GEOARCHAEOLOGICAL INVESTIGATION

LAND at MAY FARM LITTLEPORT CAMBRIDGESHIRE

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CgMs CONSULTING

GEOARCHAEOLOGICAL INVESTIGATION

LAND at
MAY FARM
LITTLEPORT
CAMBRIDGESHIRE

LOCAL PLANNING AUTHORITY: EAST CAMBRIDGESHIRE DISTRICT COUNCIL

CAMBRIDGESHIRE HER EVENT Ref: ECB3541

SITE CENTRED AT: NGR TL 601 872

MARCH 2011

NON-TECHNICAL SUMMARY

This report presents the results of a geoarchaeological borehole survey and palynological assessment of a buried peat horizon undertaken at May Farm, Littleport, Cambridgeshire. Plans are currently being prepared for development of the site, and the survey was carried out in order to establish the nature, sequence and palaeoenvironmental / archaeological potential of the site, to inform determination of a future planning application.

The geoarchaeological investigation was prepared in response to recommendations made by Kasia Gdaniec (Senior Archaeologist [Historic Environment Team - Cambridgeshire County Council]). It involved the excavation of 14 boreholes, the majority of which were grouped into 3 borehole transects, that provide a site-wide cross-section of the sediments beneath the development site (including their nature and depth), whilst also identifying the presence of any buried land surface beneath.

The boreholes were excavated through the Holocene (post-glacial) depositional sequences down to glacio-fluvial sands and gravels of probable Late Glacial derivation. The Holocene sequences comprise an initial phase of peat development over the glacio-fluvial sands and gravels. This peat formation appears to represent initial alder fen carr deposits that grade upwards into reed swamp sequences (on the basis of the macro-fossil content). Overlying the peats are various units of intercalated alluvium. The lowest alluvial unit exhibits a conformable (non-erosive) contact with the lower peats in Borehole 9, suggesting a low-energy transgressive (flooding) event. The overlying alluvial units suggest that there are discrete phases of erosion, as the alluvial units are deposited, indicating higher-energy flooding events. Towards the top of the sequences there are thin laminations of fine sands within the clay-silt alluvium. These are similar to flood warp deposits in places, and are indicative of regular flood episodes (semidiurnal) as in a tidal regime. The uppermost peat unit represents historic wetland development in the region.

At Boreholes 3 and 5 (within Transect 1) there is a raised area of sand (a probable island) which drops away to Borehole 6 (in Transect 2). In addition, at Boreholes 8 and 9 (Transects 2 and 3) there appears to be a thin horizon of sand (Borehole 8) and clays (Borehole 9) overlying a thin lower peat deposit, which is subsequently overlain by a more substantial peat unit at both locations. These thin horizons probably reflect short-lived phases of flooding as the lower peat unit was developing, or they could represent the occurrence of small channel features flowing through the developing wetland. No buried soil horizons were evident in the boreholes and there is no evidence for anthropogenic influences in the depositional sequences at this location (other than the drainage of the surface peats). The lower peat unit has the potential to produce information on the timing and nature of landscape development at this location.

Data from the preliminary palynological assessment of a buried peat horizon at May Farm (included as an appendix) indicates that the pollen assemblages studied from the lower peat unit at Borehole 2 are broadly similar to those from equivalent peat units in the wider region.

There is no evidence in the environmental record at May Farm to indicate any anthropogenic activity in the vicinity of the site, and the timing of peat development can be correlated to the evidence from Pymore (Waller and Alderson1993) and Wood Fen (Wheeler 1992). in general, the establishment of alder carr at the onset of peat formation is tentatively dated to *ca.*4500 BP, and the carr woodland was subsequently replaced by reedswamp after *ca.* 4100 BP. Alder carr then seems to have re-established towards the top of the sequence, possibly at *ca.* 4000 BP. The subsequent deposition of marine alluvium is mapped throughout the Fens, and at this location an upper peat unit formed in the Saxon and Medieval periods.

Whilst interesting in terms of corroborating the palaeoenvironmental work of Waller and Alderton (1993) and that of Wheeler (1992), the sequence from May Farm adds little to our understanding of landscape development in the Fens region and it is suggested that no further palaeoenvironmental work would be warranted at this location.

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1.0 BACKGROUND

1.1 Introduction

1.1.1 This report outlines the results of a hand auger survey that was undertaken on land situated at May Farm, Littleport, Cambridgeshire (Figure 1). The work was undertaken in accordance with a Method Statement (2011) prepared by Dr Robert Smith of CgMs Consulting Limited. The geo-archaeological survey has been allocated the reference ECB3541 by the Cambridgeshire Historic Environment Record.

1.1.2 The Method Statement was based upon the results of the recently completed *Archaeological Desk Based Assessment: Land at May Farm, Littleport, Cambridgeshire* (Flitcroft 2011) and preliminary geotechnical site information provided by Ground Engineering Limited. It was prepared in response to recommendations made by Kasia Gdaniec (Senior Archaeologist [Historic Environment Team - Cambridgeshire County Council]) in the associated Archaeological Evaluation Brief (4th February 2011: Reference - May Farm: Pre-determination Brief]).

1.2 Archaeological Background

1.2.1 The information provided in the archaeological desk based assessment (Flitcroft 2011) indicates that there are no designated heritage assets within the development site boundary or the surrounding area. There are also no undesignated assets currently identified within the site.

1.2.2 The assessment considers that there is no potential for the presence of significant archaeological deposits or features post-dating the drainage of the Burnt Fen from the 18th century onwards, and no appreciable potential for significant archaeological deposits or features of Saxon, Medieval or Post-Medieval date due to its location within the un-drained fen marshes throughout these periods.

1.2.3 The site's potential for the presence of deposits or artefacts of Bronze Age, Iron Age and Roman date is less certain, as any such archaeological remains would be associated with local areas of slightly higher, drier ground - either on localised high-points in the underlying land surface, such as the sand islands identified in the Peacock's Farm area, 3.5 km to the south-east of the site, or on the silted former watercourse roddons. The DBA identified no evidence for raised sand islands in the area around the site; no evidence for activity on the roddons in this area was identified during the Fenland Survey fieldwalking of the site and its surrounding environs.

1.2.4 The site may be considered to have a slightly greater potential for the presence of early prehistoric evidence or remains. A series of roddons are mapped as soilmarks within the study site; these are likely to have been open watercourses during the Neolithic period. Evidence for Neolithic activity is recorded at a number of sites around Peacock's Farm, situated at 3-4 km south-east of the study site, and further stray finds of Neolithic stone tools have been recorded from areas south and east of the site. However, the site's topographical position and the chronology of fen development indicate that the likelihood of significant evidence within the development site is low.

1.2.5 The site's potential for the presence of Mesolithic period evidence is uncertain. Significant groups of Mesolithic finds have previously been identified on a low sand ridge at Peacock's Farm, Shippea Hill, located at 3.5 km south-east of the study site. Any such remains within the site are anticipated to be present at depth, beneath the fen clays (and possibly the underlying basal peats).

1.3 **Palaeoenvironmental Background**

1.3.1 Archaeological excavations at Peacock's Farm in the 1930's established that the pre-fen ground surface lies at around -6 m OD; peat formed early in the deep channels of the Little Ouse with radiocarbon dates of 8620±160 BP to 4800±120 BP (8015-7305 and 3930-3340 cal BC) being determined for peat samples from Peacock's Farm. Data from more recent archaeological investigations at the Main Drain close to Peacock's Farm established that peat growth continued until around 2195-2785 cal BC before marine flooding reached this area (based on radiocarbon dates of 4350±60 BP obtained from samples at the interface between the basal peat and the marine clay).

1.3.2 Marine conditions continued until around 2400 cal BC, depositing grey clay ('fen clay') throughout the region. The marshes and mudflats were drained by a series of creeks and channels draining into the larger channel of the Little Ouse.

1.3.3 Following this first phase of marine conditions there was growth of peat over the whole area.

1.3.4 A second, lesser, period of flooding deposited coarse silts and silt-clay along the Old Croft river north-west of modern Littleport village in the period after 405-180 cal BC (based on a radiocarbon date of 2255±60BP from the upper part of the upper peat at Welney). Ground conditions in that area were dry enough for habitation in the Roman period, when they had formed roddons. There is no currently recorded evidence for similar secondary flood deposits in the vicinity of the study site.

1.3.5 During the Saxon and Medieval periods peat continued to form without interruption raising ground levels to around 3.5 m OD.

1.3.6 The current site reflects extensive drainage of the area from the 18th century onwards and intensive cultivation of the peat-based soils.

1.4 Sedimentological Background (derived from geotechnical site investigation)

1.4.1 Due to the paucity of sedimentological and palaeoenvironmental information relating to the study site and its surroundings, geotechnical investigations undertaken between the 8th and 11th February 2011 were the subject of geoarchaeological monitoring and recording by the author (RS). This was undertaken in order to provide initial information on the deposit sequence of the site which would enable an assessment of its archaeological and palaeoenvironmental potential, and to help inform the subsequent geoarchaeological investigation contained herein.

1.4.2 Information from the geotechnical borehole logs (BH1-BH5) (Ground Engineering Limited, 2011) (shown by the green dots in Figure 2) indicates that, in general, dark brown peat topsoil to *ca*. 0.40 m depth overlies blue-grey alluvium (which contains some organics) to *ca*. 2.50-2.80 m depth. The topsoil represents the remains of the (upper) peat which formed during the Saxon and Medieval periods and reflects the intensive cultivation of the area; the blue-grey clay alluvium probably equates with the 'fen clay' defined by Waller (1994). Below the alluvium, red-dark brown peat continues in the majority of the boreholes to *ca*. 3.20-4.00 m depth. Blue-grey medium-coarse sands and gravels with some clay-silts dominate to the base of the sequences throughout the survey area.

1.4.3 The exception to the depositional sequence described above is evident in BH5 where dark brown peat topsoil overlies blue-grey alluvium to 4.00 m depth; which in turn overlies red-dark brown peat to 4.50 m depth. Grey clay with occasional silts dominates to the base of the borehole.

