

A REPORT ON THE GEOARCHAEOLOGICAL BOREHOLE INVESTIGATIONS AND DEPOSIT MODELLING ON LAND AT KENAVON DRIVE, READING, BERKSHIRE

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INTRODUCTION

This report summarises the findings arising out of the deposit modelling undertaken by Quaternary Scientific (University of Reading) in connection with the proposed development at Kenavon Drive, Reading, Berkshire (National Grid Reference centred on: SU 725 736; Figures 1 and 2). The site is located just to the north of the historical centre of Reading, lying between the Rivers Kennet, less than 50m to the south, and Thames, ca. 500m to the north (Figure 1). BGS mapping (<http://www.bgs.ac.uk/opengeoscience>) shows that the site lies to the east of a spur of Wolstonian Taplow Gravel that separates the two rivers; the site itself is underlain by alluvium, which in turn overlays Kempton Park Gravel of Mid to Late Devensian age. The site lies at approximately 38m OD.

Recent geoarchaeological investigations at the Energis House site (Batchelor *et al.*, 2013; Figure 1), ca. 300m to the west and lying on the spur of Taplow Gravel discussed above, revealed a palaeochannel whose base lay at ca. 33m OD towards the north of the site, orientated east-west and infilled with alluvium containing peat. This palaeochannel was interpreted as a remnant of one of the braided channels formed towards the end of the Late Devensian, and still present at the beginning of the Holocene. The peat within the palaeochannel is likely to be of prehistoric age, and lies it at a similar OD height to the base of the alluvial sequence recorded at the Thames Valley Park site and at Kenavon Drive.

BGS borehole records to the east of Kenavon Drive (Figure 2) show that the Gravel surface lies at between 34.5 and 35.0m OD; geotechnical investigations within the site itself indicate that the Gravel surface falls westwards, lying at approximately 3.0m bgs (ca. 35.0m OD) in the eastern part of the site, and falling to between 3.5 and 4.3m bgs (ca. 34.5-33.7m OD) in the western area of the site. In general, the Gravel is overlain by inorganic alluvium, except in borehole BH1 where it contains sandy peat between 2.3 and 2.8m bgs (ca. 35.7-35.2m OD).

The aim of the geoarchaeological investigations were to evaluate the potential of the sedimentary sequences at the Kenavon Drive site for reconstructing the environmental history of the site and its environs. Specifically, the aims follow those stated in the written

scheme of investigation for this site (Young, 2013):

1. To clarify the nature of the sub-surface stratigraphy across the site;
2. To obtain a chronology for the onset and cessation of peat formation at the site;
3. To make recommendations for further geoarchaeological laboratory-based assessment/analysis (if necessary).

