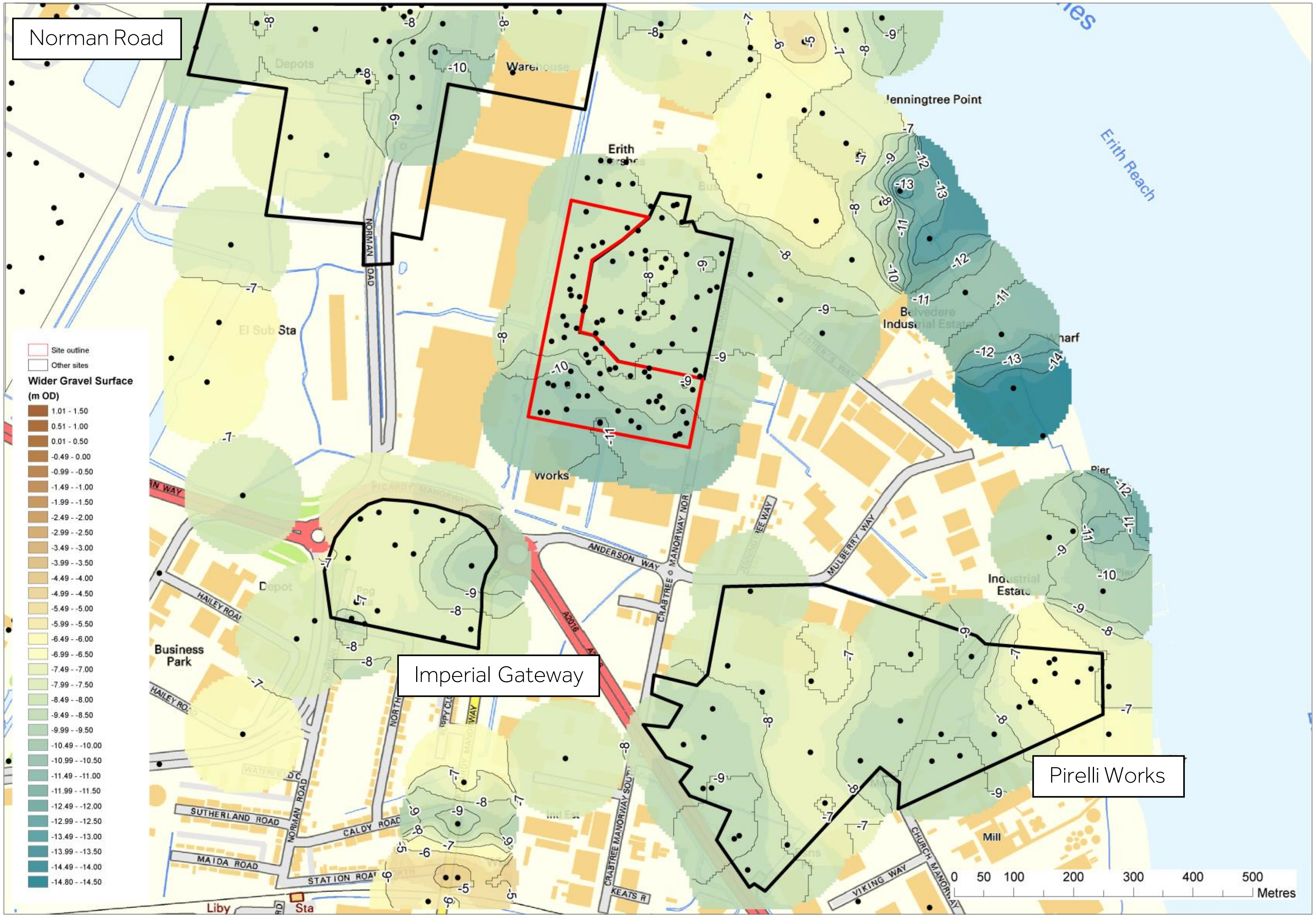

Figure 12: Surface of the Shepperton Gravel across the wider area surrounding the Alchemy Park and NuFarm sites

10. CONCLUSIONS AND RECOMMENDATIONS

The aims of the geoarchaeological investigations at the Alchemy Park site were: (1) to investigate the age of the peat horizons at the site; (2) to provide a provisional reconstruction of the environmental history of the site, (3) to highlight any evidence of human activity, and (4) to make recommendations for further analysis (if required). In order to carry out the work, a program of radiocarbon dating and an assessment of the palaeobotanical (pollen, seeds, wood, diatoms) and palaeofaunal (insects, molluscs, ostracods and foraminifera) remains was undertaken.