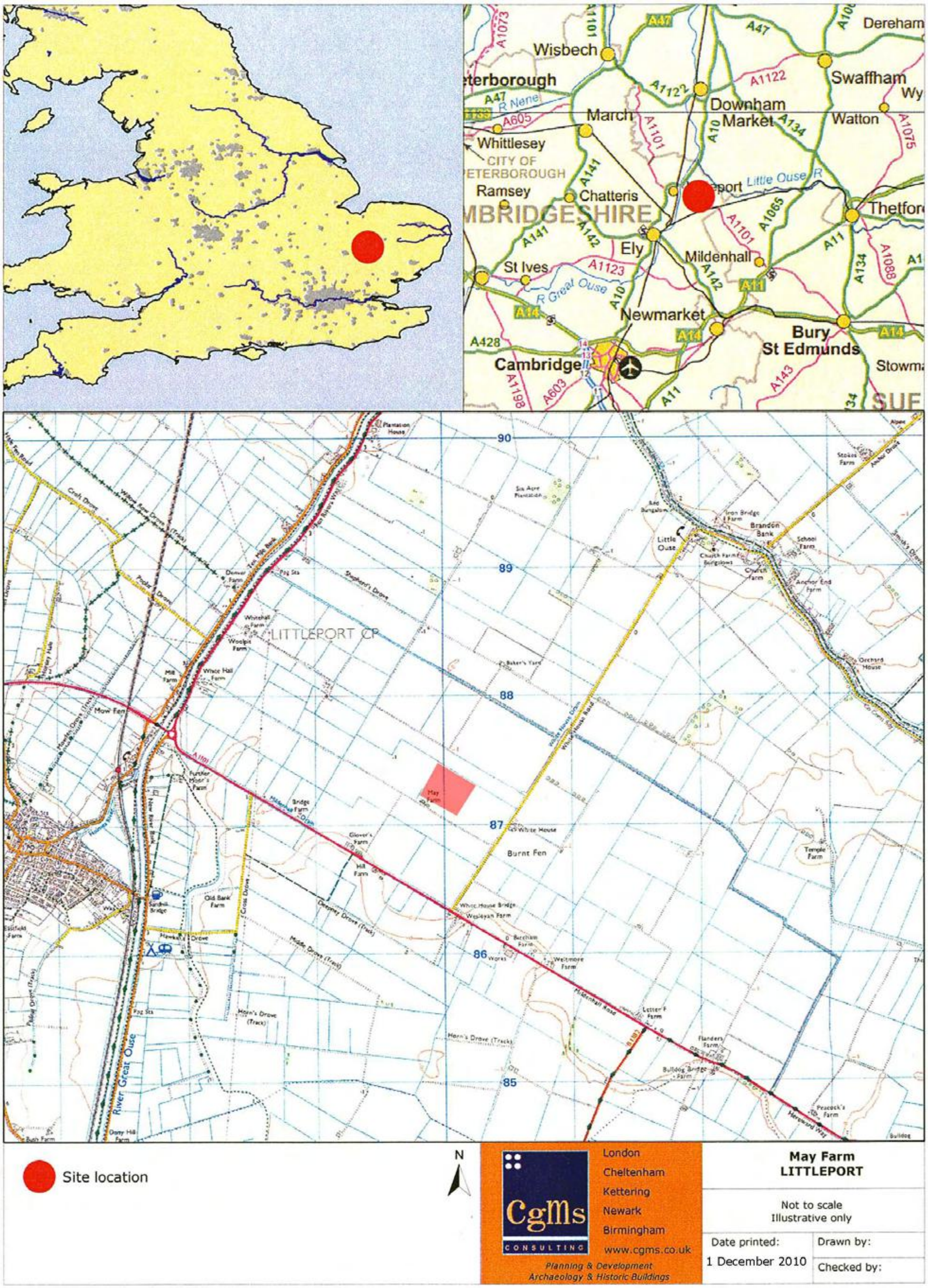


Figure 1: Site Location Map.

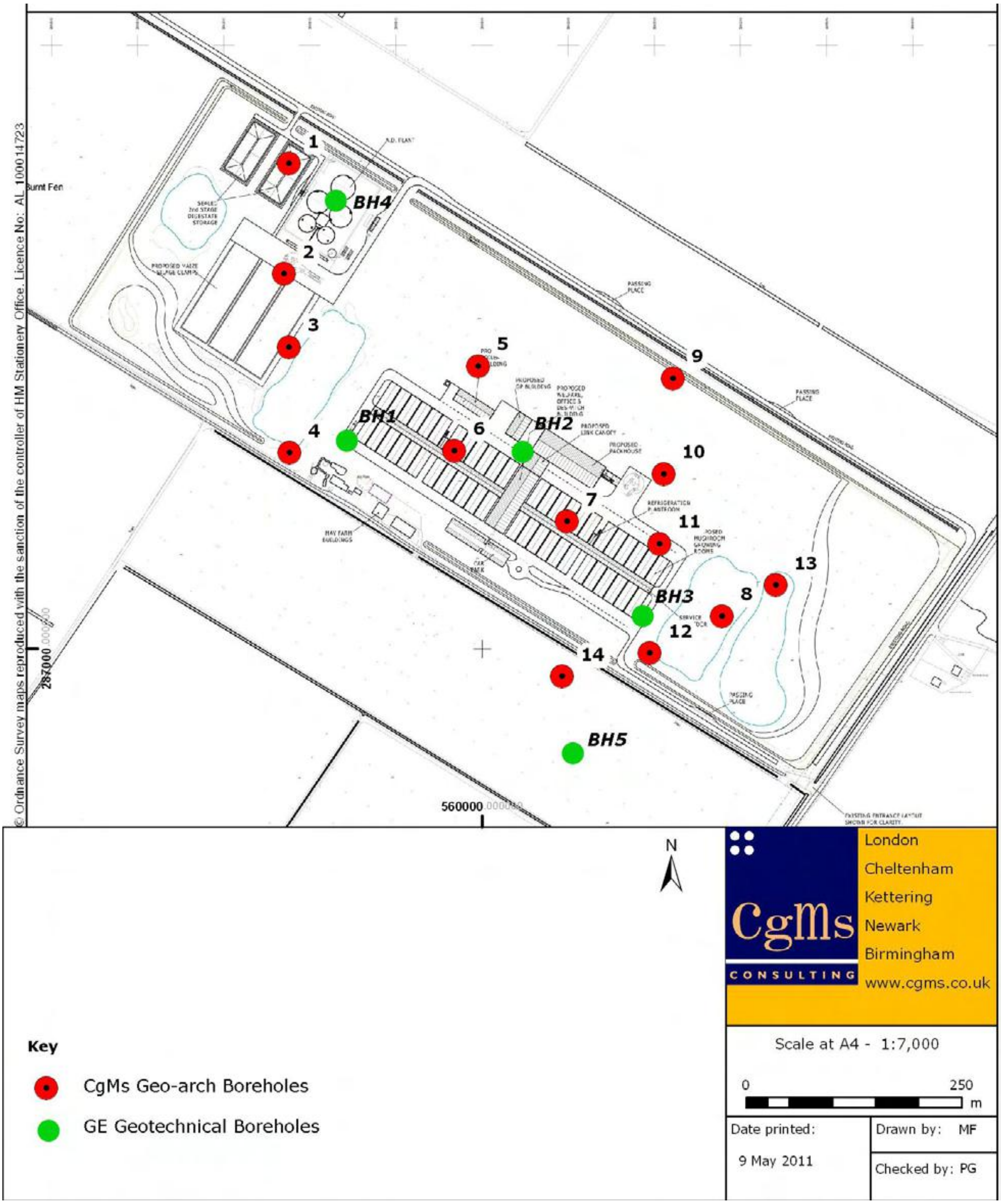


Figure 2: Borehole Locations

2.0 SITE LOCATION AND DESCRIPTION

2.1 Location

2.1.1 The site is located to the north of the junction of Mildenhall Road (A1101) and White House Road (Figure 1). The area of the proposed development is approximately 10 ha in overall size and is located at grid reference TL 601 872. It lies within agricultural fields to the north side of May Farm, and is bounded by drainage ditches and agricultural fields to the west, north and east. The buildings of May Farm and an access road leading east to White House Road lie to the south of the site.

2.1.2 Plans are being developed for an anaerobic digestion plant and associated mushroom factory to be constructed within the study site (Figure 3). The anaerobic digestion plant will include crop storage areas; digestion and storage tanks; gas engines; a water storage lagoon; ancillary structures comprising office and staff facilities; a weighbridge; and hard standing areas. The plant will require a 2.5 ha site. The mushroom factory will take the form of a series of growing tunnels, three water storage lagoons; surrounding hard standing, along with staff and servicing areas. The mushroom facility will cover an area of 4 ha.

2.1.3 The majority of ground works associated with the development will be shallow. Piling for the anaerobic digestion plant and the centre of the mushroom factory, and the excavation of four storage lagoons will be the only works undertaken at depth.

2.2 Geology

2.2.1 The solid geology of the study site area is recorded by the BGS as Mudstone of the Kimmeridge Clay Formation, overlain by superficial deposits of peat. (http://maps.bgs.ac.uk/geologyviewer_google/googleviewer.html)

2.2.2 Littleport village itself is located on a low island capped with glacial sand and gravel; further small areas of terrace sand are located at Peacock's Farm, 3.5 km south-east of the development site, and along the Little Ouse.

2.3 Topography

2.3.1 The study site is located around 3 km east of Littleport, within low-lying flat fenland fields at a height of around -2 m OD (based upon the current borehole GPS records). The site lies within a landscape of large rectangular fields bounded by drainage ditches.

2.3.2 The modern topography of the site and the surrounding area reflects large scale drainage works undertaken around Littleport from the early 17th to mid 19th centuries AD. Prior to this, the site area was comprised of fen interspersed by meandering watercourses. The former route of the Little Ouse river passes to the south of the study site, and is located on the south side of the modern A1101. Aerial photographs and satellite images show a dendritic pattern of former minor watercourses within the site and its surrounding area.