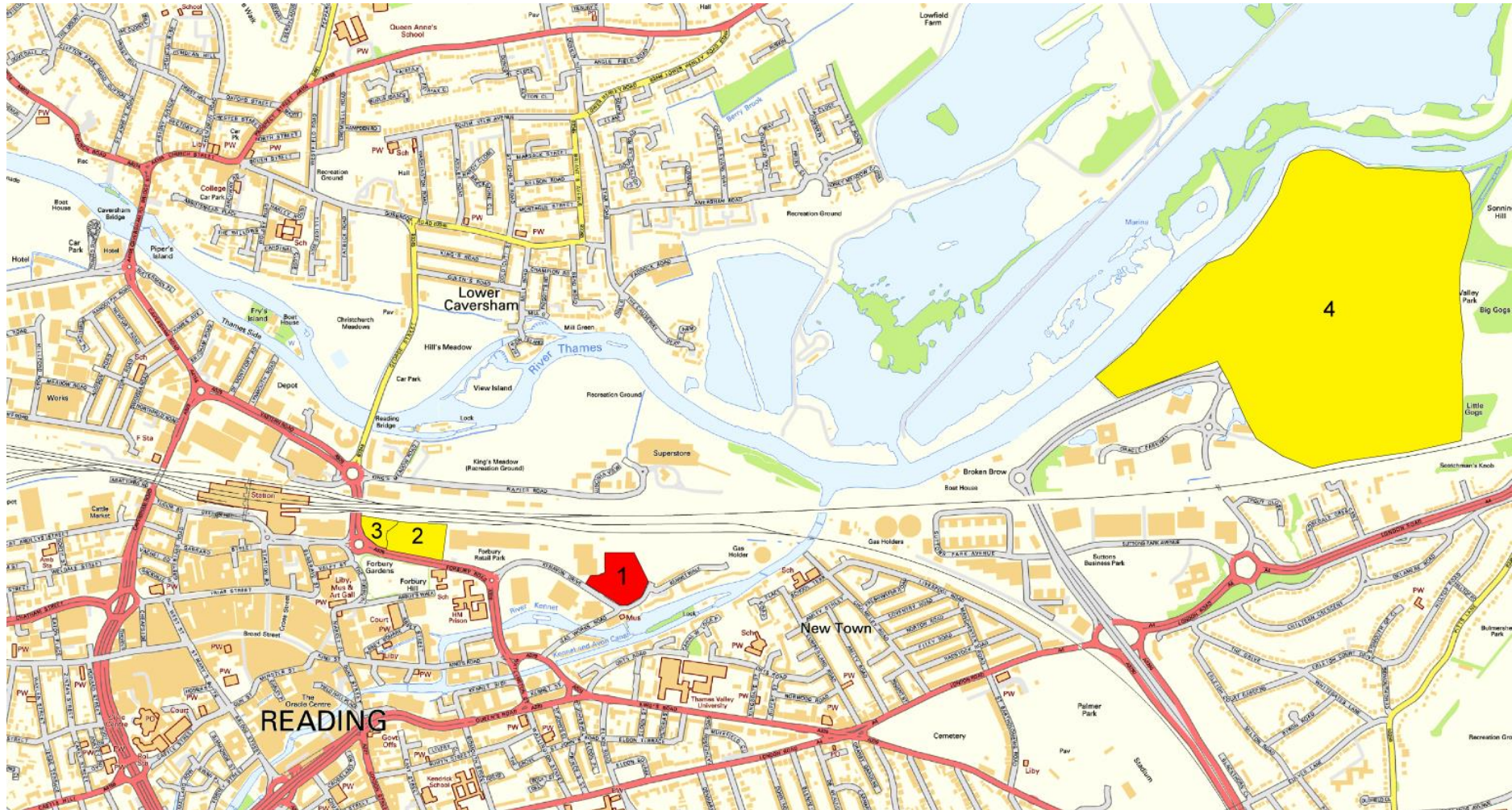


Figure 1: Location of: (1) Kenavon Drive; (2) Energis House (Batchelor *et al.*, 2013); (3) Former NCP Car Park, Forbury Road (Dinwiddie, 2008); and (4) Thames Valley Park (Barnes *et al.*, 1997). *Contains Ordnance Survey data © Crown copyright and database right [2013]*