The results have built upon the initial geoarchaeological fieldwork and deposit modelling exercise which confirmed that the site is located on a Shepperton Gravel surface resting between -7.5 and -9m OD. On the southern part of the site however, a west-east or northwest-southeast orientated deep trough (probable palaeochannel) is recorded. The channel is cut into the Shepperton Gravel surface, estimated to measure between 100 and 200m in width and ca. 2.5 in depth. A tripartite sequence of Lower Alluvium, Peat and Upper Alluvium infills the potential palaeochannel, and surrounding higher gravel surface. The Lower Alluvium began accumulating during the late Mesolithic (middle Holocene) beyond the margins of the probable palaeochannel, and earlier within the channel itself. The rate of accumulation was relatively rapid (ca. 3m/1000 years). Peat formation commenced towards the very end of the Mesolithic and continued to the Bronze Age.

During the accumulation of the Lower Alluvium and Peat (Mesolithic to early Bronze Age) the floodplain environment was dominated by wetland woodland comprising alder and a ground flora of sedges, grasses, aquatics and ferns, whilst mixed deciduous woodland occupied the dryland. At the time of the transition from Peat to Upper Alluvium (Bronze Age), woodland declined on both surfaces as a consequence of relative sea level rise (floodplain) and human activity (dryland). The vegetation history of the Alchemy Park site is broadly similar to that indicated at nearby sites. There have however, been important discoveries which might also be recorded at Alchemy Park. These include: (1) the Neolithic colonisation and decline of yew (*Taxus*) woodland, and (2) the Neolithic decline and late Bronze Age expansion of elm (*Ulmus*) woodland.

The assessment has thus been successful in demonstrating that the sequences from Alchemy Park have the potential to address aims 3 to 5 of the project, and have provided preliminary interpretations of the sedimentary and palaeoenvironmental sequences. It is therefore recommended that a targeted program of analysis is carried out focussed on: (1) radiocarbon dating to improve the chronological framework for the site; (2) pollen analysis of additional samples likely to increase knowledge/understanding of the history of elm & yew woodland; both of which have affiliations with human activity.

11. REFERENCES

Askew, P. and Spurr, G. (2006) *Crabtree Manorway South, Belvedere: an archaeological evaluation and geoarchaeological investigation report*. MoLAS Unpublished Report.

Batchelor, C.R. (2009) *Middle Holocene Environmental Changes and the History of Yew (Taxus baccata L.) Woodland in the Lower Thames Valley*. Department of Geography, Royal Holloway, University of London, Unpublished PhD thesis.

Batchelor, C.R. (2015) *Alchemy Park, Crabtree Manorway North, London Borough of Bexley: Written Scheme of Investigation*. Quaternary Scientific (QUEST) Unpublished Report December 2015; Project Number 201/15.

Batchelor, C.R. & Green, C.P. (2013) *A report on the geoarchaeological deposit modelling on land at Veridion Park, London Borough of Bexley*. Quaternary Scientific (QUEST) Unpublished Report February 2013; Project Number 225/12

Batchelor, C.R. & Young, D.S. (2016) *Alchemy Park, Crabtree Manorway North, London Borough of Bexley: Geoarchaeological fieldwork and deposit model report*. Quaternary Scientific (QUEST) Unpublished Report March 2016; Project Number 201/15.

Batchelor, C.R. & Young, D.S. (2013) *Powerwind Project, Manor Road, Erith, London Borough of Bexley (site code: PWW12): environmental archaeological analysis report*. Quaternary Scientific (QUEST) Unpublished Report April 2013; Project Number 120/12.

Batchelor, C.R., Branch, N.P., Elias, S., Green, C.P., Swindle, G.E., & Wilkinson, K.N. (2007a) *Thames Water Utilities LTD, tidal Thames quality improvements, Crossness, London Borough of Bexley: environmental archaeological analysis (site code EAW06)*. ArchaeoScape Unpublished Report.

Batchelor, C.R., Branch, N.P., Austin, P. (2007b) *Crossness Sewage Works, Crossness, London Borough of Bexley: environmental archaeological analysis of waterlogged wood remains (site code: CXS07)*. ArchaeoScape Unpublished Report.