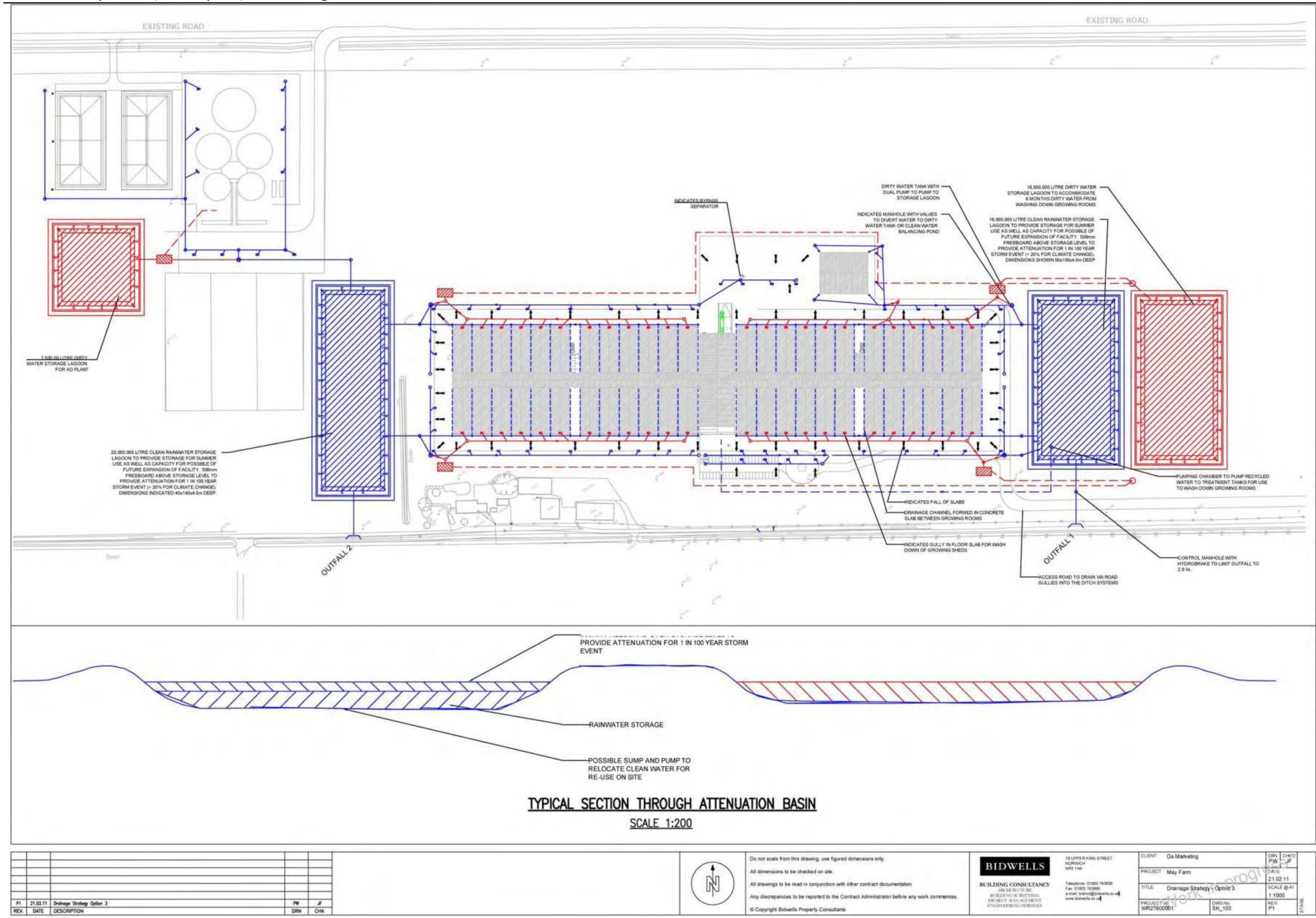


Figure 3: Indicative Plan showing depth & profile of lagoons

3.0 AIM OF GEOARCHAEOLOGICAL INVESTIGATION

3.1 The aims of the present study are to:

- Outline the nature of the sediments encountered during the geoarchaeological investigation;
- Identify the generic processes responsible for sediment deposition;
- Describe the geo-morphological development of the site;
- Assess the archaeological and palaeoenvironmental potential of the sediment deposits within the site; and
- Consider the impact of the footprint of the development upon any buried archaeological and palaeoenvironmental resource.

4.0 METHODOLOGY

4.1 In light of the information presented in Section 1, and the policy framework set at the national (Planning Policy Statement 5 [PPS5]: Planning for the Historic Environment 2010), regional (East of England Regional Spatial Strategy 2008) and local level (Local Development Framework 'Core Strategy' Development Plan Document 2009), the geoarchaeological investigation involved the targeted excavation and assessment of 14 boreholes (shown by the red dots in Figure 2), 12 of which are displayed in 3 borehole transects. The 3 transects provide a total cross-section of the sediments beneath the development (including their nature and depth).

4.2 The first borehole transect involved the excavation of 4 boreholes (Boreholes 1-4) undertaken in a north to south direction, from the proposed digestate storage area and the proposed storm water lagoon to its south.

4.3 The second borehole transect comprised the excavation of 4 boreholes (Boreholes 3 and 6 - 8) undertaken along a north-west to south-east alignment, through the central part of the proposed mushroom factory and the water storage lagoons to its south-east.

4.4 The third borehole transect involved the excavation of 4 boreholes (Boreholes 9 - 12) undertaken in a north to south direction, from the north-east of geotechnical BH2 to the south of geotechnical BH3.

4.5 The remaining 3 boreholes (Boreholes 5, 13 and 14) are located to the north-west of geotechnical BH2, to the north-east of geotechnical BH3, and to the north of geotechnical BH5, respectively.

4.6 Coring was undertaken using an Eijkelkamp hand auger and gouge (200 x 60 mm bucket and 1000 x 30 mm open chamber). According to Long and co-workers (1999: 268) this technique '…provides a flexible, cheap, and relatively rapid means of obtaining stratigraphic data to depths of *ca*. 10 m below the ground surface'.

4.7 The boreholes were excavated to a maximum depth of 5 m (or deeper if sequences that indicate a significant palaeoenvironmental potential were encountered). Coring ceased if contact with the pre-Holocene surface was reached, or where impenetrable deposits (wood, stones, sands and gravels, etc.) were encountered.

4.8 Boreholes were located in three dimensions using differential Global Positioning System (GPS) equipment. This equipment has an accuracy of ± 0.02 m. The sediment is recorded in relation to depths below the existing ground surface and actual heights in relation to OD. They are also described and recorded on pro-forma sheets to relevant professional standards (e.g. Troels-Smith 1955; Long *et al.* 1999).

4.9 According to the Troels-Smith scheme each deposit unit (sediment layer) is characterised by its components (the five main groups being *Turfa, Detritus, Limus, Argilla*, and *Grana*), with their abundance and degree of humification (on a scale of 0-4) recorded by means of a formula. Codes used are summarised in Appendix A and B. For example, a fine detritus mud containing fragments of herbaceous plants (< 2 mm) might be recorded as $Ld^0 3$ Dh1, whereas a moderately humified bryophyte peat might be recorded as $Tb^0 2$ Sh2, or $Tb^2 4$ (Aaby and Berglund 1986). According to this system of sediment description, the physical properties of a deposit unit (degrees of darkness, stratification, elasticity, dryness, and the sharpness of boundary contacts between units) are also recorded on a scale of 0-4 - detailed in Appendix B.

4.10 The computer programme Arc-GIS was used to display the lithostratigraphic data obtained from the geoarchaeological investigation. This software allows the construction of a 2-dimensional subterranean deposit model which maps the spatial extent and thickness of the Holocene deposit units.

4.11 Where sediments were encountered where further assessment is considered necessary in order to help achieve the aims of the evaluation, these were sampled and assessed. The following considerations will be followed (Association for Environmental Archaeology 1995):

- Consideration of the nature and state of preservation of contained organics;
- Nature of former soil horizons;
- Potential for dating; and
- Archaeological / palaeoenvironmental significance.

5.0 RESULTS

5.1 Detailed logs for the 14 boreholes excavated during the hand auger survey are presented in Appendix C. The 3 transects which represent the majority of boreholes are displayed diagrammatically in Figures 4-6 below. A key to the symbols used in the stratigraphic diagrams is also presented in Appendix A.

5.2 **Borehole 1**

Borehole 1 is located in the centre of the digestate storage areas. The stratigraphic sequence at Borehole 1 comprises a maximum proven depth of 3.90 m (from a ground surface at -2.025 m OD). This sequence was excavated through a dark brown degraded peat, clay-silt-sand topsoil to 0.44 m depth (-2.46 m OD). Below 0.44 m depth, weakly laminated flood warp comprising grey clay with fine light brown-yellow-orange sand laminations overlies blue grey alluvium with occasional organics at 1.32 m depth (-3.34 m OD). At 2.61 m depth (-4.63 m OD), red-brown humified peat with visible woody and herbaceous plant material is in evidence. This continues to 3.52 m depth (-5.54 m OD). Below this unit, brown-grey fine-medium sand continues to the base of the sequence at 3.90 m depth (-5.92 m OD). It was not possible to excavate below this depth due to the thixotropic nature of the sand.

5.3 **Borehole 2**

The sequence at Borehole 2 (ground surface at -2.18 m OD) comprises a dark brown peat-derived clay-silt-sand topsoil over a weakly laminated flood warp comprising grey clay with light brown and orange sand laminations at 0.22 m depth (-2.40 m OD). At 1.07 m depth (-3.25 m OD), the flood warp overlies blue-grey alluvium with occasional organics which continues to 2.67 m depth (-4.85 m OD). At this depth, red-brown humified peat with visible leaves and woody fibrous material is in evidence. This unit continues to 3.86 m depth (-6.04 m OD). Below this unit, brown-grey fine-medium sands dominate to the base of the core at 4.00 m depth (-6.18 m OD). It was not possible to excavate below this depth due to the compacted nature of the sediment.

5.4 **Borehole 3**

The sequence at Borehole 3 (ground surface at -1.291 m OD) mirrors Borehole 3 to some degree as it comprises a dark brown peat-derived clay-silt-sand topsoil over a weakly laminated flood warp deposit comprising grey clay with light brown and orange sand laminations at 0.08 m depth (-1.37 m OD). At 0.55 m depth (-1.84 m OD), this unit grades to light grey sand with orange mottling which continues to the base of the core at 2.95m depth (-4.24 m OD). It was not possible to excavate below this depth due to the compacted nature of the sediment.

5.5 **Borehole 4**

The stratigraphic sequence at Borehole 4 comprises a maximum proven depth of 4.32 m (ground surface at -1.75 m OD). This sequence was excavated through a dark brown peat-derived clay-silt-sand topsoil to 0.69 m depth (-2.44 m OD). Below 0.69 m depth (-2.44 m OD), weakly laminated flood warp comprising grey clay with fine light brown-yellow-orange sand laminations overlies blue grey alluvium with occasional organics at 1.33 m depth (-2.887m OD). At 3.12 m depth (-4.87 m OD), red-brown humified peat with visible plant macrofossils is in evidence. This unit continues to 4.01 m depth (-5.76 m OD). Below this unit, brown-grey fine-medium sand continues to the base of the sequence at 4.32 m depth (-6.07 m OD). It was not possible to excavate below this depth due to the compacted nature of the sediment.

5.6 **Borehole 5**

The depositional sequence at Borehole 5 (-1.76 m OD) comprises a dark brown peat-derived clay-silt-sand topsoil to 0.28 m depth (-2.04 m OD), which overlies weakly laminated flood warp comprising grey clay with light brown and orange sand laminations to 0.72 m depth (-2.48 m OD). Below this layer, light brown fine-medium sand with orange mottling dominates to the base of the sequence at 2.15 m depth (-3.91 m OD). It was not possible to excavate below this depth due to the thixotropic nature of the sediment.

5.7 **Borehole 6**

The sequence at Borehole 6 (-1.37 m OD) comprises a dark brown peat-derived clay-silt-sand topsoil to 0.08 m depth (-1.45 m OD), over weakly laminated flood warp comprising grey clay with light brown and orange sand laminations to 1.76 m depth (-3.13 m OD). Below this unit, grey-light brown-orange fine-medium sand overlies blue-grey fine-medium sand at 2.07 m depth (-3.44 m OD) which dominates to the base of the sequence at 2.22 m (-3.59 m OD) depth. It was not possible to excavate below this depth due to the thixotropic nature of the sediment.

5.8 **Borehole 7**

The sequence at Borehole 7 (-2.26 m OD) comprises a dark brown peat-derived clay-silt-sand topsoil to 0.23m depth (-2.49 m OD), which overlies a weakly laminated flood warp comprising grey clay with light brown and orange sand laminations to 1.17 m depth (-3.43 m OD). Below this unit, blue-grey alluvium with occasional organics continues to 2.61 m depth (-4.87 m OD). Below this depth, a distinct contact is in evidence with humified red-brown peat with visible plant macrofossils, overlying blue-grey fine-medium sand with clay at 3.17 m depth (-5.43 m OD). Blue grey sands and clay (in the upper *ca*. 0.2m) exhibit a distinct contact to basal clays, which subsequently dominate to the base of the sequence at 3.55 m depth (-5.81 m OD). It was not possible to excavate below this depth due to the compacted nature of the sediment.