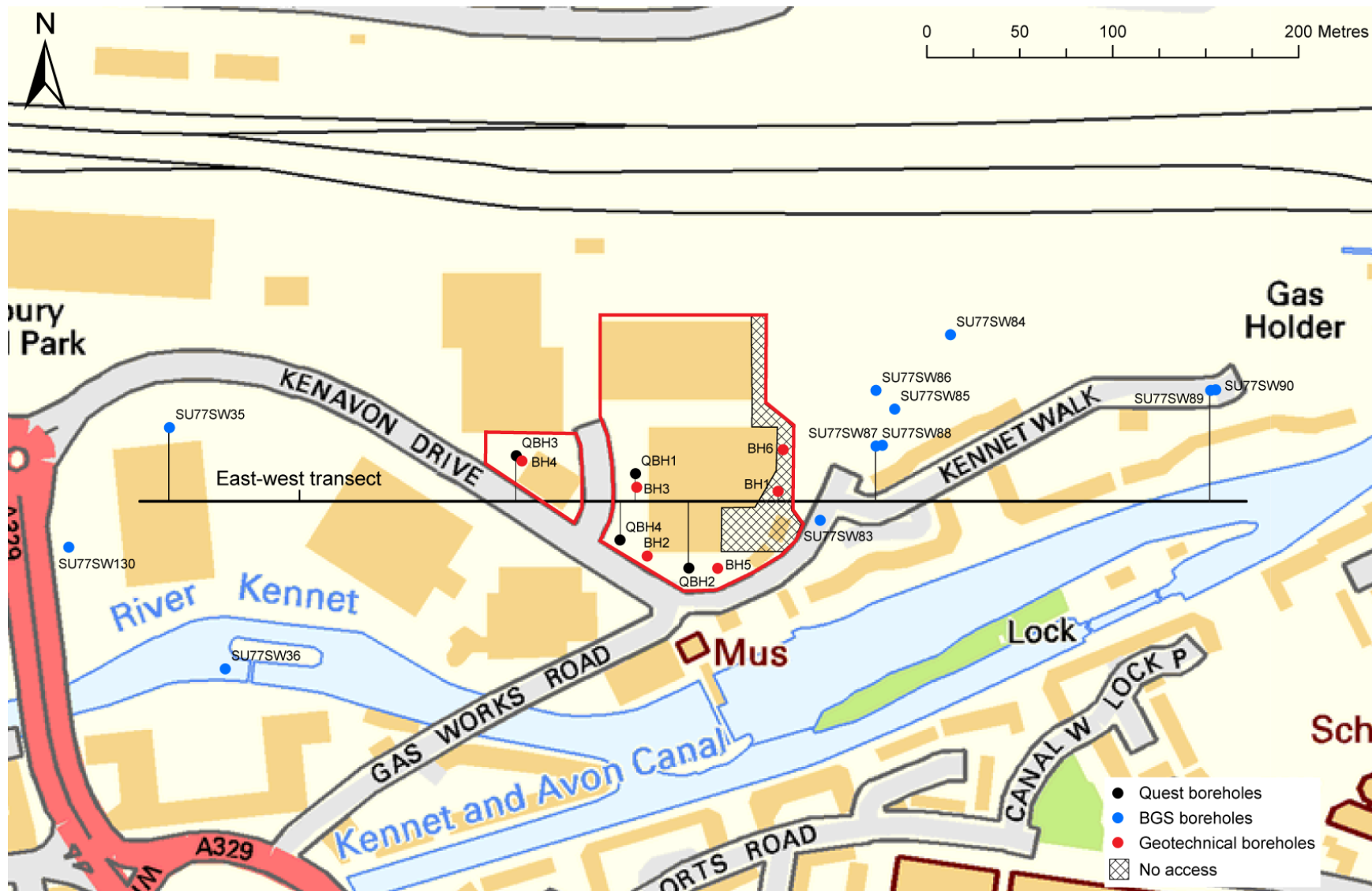


Figure 2: Detailed plan of the Kenavon Drive site, including new geoarchaeological and existing geotechnical/BGS boreholes in or close to the site. *Contains Ordnance Survey data © Crown copyright and database right [2013]*

METHODS

Geoarchaeological fieldwork and lithostratigraphic description

Four boreholes (boreholes <QBH1> to <QBH4>) were put down at the site in October 2013 (Figure 2). The proposed borehole locations were originally arranged to provide a good spatial distribution, as outlined in the written Scheme of Investigation for the site (Young, 2013); however, as outlined in Figure 2 access was not possible to the majority of the eastern extent of the site, and towards the north the current use of the site meant that it was not possible to put boreholes down in these areas. Each borehole was put down using an Eijkelkamp gouge set using an Atlas Copco TT 2-stroke percussion engine. Samples were either described in the field (<QBH1>, <QBH3> and <QBH4>) or retained and described in the laboratory (<QBH2>) 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 (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 results are displayed in Tables 2 to 5 and Figure 3. The spatial attributes of each borehole were recorded using a Leica GS09 differential GPS (Table 1 and Figure 2).