Batchelor, C.R., Branch, N.P., Elias, S., Young, D., Austin, P., Green, C.P., Morgan, P. & K, Williams. (2008a). *Former Borax works, Norman Road, Belvedere, London Borough of Bexley: environmental archaeological analysis (site code: NNB07)*. ArchaeoScape Unpublished Report.

Batchelor, C.R., Branch, N.P., Christie, R., Elias, S. Young, D.S., Austin, P., Williams, K., & Wilkinson, K. (2008b) *Imperial Gateway, Belvedere: environmental archaeological assessment report*. Quaternary Scientific (QUEST) Unpublished Report December 2008; Project Number 056/08.

Batchelor, C.R., Branch, N.P., Allison, E., Austin, P.A., Bishop, B., Brown, A., Elias, S.E., Green, C.P. & Young D.S. (2014) The timing and causes of the Neolithic elm decline: New evidence from the Lower Thames Valley (London, UK). *Environmental Archaeology* **19(3)**, 263-290.

Batchelor, C.R., Branch, N.P., Carew, T., Elias, S.E., Gale, R., Lafferty, G.E., Matthews, I.P., Meddens, F., Vaughan-Williams A. & Webster, L. (in prep). Middle Holocene environmental change and Bronze Age human activities in the Lower Thames Valley (London, UK). Manuscript in prep.

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.

Branch, N.P., Silva, B. & Swindle, G.E. (2004) *An Environmental Archaeological Assessment: North Bexley Drainage Improvements, Belvedere, Kent (EWY01)*. ArchaeoScape Unpublished Report, 2004.

Branch, N.P., Batchelor, C.R., Cameron, N.G., Coope, R., Densem, R., Gale, R., Green, C.P. & Williams (2012) Holocene Environmental Changes at Hornchurch Marshes, London, UK: implications for our understanding of the history of Taxus (L.) woodland in the Lower Thames Valley. *The Holocene*, **22 (10)** 1143-1158.

Campbell, I.D. (1999) Quaternary pollen taphonomy: examples of differential redeposition and differential preservation. *Palaeogeography, Palaeoclimatology, Palaeoecology*, **149**, 245-256.

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

Corcoran, J. & Lam, J. (2002) *Land at Project Alice, the former British Gypsum Site, Corinthian Quay, Church Manor Way, Erith: a report on the geoarchaeological evaluation*. MoLAS Unpublished Report.

Cushing, E.J. (1967) Evidence for differential pollen preservation in late Quaternary sediments in Minnesota. *Review of Palaeobotany and Palynology*, **4**, 87-101.

Devoy, R.J.N. (1979) Flandrian sea-level changes and vegetational history of the lower Thames estuary. *Philosophical Transactions of the Royal Society of London*, **B285**, 355-410.

Green, C.P., Batchelor, C.R., Austin, P., Brown, A., Cameron, N., Young, D.S. (2014) Holocene Alluvial Environments at Barking, Lower Thames Valley, UK. *Proceedings of the Geologists Association* **125**, 179-295.

Hendy, N.I. (1964). *An introductory account of the smaller algae of the British coastal waters. Part V: Bacillariophyceae (Diatoms)*. Fisheries Investigation Series, I, H.M.S.O., London.

Krammer, K. & Lange-Bertalot, H. (1986-1991). *Subwasserflora von Mitteleuropa. Bacciliarophyceae: 2 (1) Naviculaceae; 2 (2) Bacillariacceae, Epithemiaceae, Surirellaceae; 2 (3) Centrales, Fragilariaceae, Eunotiaceae; 2 (4) Achnanthaceae*. Fischer, Stuttgart.

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

Parker, A.G., Goudie, A.S., Anderson, D.E., Robinson, M.A. & Bonsall, C. (2002) A review of the mid-Holocene elm decline in the British Isles. *Progress in Physical Geography*, 26(1), 1-45.

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

RSK Geotechnics Ltd (2004) *Proposed commercial development at land adjacent to Burt's Wharf, Belvedere, Kent – Area 2, for Burt Boulton Holdings Limited: Ground Investigation Report*. Unpublished RSK Geotechnics report number 9209/2; June 2004.