5.9 **Borehole 8**

Borehole 8 (ground level at -1.73 m OD) comprises a dark brown peat-derived clay-silt-sand topsoil to 0.27 m depth (-2.00 m OD) which grades to weakly laminated flood warp comprising grey clay with light brown and orange sand laminations to 1.43 m depth (-3.16 m OD). Between 1.43 and 3.20 m depth blue-grey fine-medium sand overlies a humified red-brown peat unit which dominates the sequence below 3.20 m depth (-4.93 m OD). The peat contains a visible plant macrofossil component through the sequence and overlies a dark grey-brown fine-medium sand unit at 3.46 m depth (-5.19 m OD). Below 3.82 m depth (-5.55 m OD), a thin humified red-brown peat with visible plant macrofossils is in evidence to 3.88 m depth (-5.61 m OD), which in turn overlies blue-grey clay and fine-medium brown sand which continues to the base of the core at 4.10 m depth (-5.83 m OD). It was not possible to excavate below this depth due to the compacted nature of the sediment.

5.10 **Borehole 9**

The sequence at Borehole 9 (-1.48 m OD) comprises a dark brown peat-derived clay-silt-sand topsoil to 0.58 m depth (-2.06 m OD) which overlies weakly laminated flood warp, comprising grey clay with light brown and orange sand laminations to 1.65 m depth (-3.13 m OD). Light brown-orange fine-medium sand dominates the sequence to 1.75 m depth (-3.23 m OD), and overlies blue-grey fine-medium sands to 2.15 m depth (-3.63 m OD). Below this layer, blue-grey alluvium with occasional organics is in evidence to 3.82 m depth (-5.30 m OD). This in turn overlies a humified red-brown peat with visible plant macrofossil content to 4.11 m depth (-5.59 m OD). Below this unit, blue-grey alluvium with occasional organics overlies a humified red-brown peat with visible plant macrofossils at 4.16 m depth (-5.64 m OD). Blue-grey clay and medium-coarse sand underlies this lower peat unit from 4.25 m depth (-5.68 m OD), and continues to the base of the core at 4.40 m depth (-5.88 m OD). It was not possible to excavate below this depth due to the compacted nature of the sediment.

5.11 **Borehole 10**

The sequence at Borehole 10 (-2.40 m OD) comprises a dark brown peat-derived clay-silt-sand topsoil to 0.14 m depth (-2.54 m OD) which overlies a weakly laminated flood warp comprising grey clay with light brown and orange sand laminations to 1.55 m depth (-3.95 m OD). Below this unit, blue-grey alluvium with occasional organics continues to 2.41 m depth (-4.81 m OD), and this in turn overlies a humified red-brown peat with visible pant macrofossil content to 3.49 m depth (-5.89 m OD). The lowest horizon in this sequence comprises blue-grey clay and fine-medium brown sand which continues to the base of the core at 3.76 m depth (-6.16 m OD). It was not possible to excavate below this depth due to the compacted nature of the sediment.

5.12 **Borehole 11**

The sequence at Borehole 11 (-2.08 m OD) comprises a dark brown peat-derived clay-silt-sand topsoil to 0.61 m depth (-2.69 m OD), which overlies a weakly laminated flood warp comprising grey clay with light brown and orange sand laminations to 1.43 m depth (-3.51 m OD). Below this unit, blue-grey alluvium with occasional organics continues to 2.50 m depth (-4.58 m OD), which exhibits a distinct contact to a humified red-brown peat with visible plant macrofossils to 3.20 m depth (-5.28 m OD). Fine-medium brown sand dominates to the base of the core at 3.35 m depth (-5.43 m OD). It was not possible to excavate below this depth due to the thixotropic nature of the sediment.

5.13 **Borehole 12**

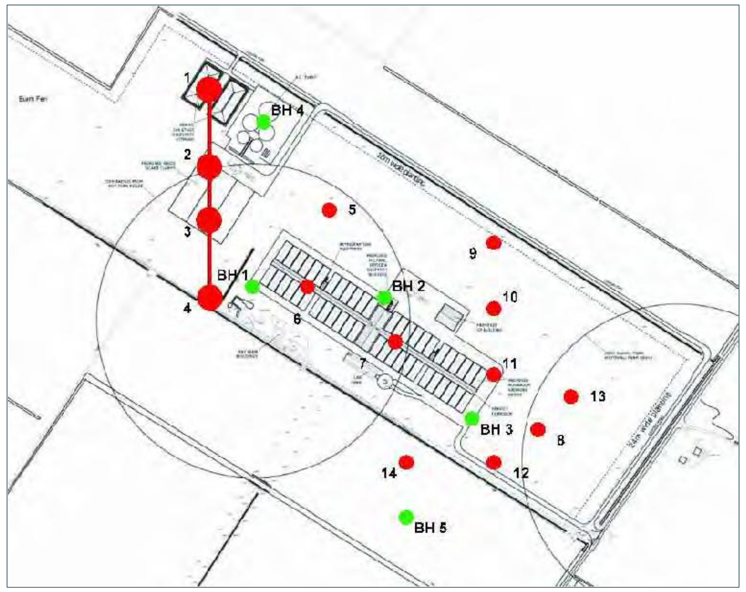
The depositional sequence at Borehole 12 (-2.48 m OD) comprises a dark brown peat-derived clay-silt-sand topsoil to 0.28 m depth (-2.76 m OD) which overlies a weakly laminated flood warp comprising grey clay with light brown and orange sand laminations to 1.04 m depth (-3.52 m OD). Below this unit, blue-grey alluvium with occasional organics continues to 2.07 m depth (-4.55 m OD), onto a humified red-brown peat with visible plant macrofossils to 2.73 m depth (-5.21 m OD). At the base of the core this peat overlies fine-medium brown sands which continues to the base of the core at 3.05 m depth (-5.53 m OD). It was not possible to excavate below this depth due to the thixotropic nature of the sediment.

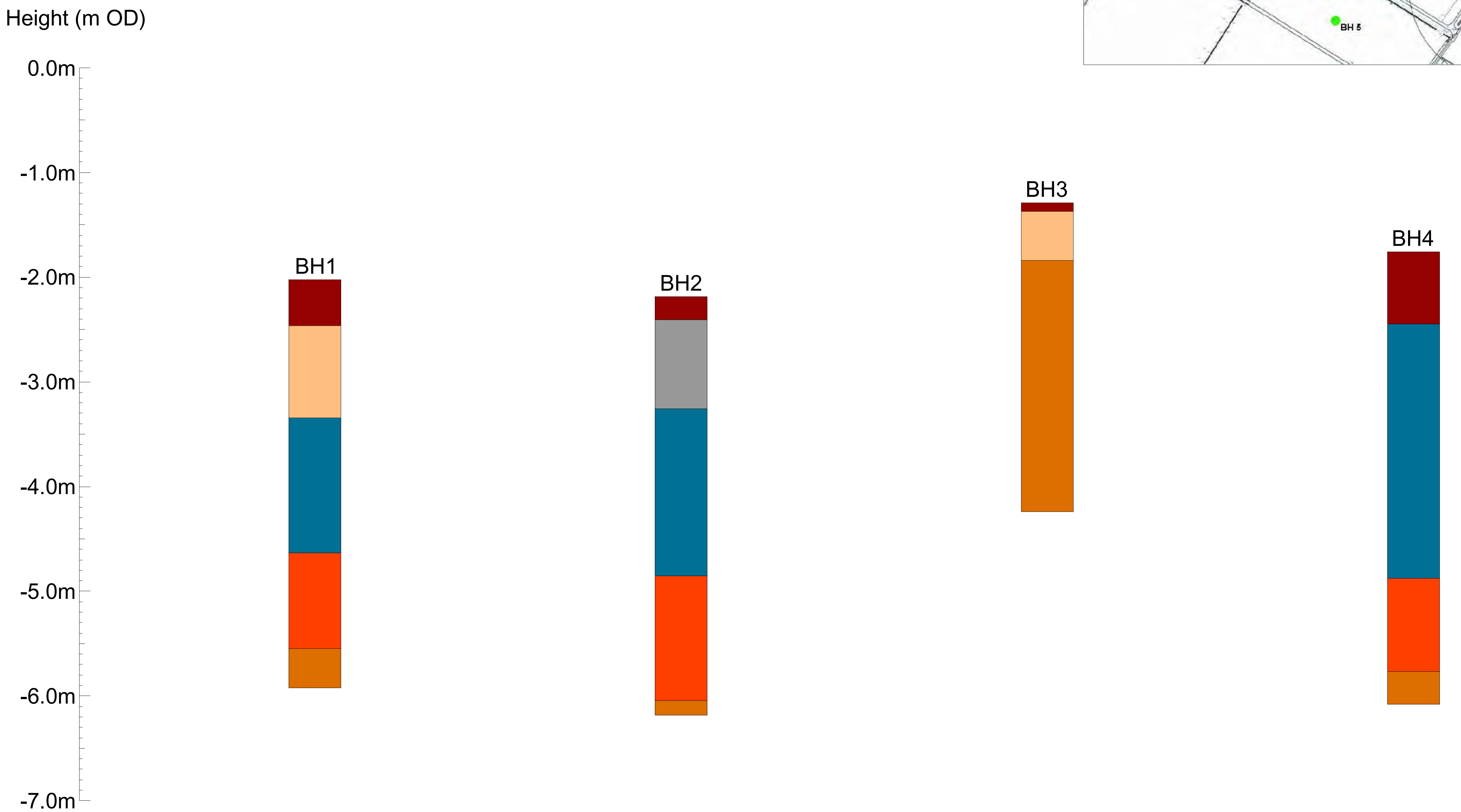
5.14 **Borehole 13**

Borehole 13 (-1.50 m OD) comprises a dark brown peat-derived clay-silt-sand topsoil to 0.13 m depth (-1.63 m OD), which overlies a weakly laminated flood warp comprising grey clay with light brown and orange sand laminations to 1.81 m depth (-3.31 m OD). The base of the sequence comprises orange fine-medium sand to 2.50 m depth (-4.00 m OD). It was not possible to excavate below this depth due to the thixotropic nature of the sediment.

5.15 **Borehole 14**

The depositional sequence at Borehole 14 (-1.59 m OD) comprises a dark brown peat-derived clay-silt-sand topsoil to 0.32 m depth (-1.91 m OD), which overlies a weakly laminated flood warp comprising grey clay with light brown and orange sand laminations to 2.21 m depth (-3.807 m OD). Below this unit, blue-grey alluvium with occasional organics continues to 3.74 m depth (-5.33 m OD), onto a humified red-brown peat with visible plant macrofossils to 4.61 m depth (-6.20 m OD). This in turn overlies fine-medium brown sands to 4.80 m depth (-6.39 m OD). Finally, blue-grey clays continue to the base of the core at 5.00 m depth (-6.59 m OD). It was not possible to excavate below this depth due to the compacted nature of the sediment.