Of the four boreholes, that which recorded the sequence of greatest geoarchaeological potential (<QBH2>) was retained for further laboratory assessment using an Eijkelkamp window sampler driven by 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 recovered core samples were wrapped in clear plastic to prevent moisture loss, labelled with the depth (metres from ground surface) and orientation (top and base) and returned to Quaternary Scientific for storage in a purpose built facility at 2°C. This temperature prevents fungal growth on the core surface, which may lead to anomalous radiocarbon dates, and moisture loss.

Radiocarbon dating

Two sub-samples of twig wood were extracted for radiocarbon dating from the base and top of the peat in borehole <QBH2>. The two samples were submitted for AMS radiocarbon dating to Beta Analytic INC, Radiocarbon Dating Laboratory, Florida, USA. The results have

been calibrated using OxCal v4.0.1 Bronk Ramsey (1995, 2001 and 2007) and the IntCal04 atmospheric curve (Reimer *et al.*, 2004). The results are displayed in Figure 3 and in Table 6.

Deposit modelling

The following resources were used for the collection of stratigraphic information to aid clarification of the nature of the sub-surface stratigraphy across the site: (1) recent geoarchaeological boreholes put down at the site by Quaternary Scientific (this report); (2) boreholes put down previously across the site by Geotechnical and Environmental Associates (2005) and (3) boreholes put down nearby to the site, provided by the British Geological Society (NERC). Boreholes were selected for the transect based on the quality of the data available; in some cases boreholes were omitted due to a lack of surface OD height, or where the records were not considered reliable. This resulted in the production of an east-west 2-Dimensional transect (Figure 3) comprising 7 boreholes.

Table 1: Spatial data for the new geoarchaeological boreholes at Kenavon Drive, Reading, Berkshire

Borehole	Easting	Northing	Surface elevation (m OD)
QBH1	472470.58	173605.13	37.78
QBH2	472499.28	173554.27	38.03
QBH3	472406.49	173614.82	38.09
QBH4	472462.27	173569.40	37.83

RESULTS AND INTERPRETATION OF THE GEOARCHAEOLOGICAL FIELDWORK, DEPOSIT MODELLING AND RADIOCARBON DATING

The results of the lithostratigraphic descriptions are displayed in Tables 2 to 5, with the results of the radiocarbon dating of borehole <QBH2> displayed in Table 6 and in Figure 3. Figure 3 provides an east-west transect of selected sequences across and beyond the margins of the site.

The lowermost unit recorded within the Kenavon Drive site is a horizon of sandy gravel, laid down on the valley floor within a high energy braided river system, most likely at the end of the Late Glacial period (Marine Isotope Stage 2, Late Devensian, ca. 16,000-11,500 cal BP). The surface of the Gravel falls towards the centre of the site (Figure 3) to 33.51 and 33.06m OD in boreholes <QBH1> and <QBH2> respectively. To the west it rises towards boreholes <QBH4> (34.52m OD) and <QBH3> (35.19m OD), and to the east to ca. 35.0m OD in geotechnical borehole BH1. Further east the Gravel surface lies at 35.02m OD in BGS borehole SU77SW87 (www.bgs.ac.uk/opengeoscience), before falling again to 33.49m OD in borehole SU77SW89. Within the site the Gravel surface thus demonstrates a depression in the pre-Holocene topography which may be indicative of a broadly north-south aligned palaeochannel, whose main axis lies towards the centre of the site in the area of boreholes <QBH1> and <QBH2>. It is possible that this channel represents a former channel either of, or tributary to, the River Kennet, close to its confluence with the River Thames. West of the site and lying beyond the course of the Kennet, the pre-Holocene sediment recorded directly underlying the Made Ground at 38.37m OD in borehole SU77SW35 is the Chalk bedrock.