RSK Geotechnics Ltd (2005) *Proposed commercial development at land adjacent to Burt's Wharf, Belvedere, Kent – Area 2, for Burt Boulton Holdings Limited Additional Investigation*: Ground Investigation Report. Unpublished RSK Geotechnics report number 9699/1; October 2005.

RSK Geotechnics Ltd (2006) *Proposed commercial development at land adjacent to Burt's Wharf, Belvedere, Kent – Area 1, for Burt Boulton Holdings Limited Additional Investigation: Ground Investigation Report*. Unpublished RSK Geotechnics report number 9927/2; January 2006.

Scaife, R.G. & Burrin, P.J. (1992) Archaeological inferences from alluvial sediments: some findings from southern England. In (Needham, S. & Macklin, M.G. eds), *Alluvial Archaeology in Britain*. Oxford: Oxbow Monograph 27, 75–91.

Seel, S.P.S. (2001) *Late Prehistoric woodlands and wood use on the Lower Thames floodplain*. University College, London: Unpublished PhD thesis.

Sidell, E.J. (2003) *Relative sea-level change and archaeology in the inner Thames estuary during the Holocene*. University College, London, Unpublished PhD Thesis.

Sidell, E.J., Scaife, R., Wilkinson, K., Giorgi, J., Goodburn, D. & Gray-Rees, L. (1996) *Spine Road Development, Erith, Bexley (site 2649): a palaeoenvironmental assessment*: MoLAS Unpublished Report.

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

van Der Werff & Huls (1958-1974). *Diatomeeënflora van Nederland*. Eight parts, published privately by van der Werff, De Hoef (U), The Netherlands.

Waller, M.P. (1993) Flandrian vegetational history of south-eastern England. Pollen data from Pannel Bridge, East Sussex. *New Phytologist*, 124, 345-369.

Young, D.S., Batchelor, C.R. and Braithwaite, R.A. (2008a) *The Former NuFarm Site, Church Manorway North, Belvedere: geoarchaeological fieldwork report*. Quaternary Scientific (QUEST) Unpublished Report October 2012; Project Number 145/12.

Young, D.S., Batchelor, C.R., Green, C.P and Braithwaite, R.A. (2008b) *Pirelli Works, Church Manorway, Erith, (site code: PWR12): environmental archaeological assessment report*. Quaternary Scientific (QUEST) Unpublished Report September 2012; Project Number 053/12.

12. APPENDIX 1: OASIS

OASIS ID: quaterna1-245451

Project details

Project name	Alchemy Park, Crabtree Manor Way North, Bexley
Short description of the project	Three geoarchaeological boreholes were put down across the site and combined with over 100 geotechnical records to provide a detailed deposit model for the site. The results reveal a deep west-east orientated palaeochannel on the southern part of the site cut into the river terrace gravels. A sequence of alluvial and peat sediments overlies the gravels, capped by made ground. The peat dates from the late Mesolithic to Bronze Age period and has good potential for providing a reconstruction of the environmental history of the site and elucidating evidence for human activity.
Project dates	Start: 01-02-2016 End: 02-10-2016
Previous/future work	No / Yes
Any associated project reference codes	ALY16 - Sitecode
Type of project	Environmental assessment
Monument type	PEAT Late Prehistoric
Significant Finds	PEAT Late Prehistoric
Survey techniques	Landscape

Project location

Country	England
Site location	GREATER LONDON BEXLEY BEXLEY Alchemy Park
Postcode	DA17 1AX
Study area	4 Hectares
Site coordinates	TQ 550000 185010 50.944507274775 0.206628764437 50 56 40 N 000 12 23 E Point

Project creators

Name of Organisation	Quaternary Scientific (QUEST)
Project brief originator	Consultant
Project design originator	Dr C.R. Batchelor
Project director/manager	C.R. Batchelor
Project supervisor	C.R. Batchelor
Type of sponsor/funding body	Developer

Project archives

Physical Archive	No

Exists?	
Digital Archive Exists?	No
Paper Archive recipient	LAARC
Paper Media available	"Report"

Project bibliography 1

Publication type	Grey literature (unpublished document/manuscript)
Title	Alchemy Park, Crabtree Manorway North, London Borough of Bexley: Geoarchaeolgoical fieldwork and deposit model report
Author(s)/Editor(s)	Batchelor, C.R.
Author(s)/Editor(s)	Green, C.P.
Author(s)/Editor(s)	Young, D.S.
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