Key:

Troels Smith Sediment Type

- As2, Ag2 Clay-silt plough soil
- As3, Gmin1 Clay with some sand
- As4 Clay
- Peat
- Gmin4 Sand
- As2, Gmin2 Clay-sand
- Gmin3, As1 Sand with some clay

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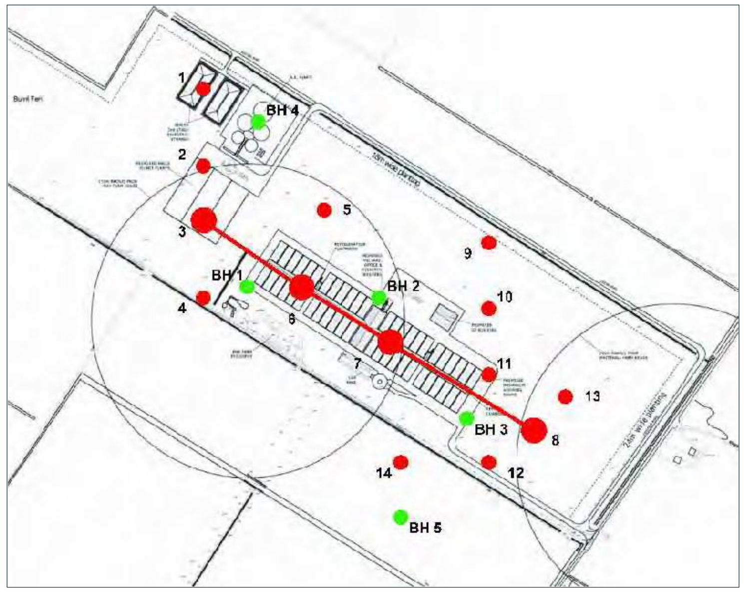
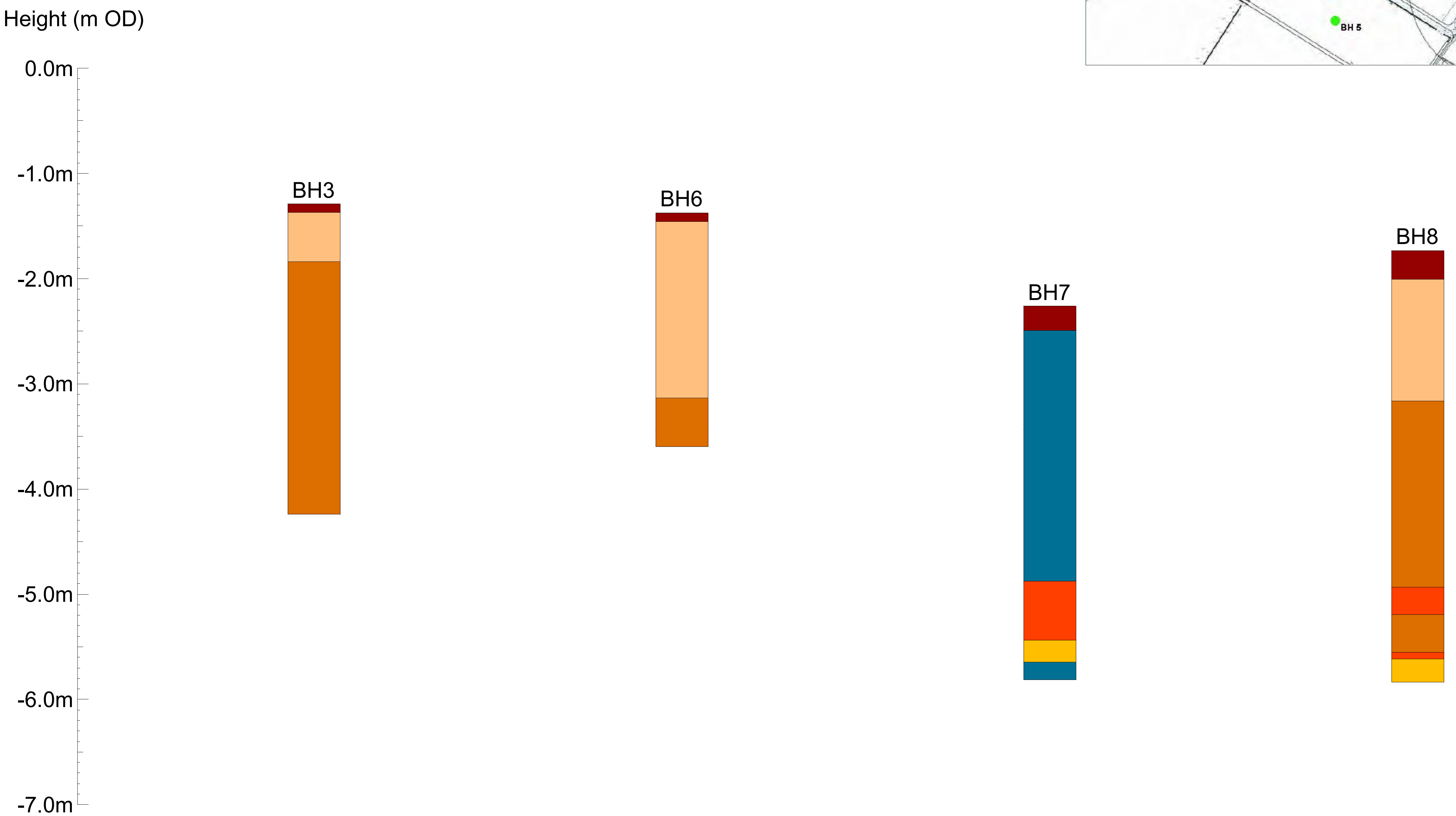
Figure 4: Borehole Transect 1: BH1-BH4





Key:

Troels Smith Sediment Type

- As2, Ag2 Clay-silt plough soil
- As3, Gmin1 Clay with some sand
- As4 Clay
- Peat
- Gmin4 Sand
- As2, Gmin2 Clay-sand
- Gmin3, As1 Sand with some clay

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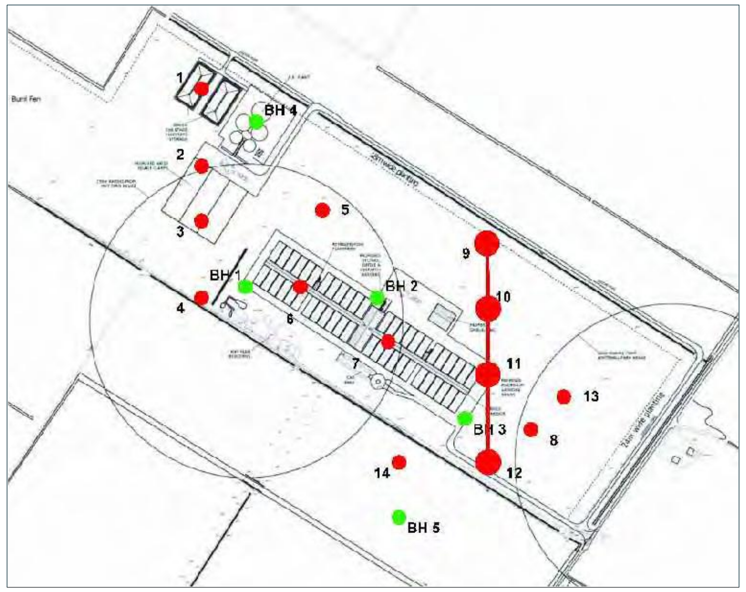
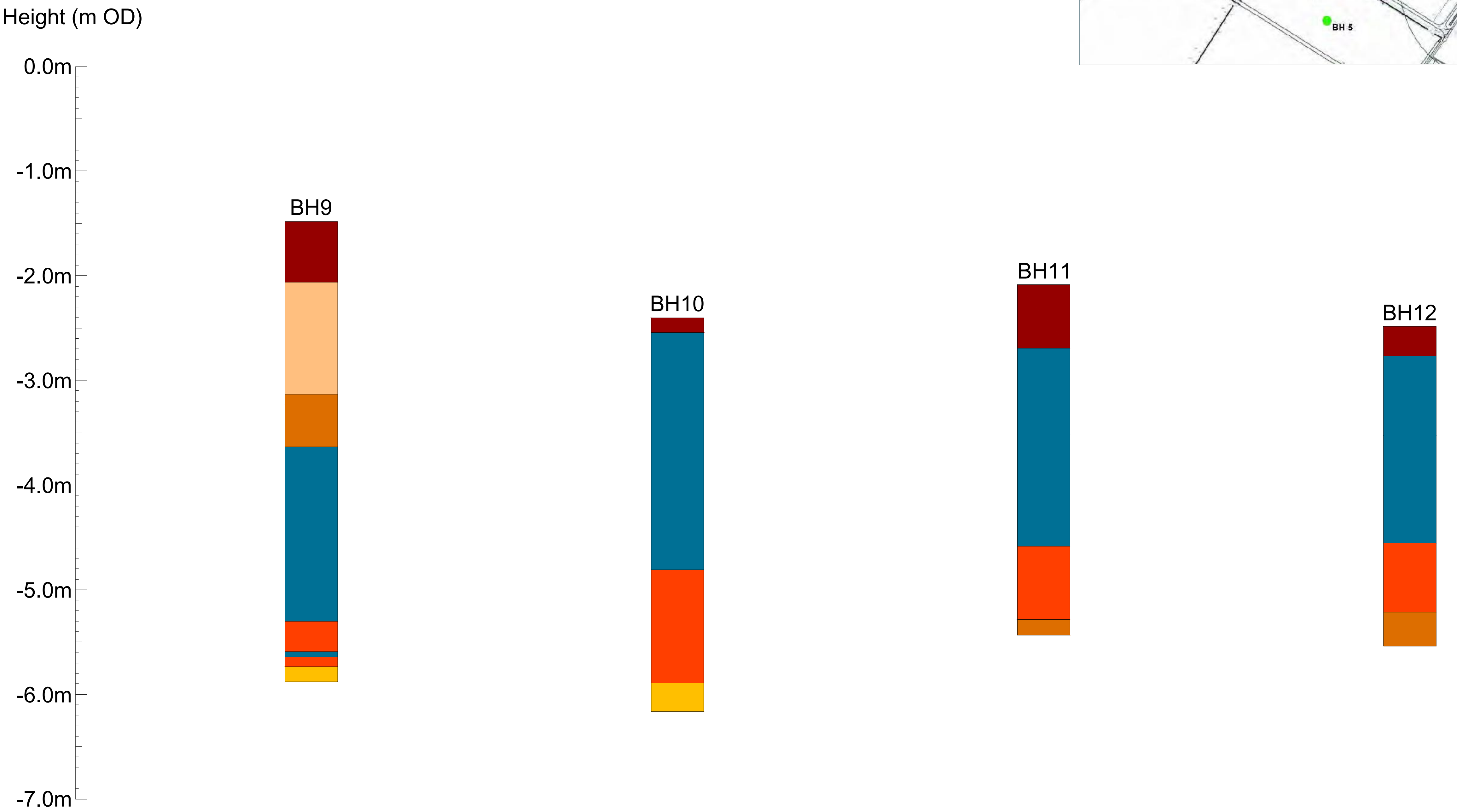
Figure 5: Borehole Transect 2: BH3, BH6-BH8





Key:

Troels Smith Sediment Type

- As2, Ag2 Clay-silt plough soil
- As3, Gmin1 Clay with some sand
- As4 Clay
- Peat
- Gmin4 Sand
- As2, Gmin2 Clay-sand
- Gmin3, As1 Sand with some clay

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Figure 6: Borehole Transect 3: BH9-BH12

6.0 DISCUSSION

6.1 The detailed sediment descriptions highlighted in Section 5, can be summarised as a (generic) sedimentary sequence as follows (displayed in Figures 4-6 above):

- Dark brown clay-silt-sand topsoil is evident in all the boreholes excavated.
- Weakly laminated flood warp comprising grey clay with light brown and orange sand laminations is present in some of the boreholes within the 3 transects.
- Underlying the uppermost horizon/s, unoxidised blue-grey alluvium of Holocene Age (which probably equates to the 'fen clay' defined by Waller [1994]) is present in the majority of the boreholes that comprise Transects 1 and 3.
- Below the alluvium, red-brown peat is in evidence in these boreholes.
- Brown fine-medium sands dominate to the base of all the boreholes (with the exception of Borehole 7).