Overlying the Gravel across the majority of the site is a horizon of clayey silt Alluvium which in places contains inclusions of Mollusca and gravel clasts. Within the margins of the possible former channel described above, Peat is recorded within the Alluvium at between 33.88 and 33.62m OD in borehole <QBH1>, and between 33.47 and 33.18m OD in borehole <QBH2>. The Peat horizons in these boreholes lie at slightly different elevations, and may be indicative of migration up-slope and possible erosion (truncation) of the upper part of the Peat in borehole <QBH2>. Since the Peat appears to be accumulating only within this depression, it is indicative of the abandonment or migration of the former channel, and the development of a dry semi-terrestrial surface supporting wetland fen vegetation, most likely including herbaceous and woody taxa. The base of this Peat horizon (33.22 to 33.20m OD) was radiocarbon dated to 5920 to 5750 cal BP (3970 to 3800 cal BC); however, there is a significant age reversal demonstrated by the radiocarbon date from the top of the Peat (33.48 to 33.44m OD), which was radiocarbon dated to 10740 to 10570 cal BP (8800 to 8620 cal BC). Although the $\delta^{13}\text{C}$ (‰) values are consistent with that expected for Peat sediment

and there is no evidence for mineral or biogenic carbonate contamination, it is likely that one of the two radiocarbon dates is incorrect. It is possible that an anomalous radiocarbon date has been caused by laboratory error; however, given the very early age of the upper sample, it is suggested here that this date may have been affected by the redeposition of older sediments from elsewhere, which may have incorporated older material in to the upper part of the Peat at its contact with the overlying Alluvium. If the date for the base of the Peat is correct, it suggests that Peat accumulation began during the Neolithic period. The duration of Peat formation is also uncertain, but assuming that accumulation occurs at a rate of approximately 1000 years per 1m of peat, could represent a period of ca. 300 years. The Peat at the Kenavon Drive site has the potential for good preservation of biological (ecofact) remains.

Peat was also recorded in geotechnical borehole BH1 between ca. 35.7 and 35.2m OD. This horizon is significantly higher than the Peat recorded elsewhere within the site. Although it was not possible to obtain a borehole at the location of BH1 (see above), no Peat horizons were recorded at this elevation within any of the new geoarchaeological boreholes. It is therefore considered possible that this Peat, described as a 'slightly sandy Peat with occasional shell fragments' and directly underlying the Made Ground, may in fact represent redeposited Alluvium/Peat that forms part of the Made Ground, and was recorded elsewhere (namely in boreholes <QBH1> and <QBH4>). Alternatively, it may represent a localised, later period of Peat formation at the site.

Overlying the Peat and above this elevation elsewhere is a horizon of silty clay or clay and silt Alluvium, which in places is slightly sandy or contains occasional gravel clasts. The deposition of these sediments is indicative of deposition within a fluvial system with occasional overbank deposition; in boreholes <QBH1> and <QBH2>, horizons of calcareous silt and clay (potentially marl), suggesting the deposition of calcareous-rich mud within a very low energy aquatic environment were recorded between 34.18 to 34.02 (<QBH1>) and 33.76 to 33.52m OD (<QBH2>). These calcareous-rich horizons occur only within the depression in the Gravel surface, and are indicative of multiple changes in the environment and hydrology of the floodplain within this depression. The surface of the Alluvium lies at ca. 35.5m OD across the majority of the site, and is overlain by between 2 and 3m of Made Ground so that the modern elevation of the site lies at ca. 38m OD.

Table 2: Lithostratigraphic description of borehole <QBH1> (described in the field), Kenavon Drive, Reading, Berkshire

Depth (m bgs)	Depth (m OD)	Description
0.00 to 2.10	37.78 to 35.68	Made Ground
2.10 to 2.25	35.68 to 35.53	Made Ground/redeposited Alluvium. Diffuse contact in to:
2.25 to 2.40	35.53 to 35.38	As3 Ag1; dark grey silty clay with occasional Mollusca fragments. Diffuse contact in to:
2.40 to 3.60	35.38 to 34.18	As3 Ag1; grey silty clay with occasional Mollusca fragments; some iron staining in vertical root channels. Sharp contact in to:
3.60 to 3.76	34.18 to 34.02	Ag2 As2; light grey calcareous ?marl, silt and clay. Sharp contact in to:
3.76 to 3.90	34.02 to 33.88	Ag2 As2; grey silt and clay. Sharp contact in to:
3.90 to 4.16	33.88 to 33.62	Sh3 Ag1 Th+ Tl+; humo. 3; dark reddish black well humified silty peat with traces of woody and herbaceous material. Sharp contact in to:
4.16 to 4.27	33.62 to 33.51	Ag3 Sh1; dark olive grey organic silt. Sharp contact in to:
4.27 to 4.59	33.51 to 33.19	Gg2 Ga1 Ag1; orange silty, sandy gravel. Diffuse contact in to:
4.59 to 5.00	33.19 to 32.78	Gg3 Ga1; orange sandy gravel.

Table 3: Lithostratigraphic description of borehole <QBH2> (described in laboratory), Kenavon Drive, Reading, Berkshire

Depth (m bgs)	Depth (m OD)	Description
0.00 to 2.30	38.03 to 35.73	Made Ground
2.30 to 2.56	35.73 to 35.47	7.5YR 3/1; As3 Ag1 Gg+ Sh+ Dh+; very dark grey silty clay with a trace of organic matter and detrital herbaceous material; occasional gravel clasts. Diffuse contact in to:
2.56 to 3.38	35.47 to 34.65	2.5Y 5/2; Ag2 As2; greyish brown silt and clay with occasional Mollusca fragments and small whole Mollusca. Diffuse contact in to:
3.38 to 4.17	34.65 to 33.86	2.5Y 4/1; Ag2 As2 Gg+; dark grey silt and clay with frequent Mollusca fragments and small whole Mollusca; occasional gravel clasts (2-6mm in diameter). Some vertical root penetration. Diffuse contact in to:
4.17 to 4.27	33.86 to 33.76	2.5Y 3/1; As3 Ag1 Ga+ Gg+ Sh+ Dh+; very dark grey silty clay with a trace of sand, organic matter and detrital herbaceous material. Occasional gravel clasts. Sharp contact in to:
4.27 to 4.51	33.76 to 33.52	2.5Y 7/1; Ag3 Ga1 Dh+; sandy silt with calcareous ?marl and frequent Mollusca and a trace of detrital herbaceous material. Some vertical root penetration. Sharp contact in to:
4.51 to 4.56	33.52 to 33.47	Gley1 3/1; Ag3 As1; very dark grey clayey silt. Sharp contact in to:
4.56 to 4.85	33.47 to 33.18	2.5YR 2.5/1; Sh3 Th ³ 1 Ag+; humo. 3; reddish black well humified peat with herbaceous material and a trace of silt. Sharp contact in to:
4.85 to 4.97	33.18 to 33.06	2.5Y 4/2; Ag2 As1 Gg1; dark greyish brown clayey silt with gravel clasts. Sharp contact in to:

4.97 to 5.00	33.06 to 33.03	2.5Y 3/1; Ga3 Gg1; very dark grey gravelly sand.
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Table 4: Lithostratigraphic description of borehole <QBH3> (described in the field), Kenavon Drive, Reading, Berkshire

Depth (m bgs)	Depth (m OD)	Description
0.00 to 2.50	38.09 to 35.59	Made Ground
2.50 to 2.90	35.59 to 35.19	Ag2 As2; greyey blue silt and clay. Sharp contact in to:
2.90 to 4.00	35.19 to 34.09	Gg3 Ga1; orangey yellow sandy gravel.