6.2 In general, the sequences identified from Boreholes 3, 5, 6, 8, 9, 13 and 14 reflect varying aggradation / inundation and channel flow regimes of relatively low energy in the vicinity of the Little Ouse river. The sediment particle sizes within the Holocene sequences rarely exceed a fine sand component, with the laminated sequences reflecting normal sedimentation (aggradation) of material of warp-like character out of suspension. The finer grained alluvium towards the upper part of Boreholes 1, 2, 4, 7, 9-12 and 14 reflects a removal and/or cessation of inundation / channel flow regimes in the upper 3.00-4.00 m of the sequences in this area. Overlying these sequences is a combination of warp deposits derived from natural processes, such as overbank flooding.

6.3 At Borehole 9 the basal peats (*sensu* Waller 1994) recovered during the borehole survey (between -5.01 to -5.56 m OD) demonstrate the existence of alternating zones of wood peat and a fine detrital peat, with some fine mineral material. Given the context, these sediments most likely record long-term oscillations in spatial organisation within a floodplain environment, with periods of woodland carr (typically alder or willow carr) alternating with more open fen vegetation which receives higher energy water flow from the main channel, and therefore tends to trap mineral sediment as well as organic material.

6.4 As the basal 0.08 m of this peat unit comprises quite compact wood horizons, the lowest peat sample occurs between -5.47 to -5.48 m OD. Despite the occurrence of a further 50 mm of wood above this peat sampling point, the presence of more continuous peats above -5.39 m OD would mean that this would be the lowest point in this core from which to recover a palaeoenvironmental sequence for the onset of peat formation.

6.5 The range of macrofossil plant material in Borehole 9 suggests that several contrasting vegetation phases were present. These dynamic changes may reflect internal system dynamics or alternatively they could be reflecting changes in the position of the main river channel, or possibly regional water table oscillations in response to sea level change.

6.6 At Borehole 11 a slightly thicker (*ca*. 0.65 m) peat unit with a more continuous developmental sequence (with far fewer woody inclusions) was identified. The thickness of the peat horizon at his location, which occurs between -4.54 to -5.19 m OD, coupled with the more uniform sampling opportunities, would indicate that this sequence is appropriate for facilitating a palaeoenvironmental reconstruction of the environment in the Holocene, potentially from (at least) the later Mesolithic period onwards.

6.7 Similarly, at Borehole 2 a thick (*ca*. 0.97 m) peat unit which occurs between -4.73 and -5.70 m OD, and which grades from a humified peat with no woody inclusions, towards an increasingly woody humified peat below *ca*. -5.17 m OD. As the base of the peat in Borehole 2 is at -5.70 m OD, this location would provide the lowest stratigraphic point for the onset of peat development in the study area. Furthermore, the thicker stratigraphy and relatively low wood macrofossil content (when compared to Borehole 9) would make Borehole 2 the optimum sampling point for any palaeoenvironmental assessment in the area of the proposed development (Appendix E).

6.8 Finally, the observation that there appears to be discrete depositional episodes within the main alluvial unit at this location accords well with the observations of Waller (1994:14-15) who notes that all of the fen clay sediments in south Fenland are asynchronous in nature, despite similarities in their lithological composition.

7.0 CONCLUSIONS

7.1 As stated in Section 3, the aims of the present study were to:

- Outline the nature of the sediments encountered during the geoarchaeological investigation;
- Identify the generic processes responsible for sediment deposition;
- Describe the geo-morphological development of the site;
- Assess the archaeological and palaeoenvironmental potential of the sediment deposits within the site; and
- Consider the impact of the footprint of the development upon any buried archaeological and palaeoenvironmental resource.

7.2 The results of the geoarchaeological investigation did not produce any indication of the presence of stratified archaeological deposits or evidence for buried land surfaces. The investigation has shown that stratified sequences of flood warp, channel infill and alluvium occur throughout much of the floodplain area. The cores excavated at Boreholes 1, 2, 4, 8, 9-12 and 14 also show organic sequences beneath the alluvium and warp to depths of *ca*. 2.50-4.00 m below the modern ground surface.

7.3 Furthermore, at Borehole 3, the alluvium sequence appears to overlie a sand ridge / island at 0.55 m depth. This location is outside those areas proposed for deep excavation, although one of the water storage lagoons is located a short distance to the southeast.

7.4 The main findings of the current study are that this area has not identified potential for the presence of archaeological features or contexts, but some potential for the recovery of palaeoenvironmental evidence for the Late Mesolithic through to middle Bronze Age periods of landscape development in this region, and for the dating of the onset of alluvial deposition in the area. However, the contained sequences are generally buried beneath *ca*. 2.50 m of alluvium and warp deposits.

7.5 In light of this observation, and given the fact that the majority of ground works associated with the development will be shallow, it is suggested that only those areas where significant sediment removal and/or compaction may be prevalent could have the potential to compromise the archaeo-environmental resource in this area.

8.0 REFERENCES

Aaby, B. and Berglund, B.E. 1986. Characterisation of peat and lake deposits, in B.E. Berglund (ed) *Handbook of Holocene Palaeoecology and Palaeohydrology*, 231-246. John Wiley and Sons, Chichester.

Association for Environmental Archaeology. 1995. Environmental archaeology and archaeological evaluations. Recommendations concerning the environmental archaeology component of archaeological evaluations in England. *Working Papers of the Association for Environmental Archaeology*: **2**, 8. Association for Environmental Archaeology, York.

Flitcroft, M. 2011. *Archaeological Desk Based Assessment: Land at May Farm, Littleport, Cambridgeshire*. CgMs Consulting Limited, London.

Long A. J., Innes J. B., Shennan I. and Tooley M. J. 1999. Coastal stratigraphy: a case study from John River, Washington, USA, in A.P. Jones, M.E. Tucker and J.K. Hart (eds) *The Description and Analysis of Quaternary Stratigraphic Data: Technical Guide* **7**, 267–286. Quaternary Research Association, London.

Troels-Smith, J. 1955. Characterisation of Loose Sediment. *Denmarks Geologiske Undersogelse* **4**, 1-73.

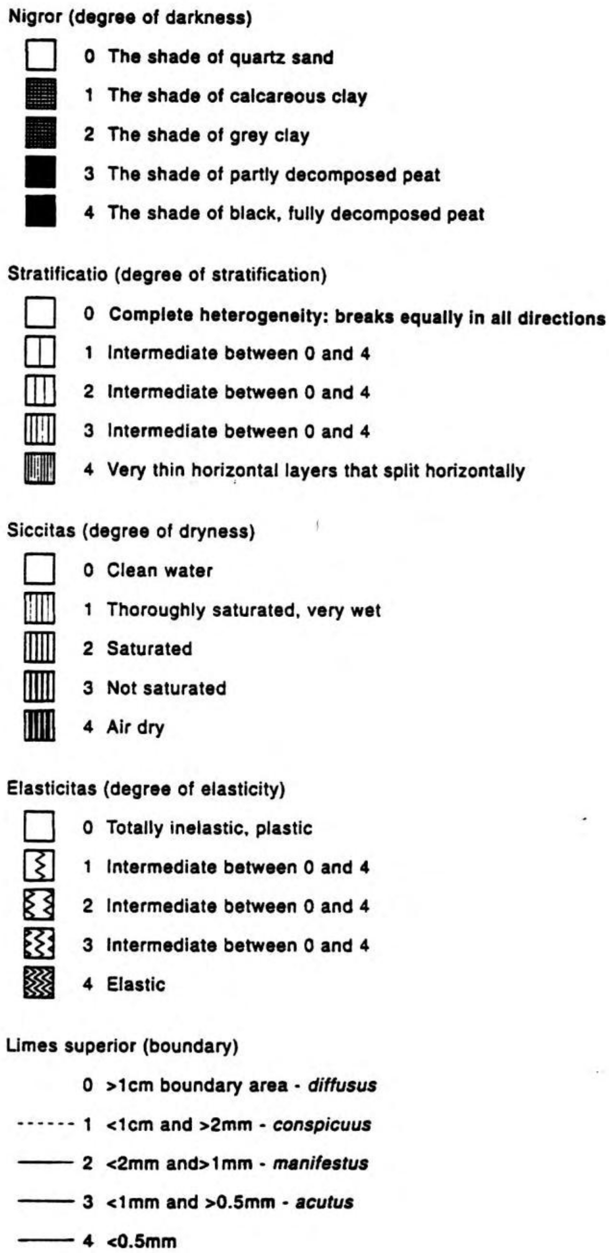
Waller, M. 1994. Geological History, in M. Waller (ed) *The Fenland Project, Number 9: Flandrian Environmental Change in Fenland*. East Anglian Archaeology Report **70**, 7-17.