Table 5: Lithostratigraphic description of borehole <QBH4> (described in the field), Kenavon Drive, Reading, Berkshire

Depth (m bgs)	Depth (m OD)	Description
0.00 to 2.00	37.83 to 35.83	Made Ground
2.00 to 2.50	35.83 to 35.33	Made Ground/redeposited Alluvium
2.50 to 2.83	35.33 to 35.00	As3 Ag1 Ga+; dark grey silty clay with a trace of sand and Mollusca fragments. Diffuse contact in to:
2.83 to 3.31	35.00 to 34.52	Ag2 As2; bluey grey silt and clay with Mollusca fragments. Sharp contact in to:
3.31 to 4.00	34.52 to 33.83	Gg3 Ga1 Ag+; orangey brown sandy gravel with a trace of silt.

Table 6: Results of the borehole <QBH2> radiocarbon dating, Kenavon Drive, Reading, Berkshire

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-361783	Indeterminate twig wood; top of Peat	33.48 to 33.44	9430 ± 40 BP	8800 to 8620 cal BC (10740 to 10570 cal BP)	-26.3
Beta-361784	Indeterminate twig wood; base of Peat	33.22 to 33.20	5100 ± 30 BP	3970 to 3800 cal BC (5920 to 5750 cal BP)	-27.0

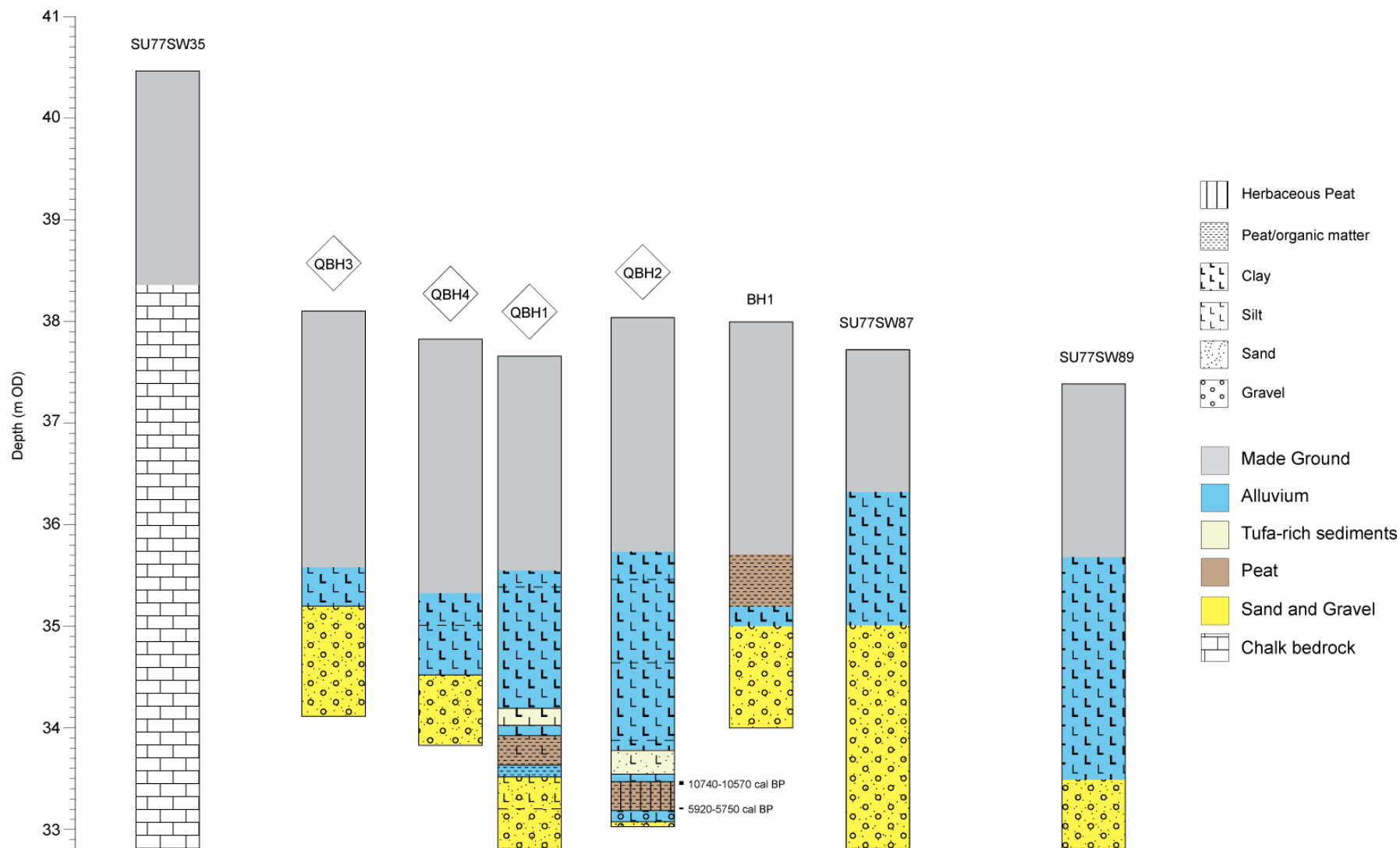


Figure 3: East-west transect of geotechnical and geotechnical boreholes across the Kenavon Drive site and surrounding area, showing the results of the radiocarbon dating of borehole <QBH2>. Boreholes are spaced approximately according to their geographical distribution. Assumed surfaced height of geotechnical borehole BH1 is 38.0m OD.

DISCUSSION AND CONCLUSIONS

The aim of the geoarchaeological investigations was to clarify the nature of the sub-surface stratigraphy across the Kenavon Drive site, and to identify the age of the Peat horizon recorded during the previous geotechnical investigations.

The results of these investigations suggest that a palaeochannel, whose base lies at *ca.* 33m OD and may be aligned broadly north-south, crosses the middle of the site, and is infilled with a Peat horizon that lies at between *ca.* 33.2 and 33.9m OD. Although two radiocarbon dates obtained from the base and top of the Peat demonstrate a significant age reversal, the lower of these two dates (considered more reliable) suggests that Peat accumulation began during the Neolithic period (5920 to 5750 cal BP; 3970 to 3800 cal BC).

A Peat filled palaeochannel aligned broadly WNW-ESE and whose base also lay at *ca.* 33m OD was recorded at the Energis House site (Batchelor *et al.*, 2013) *ca.* 300m to the west (Figure 1), interpreted as a ‘...remnant of one of the braided channels formed towards the end of the Late Devensian Late Glacial, still present at the beginning of the Holocene’ and considered as ‘...a minor tributary of the River Kennet’. It is unclear at this stage if the two channels are contemporaneous, or if either was tributary to the other. Peat was recorded directly overlying the Gravel at the base of the palaeochannel at the Energis House site, at between *ca.* 32.70 and 34.01m OD. Although undated and slightly thicker at the Energis House site, it is possible that this Peat is (at least in part) contemporaneous with that recorded at Kenavon Drive, since it lies at a similar height OD.

The base of the sequence within the palaeochannel at the Kenavon Drive site (and that at the Energis House site) is recorded at a similar elevation to the base of the palaeochannel fill at Thames Valley Park, *ca.* 1.5km to the northeast (Barnes *et al.*, 1997). Here, no radiocarbon determinations were carried out, but the pollen-stratigraphic sequence indicates that it spans from the Late Glacial to the present day. As a consequence of the age (probably Neolithic) and elevation of the Peat recorded at Kenavon Drive, it thus represents an important archive for ecofactual remains that can be used to provide a detailed reconstruction of environmental changes (e.g. woodland clearance and agriculture) at the site and its surroundings.

The collection of additional boreholes in the northern part of the site is recommended when the site becomes vacant, to determine the extent and alignment of the potential palaeochannel recorded in the east-west transect. Further assessment of the sequence from borehole QBH2 is also recommended.

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