9.0 APPENDIX A

Name	Code	Sediment type	Field characteristics
Argilla steatodes	As	Clay <0.002mm	May be rolled into a thread < or = 2mm diameter without breaking. Plastic when wet, hard when dry.
Argilla granosa	Ag	Silt 0.06-0.002mm	Will not roll into thread without splitting. Will rub into dust on drying (such as on hands). Gritty on back of teeth.
*Grana minora**	Gmin	Fine, medium and coarse sand (0.06-2.0mm)	Crunchy between teeth. Lacks cohesion when dry. Grains visible to naked eye.
*Grana majora**	Gmaj	Fine, medium and coarse gravel (2-60mm)	
Testae (molluscorum)	test.(moll)	Whole mollusc shells	
Particulae testarum (molluscorum)	part. test. (moll)	Shell fragments	
Substantia humosa	Sh	Humified organics beyond identification	Fully distintegrated deposit lacking macroscopic structure, usually dark brown or black.
Turfa herbacea	Th^{0-4}	Roots, stems and rhizomes of herbaceous plants	Can be seen vertically aligned or matted within sediment in growth position.
Turfa bryophytica	Tb^{0-4}	The protonema, rhizods, stems, leaves etc. of mosses	Can be seen vertically aligned or matted within sediment in growth position.
Turfa lignosa	Tl^{0-4}	The roots and stumps of woody plants and their trunks, branches and twigs.	Can be seen vertically aligned or layered within sediment in growth position.
Detritus lignosus	Dl	Detrital fragments of wood and bark >2mm	Non-vertical or random alignment. may be laminated, not in growth position.
Detritus herbosus	Dh	Fragments of stems and leaves of herbaceous plants >2mm	Non-vertical or random alignment. may be laminated, not in growth position.
Detritus granosus	Dg	Woody and herbaceous humified plant remains <2mm >0.1mm that cannot be separated.	Non-vertical or random alignment. may be laminated, not in growth position.
Limus detrituosus	Ld^{0-4}	Fine detritus organic mud (particles <0.1mm).	Homogeneous, non-plastic, often becomes darker on oxidation and will shrink on drying. Most shades of colour.
Limus ferrugineus	Lf	Mineral and/or organic iron oxide	Forms mottled staining. Can be crushed between fingers. Often in root channels or surrounding Th.
Anthrax	**Anth**	**Charcoal**	**Crunchy black fragments**
Stirpes	**Stirp**	**Tree stump**	
Stratum confusum	**Sc**	**Disturbed stratum**	

List of Troels-Smith symbols for commonly encountered sediment types (*after* Long *et al.* 1999: 270).

10.0 APPENDIX B



Physical properties and boundary characteristics for deposit units according to the Troels-Smith scheme of sediment description (*after* Long *et al.* 1999: 273).

11.0 APPENDIX C

Borehole logs of each core excavated during the auger survey are presented below. The list of Troels-Smith symbols for commonly encountered sediment types are displayed in Appendix A, whilst the physical properties and boundary characteristics of depositional units are highlighted in Appendix B. The physical properties and boundary characteristics of each borehole will be described in the following order:

Sediment, Nigror, Elasticas, Stratification, Limes superior, Siccitas

Borehole 1
Location: NGR 559776.00 287563.59
Ground Surface: -2.02 m AOD
Layer 1
Depth: 0 - 0.44 m
Description: Dark brown peat ploughsoil
As 2, Ag 2, Gmin +, Nig 3, Elas 2, Strf 1, Lim sup n/a, Sicc 4

Layer 2
Depth: 0.44 - 1.32 m
Description: Grey clay and light brown-orange fine sand
As 3, Gmin 1, Nig 2, Elas 2, Strf 1, Lim sup 0, Sicc 3

Layer 3
Depth: 1.32 - 2.61 m
Description: Blue-grey clay with occasional organics
As 4, Th +, Gmin +, Nig 2, Elas 2, Strf 1, Lim sup 0, Sicc 3

Layer 4
Depth: 2.61 - 3.52 m
Description: Red-brown peat
Sh 3, Th^2 1, Dg +, Nig 3, Elas 2, Strf 1, Lim sup 0, Sicc 3

Layer 5
Depth: 3.52 - 3.90 m
Description: Brown-grey fine/medium sand
Gmin 4, Nig 3, Elas 2, Strf 1, Lim sup 0, Sicc 3
Base of core at 3.90 m

Borehole 2
Location: NGR 559770.56 287435.74
Ground Surface: -2.18 m AOD
Layer 1
Depth: 0 - 0.22 m
Description: Dark brown peat ploughsoil
As 2, Ag 2, Gmin +, Nig 3, Elas 2, Strf 1, Lim sup n/a, Sicc 4
Layer 2
Depth: 0.22 - 1.07 m
Description: Grey clay and light brown-orange fine sand
As 2, Gmin 2, Nig 2, Elas 2, Strf 1, Lim sup 0, Sicc 3

Layer 3

Depth: 1.07 - 2.67 m
Description: Blue-grey clay with occasional organics
As 4, Th +, Gmin +, Nig 2, Elas 2, Strf 1, Lim sup 0, Sicc 3

Layer 4
Depth: 2.67 - 3.86 m
Description: Red-brown peat
Sh 1, Th^3 +, $Tl\ ^3$2, Dg 1, Nig 3, Elas 2, Strf 1, Lim sup 0, Sicc 3

Layer 5
Depth: 3.86 - 4.00 m
Description: Brown-grey fine/medium sand
Gmin 4, Nig 3, Elas 2, Strf 1, Lim sup 0, Sicc 3
Base of core at 4.00 m

Borehole 3
Location: NGR 559776.858 287350.242
Ground Surface: -1.29 m AOD
Layer 1
Depth: 0 - 0.08 m
Description: Dark brown peat ploughsoil
As 2, Ag 2, Gmin +, Nig 3, Elas 2, Strf 1, Lim sup n/a, Sicc 4

Layer 2
Depth: 0.08 - 0.55 m
Description: Grey clay and light brown-yellow fine sand laminations
As 3, Gmin 1, Nig 2, Elas 2, Strf 1, Lim sup 0, Sicc 3

Layer 3
Depth: 0.55 - 2.95 m
Description: Light grey sand with orange mottling
Gmin 4, Nig 2, Elas 2, Strf 1, Lim sup 0, Sicc 3
Base of core at 2.95 m

Borehole 4
Location: NGR 559764.62 287200.10
Ground Surface: -1.75 m AOD
Layer 1
Depth: 0 - 0.69 m
Description: Dark brown peat ploughsoil
As 2, Ag 2, Gmin +, Nig 3, Elas 2, Strf 1, Lim sup n/a, Sicc 4

Layer 2
Depth: 0.69 - 1.33 m
Description: Grey clay and fine orange sand
As 4, Gmin +, Nig 2, Elas 2, Strf 1, Lim sup 0, Sicc 3

Layer 3
Depth: 1.33 - 3.12 m
Description: Blue-grey clay with occasional organics
As 4, Th +, Nig 2, Elas 2, Strf 1, Lim sup 1, Sicc 3

Layer 4
Depth: 3.12 - 4.01 m
Description: Red-brown peat
Sh 3, Th^2 1, Dg +, Nig 3, Elas 2, Strf 1, Lim sup 0, Sicc 3

Layer 5
Depth: 4.01 - 4.32 m
Description: Dark brown-dark grey medium/coarse sand
Gmin 4, Nig 3, Elas 2, Strf 1, Lim sup 0, Sicc 3
Base of core at 4.32 m

Borehole 5
Location: NGR 559996.59 287328.20
Ground Surface: -1.76 m AOD
Layer 1
Depth: 0 - 0.28 m
Description: Dark brown peat ploughsoil
As 2, Ag 2, Gmin +, Nig 3, Elas 2, Strf 1, Lim sup n/a, Sicc 4

Layer 2
Depth: 0.28 - 0.72 m
Description: Grey clay and light brown-yellow fine sand laminations
As 3, Gmin 1, Nig 2, Elas 2, Strf 1, Lim sup 0, Sicc 3

Layer 3
Depth: 0.72 - 2.15 m
Description: Light brown fine/medium sand with orange mottling
Gmin 4, Nig 2, Elas 2, Strf 1, Lim sup 0, Sicc 3
Base of core at 2.15 m

Borehole 6
Location: NGR 559968.01 287230.66
Ground Surface: -1.37 m AOD
Layer 1
Depth: 0 - 0.08 m
Description: Dark brown peat ploughsoil
As 2, Ag 2, Gmin +, Nig 3, Elas 2, Strf 1, Lim sup n/a, Sicc 4

Layer 2
Depth: 0.08 - 1.76 m
Description: Grey clay and fine light brown-yellow sand laminations
As 3, Gmin 1, Nig 2, Elas 2, Strf 1, Lim sup 0, Sicc 3

Layer 3
Depth: 1.76 - 2.07 m
Description: Grey-light brown-orange fine/medium sand with orange mottling
Gmin 4, Nig 2, Elas 2, Strf 1, Lim sup 0, Sicc 3

Layer 4
Depth: 2.07 - 2.22 m
Description: Blue-grey fine/medium sand
Gmin 4, Nig 2, Elas 2, Strf 1, Lim sup 0, Sicc 3
Base of core at 2.22 m

Borehole 7
Location: NGR 560099.42 287148.18
Ground Surface: -2.94 m AOD

Layer 1
Depth: 0 - 0.23 m

Description: Dark brown peat ploughsoil
As 2, Ag 2, Gmin +, Nig 3, Elas 2, Strf 1, Lim sup n/a, Sicc 4

Layer 2
Depth: 0.23 - 1.17 m
Description: Grey clay and fine orange sand
As 4, Gmin +, Nig 2, Elas 2, Strf 1, Lim sup 0, Sicc 3

Layer 3
Depth: 1.17 - 2.61 m
Description: Blue-grey clay with occasional organics
As 4, Th +, Nig 2, Elas 2, Strf 1, Lim sup 1, Sicc 3

Layer 4
Depth: 2.61 - 3.17 m
Description: Red-brown peat
Sh 3, Th^2 1, Dg +, Nig 3, Elas 2, Strf 1, Lim sup 3, Sicc 3

Layer 5
Depth: 3.17 - 3.38 m
Description: Blue-grey fine/medium sand and clay
Gmin 3, As 1, Nig 2, Elas 2, Strf 1, Lim sup 0, Sicc 3

Layer 6
Depth: 3.38 - 3.55 m
Description: Blue-grey clay
As 4, Nig 2, Elas 2, Strf 1, Lim sup 3, Sicc 3

Base of core at 3.55 m

Borehole 8
Location: NGR 560279.70 287038.24
Ground Surface: -2.00 m AOD

Layer 1
Depth: 0 - 0.27 m
Description: Dark brown peat ploughsoil
As 2, Ag 2, Gmin +, Nig 3, Elas 2, Strf 1, Lim sup n/a, Sicc 4

Layer 2
Depth: 0.27 - 1.43 m
Description: Grey clay and light brown-yellow fine sand laminations
As 3, Gmin 1, Nig 2, Elas 2, Strf 1, Lim sup 0, Sicc 3

Layer 3
Depth: 1.43 - 3.20 m
Description: Blue-grey fine/medium sand
Gmin 4, Nig 2, Elas 2, Strf 1, Lim sup 0, Sicc 3

Layer 4
Depth: 3.20 - 3.46 m
Description: Red-brown peat
Sh 3, Th^2 1, Dg +, Nig 3, Elas 2, Strf 1, Lim sup 0, Sicc 3

Layer 5
Depth: 3.46 - 3.82 m
Description: Dark grey-brown fine/medium sand
Gmin 4, Nig 2, Elas 2, Strf 1, Lim sup 0, Sicc 3

Layer 6
Depth: 3.82 - 3.88 m

Description: Red-brown peat
Sh 3, Th^2 1, Dg +, Nig 3, Elas 2, Strf 1, Lim sup 0, Sicc 3

Layer 7
Depth: 3.88 - 4.10 m
Description: Blue-grey clay and brown fine/medium sand
Gmin 3, As 1, Nig 2, Elas 2, Strf 1, Lim sup 0, Sicc 3

Base of core at 4.10 m

Borehole 9

Location: NGR 560222.52 287314.60
Ground Surface: -2.06 m AOD

Layer 1
Depth: 0 - 0.58 m
Description: Dark brown peat ploughsoil
As 2, Ag 2, Gmin +, Nig 3, Elas 2, Strf 1, Lim sup n/a, Sicc 4

Layer 2
Depth: 0.58 - 1.65 m
Description: Grey clay and fine light brown-yellow sand laminations
As 3, Gmin 1, Nig 2, Elas 2, Strf 1, Lim sup 0, Sicc 3

Layer 3
Depth: 1.65 - 1.75 m
Description: Grey-light brown-orange fine/medium sand with orange mottling
Gmin 4, Nig 2, Elas 2, Strf 1, Lim sup 0, Sicc 3

Layer 4
Depth: 1.75 - 2.15 m
Description: Blue-grey fine/medium sand
Gmin 4, Nig 2, Elas 2, Strf 1, Lim sup 0, Sicc 3

Layer 5
Depth: 2.15 - 3.82 m
Description: Blue-grey clay with occasional organics
As 4, Th +, Nig 2, Elas 2, Strf 1, Lim sup 1, Sicc 3

Layer 6
Depth: 3.82 - 4.11 m
Description: Red-brown peat
Sh 3, Th^2 1, Dg +, Nig 3, Elas 2, Strf 1, Lim sup 2, Sicc 3

Layer 7
Depth: 4.11 - 4.16 m
Description: Blue-grey clay with occasional organics
As 4, Th +, Nig 2, Elas 2, Strf 1, Lim sup 2, Sicc 3

Layer 8
Depth: 4.16 - 4.25 m
Description: Red-brown peat
Sh 3, Th 1, Dg +, Nig 3, Elas 2, Strf 1, Lim sup 2, Sicc 3

Layer 9
Depth: 4.25 - 4.40 m
Description: Blue-grey clay and brown fine/medium sand
Gmin 3, As 1, Nig 2, Elas 2, Strf 1, Lim sup 2, Sicc 3

Base of core at 4.40 m

Borehole 10

Location: NGR 560211.35 287203.34
Ground Surface: -2.40 m AOD
Layer 1
Depth: 0 - 0.14 m
Description: Dark brown peat ploughsoil
As 2, Ag 2, Gmin +, Nig 3, Elas 2, Strf 1, Lim sup n/a, Sicc 4

Layer 2
Depth: 0.14 - 1.55 m
Description: Grey clay and fine orange sand
As 4, Gmin +, Nig 2, Elas 2, Strf 1, Lim sup 0, Sicc 3

Layer 3
Depth: 1.55 - 2.41 m
Description: Blue-grey clay with occasional organics
As 4, Th +, Nig 2, Elas 2, Strf 1, Lim sup 1, Sicc 3

Layer 4
Depth: 2.41 - 3.49 m
Description: Red-brown peat
Sh 3, Th^2 1, Dg +, Nig 3, Elas 2, Strf 1, Lim sup 1, Sicc 3

Layer 5
Depth: 3.49 - 3.76 m
Description: Blue-grey clay and brown fine/medium sand
Gmin 3, As 1, Nig 2, Elas 2, Strf 1, Lim sup 1, Sicc 3
Base of core at 3.76 m

Borehole 11
Location: NGR 560206.53 287112.88
Ground Surface: -2.08 m AOD
Layer 1
Depth: 0 - 0.61 m
Description: Dark brown peat ploughsoil
As 2, Ag 2, Gmin +, Nig 3, Elas 2, Strf 1, Lim sup n/a, Sicc 4

Layer 2
Depth: 0.61 - 1.43 m
Description: Grey clay and fine orange sand
As 4, Gmin +, Nig 2, Elas 2, Strf 1, Lim sup 0, Sicc 3

Layer 3
Depth: 1.43 - 2.50 m
Description: Blue-grey clay with occasional organics
As 4, Th +, Nig 2, Elas 2, Strf 1, Lim sup 0, Sicc 3

Layer 4
Depth: 2.50 - 3.20 m
Description: Red-brown peat
Sh 3, Th^2 1, Dg +, Nig 3, Elas 2, Strf 1, Lim sup 4 , Sicc 3

Layer 5
Depth: 3.20 - 3.35 m
Description: Brown fine/medium sand
Gmin 4, Nig 2, Elas 2, Strf 1, Lim sup 1, Sicc 3
Base of core at 3.35 m

Borehole 12
Location: NGR 560195.73 286995.02
Ground Surface: -2.48 m AOD
Layer 1
Depth: 0 - 0.28 m
Description: Dark brown peat ploughsoil
As 2, Ag 2, Gmin +, Nig 3, Elas 2, Strf 1, Lim sup n/a, Sicc 4

Layer 2
Depth: 0.28 - 1.04 m
Description: Grey clay and fine orange sand
As 4, Gmin +, Nig 2, Elas 2, Strf 1, Lim sup 0, Sicc 3

Layer 3
Depth: 1.04 - 2.07 m
Description: Blue-grey clay with occasional organics
As 4, Th +, Nig 2, Elas 2, Strf 1, Lim sup 0, Sicc 3

Layer 4
Depth: 2.07 - 2.73 m
Description: Red-brown peat
Sh 3, Th^2 1, Dg +, Nig 3, Elas 2, Strf 1, Lim sup 1 , Sicc 3

Layer 5
Depth: 2.73 - 3.05 m
Description: Brown fine/medium sand
Gmin 4, Nig 2, Elas 2, Strf 1, Lim sup 0, Sicc 3
Base of core at 3.05 m

Borehole 13
Location: NGR 560341.05 287074.13
Ground Surface: -1.50 m AOD
Layer 1
Depth: 0 - 0.13 m
Description: Dark brown peat ploughsoil
As 2, Ag 2, Gmin +, Nig 3, Elas 2, Strf 1, Lim sup n/a, Sicc 4

Layer 2
Depth: 0.13 - 1.81 m
Description: Grey clay and fine light brown-yellow sand laminations
As 3, Gmin 1, Nig 2, Elas 2, Strf 1, Lim sup 0, Sicc 3

Layer 3
Depth: 1.81 - 2.50 m
Description: Orange fine/medium sand
Gmin 4, Nig 2, Elas 2, Strf 1, Lim sup 0, Sicc 3
Base of core at 2.50 m

Borehole 14
Location: NGR 560093.96 286968.20
Ground Surface: -1.59 m AOD
Layer 1
Depth: 0 - 0.32 m
Description: Dark brown peat ploughsoil
As 2, Ag 2, Gmin +, Nig 3, Elas 2, Strf 1, Lim sup n/a, Sicc 4

Layer 2
Depth: 0.32 - 2.21 m
Description: Grey clay and fine light brown-yellow sand laminations
As 3, Gmin 1, Nig 2, Elas 2, Strf 1, Lim sup 0, Sicc 3

Layer 3
Depth: 2.21 - 3.74 m
Description: Blue-grey clay with occasional organics
As 4, Th +, Nig 2, Elas 2, Strf 1, Lim sup 1, Sicc 3

Layer 4
Depth: 3.74 - 4.61 m
Description: Red-brown peat
Sh 3, Th^2 1, Dg +, Nig 3, Elas 2, Strf 1, Lim sup 4, Sicc 3

Layer 5
Depth: 4.61 - 4.80 m
Description: Brown fine/medium sand
Gmin 4, Nig 2, Elas 2, Strf 1, Lim sup 0, Sicc 3

Layer 6
Depth: 4.80 - 5.00 m
Description: Blue-grey clay
As 4, Nig 2, Elas 2, Strf 1, Lim sup 3, Sicc 3

Base of core at 5.00 m

12.0 APPENDIX D

Sedimentological and Palynological Investigations at May Farm, Littleport, Cambridgeshire

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April 2011

Wetland
Archaeology &
Environments
Research
Centre

University of Hull

Sedimentological and Palynological Investigations at May Farm, Littleport, Cambridgeshire

(NGR TL 601 872)

April 2011

By

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(MFL/01-0411)

Client: CgMs Consulting Ltd.
(12405)

Non-Technical Summary

This report present the results of a preliminary palynological assessment of a buried peat horizon at May Farm, Littleport, Cambridgeshire. The data indicate that the pollen assemblages studied from the lower peat unit at Borehole 2 are broadly similar to those from equivalent peat units in the wider region.

There is no evidence in the environmental record at May Farm to indicate any anthropogenic activity in the vicinity of the site, and the timing of peat development can be correlated to the evidence from Pymore (Waller and Alderton 1993) and Wood Fen (Wheeler 1992). In general, the establishment of alder carr at the onset of peat formation is tentatively dated to *ca.* 4500 BP, and the carr woodland was subsequently replaced by reedswamp after *ca.* 4100 BP. Alder carr then seems to have re-established towards the top of the sequence, possibly at *ca.* 4000 BP. The subsequent deposition of marine alluvium is mapped throughout the Fens, and at this location an upper peat unit formed in the Saxon to Medieval periods.

Whilst interesting in terms of corroborating the palaeoenvironmental work of Waller and Alderton (1993) and that of Wheeler (1992), the sequence from May Farm adds little to our understanding of landscape developments in the Fens region and it is suggested that no further palaeonvironmental work would be warranted at this location.

Acknowledgements

We would like to thank Chelsea Budd for assisting with the field sampling and recording during the recovery of material from boreholes 2, 9 and 11.

Contents

List of Figures

1. Introduction

1.1 This report outlines the results of palynological investigations undertaken on a peat sequence recovered from Borehole 2 (Smith and Lillie 2011) in the vicinity of May Farm near Littleport in Cambridgeshire (NGR TL 601 872). The analysis was commissioned by CgMs Consulting Ltd on behalf of the landowner, G's Marketing.

1.2 The site is located to the north of the junction of Mildenhall Road (A1101) and White House Road, with the area of the proposed development being approximately 10 ha. The current land use is arable, with a small area of set aside immediately to the north of May Farm The area is bounded by drainage ditches and agricultural fields to the west, north and east. The buildings of May Farm and an access road leading east to White House Road lie to the south of the site.

1.3 The assessment of the depositional sequences in the immediate vicinity of May Farm (Smith and Lillie 2011) has shown that the Holocene deposits in the area comprise a superficial peat underlain by alluvium to depth. Below the alluvial unit is a lower peat unit which sits conformably on glacio-fluvial sands and gravels. The current investigation represents a preliminary assessment of the lowest peat unit, which was determined to be best represented by borehole 2 (Appendices 1 and 2). The peat is located at between -4.735 to -5.705m OD at this location (NGR 559770.56 287435.74).

1.4 The aims of the current investigation were to:

- Infer relative ages for the sedimentary sequences at the site on the basis of the pollen assemblages contained within the peat, and potentially refine the chronologies for the ‘Fen Clay’ deposits in the region
- Assess the potential of the sequences to enhance the palaeoecological record for the area, particularly with regards to early woodland, human impact and the presence of acidophilous taxa

2. Palaeoenvironmental Background

2.1 As noted by Smith and Lillie (2011:4), archaeological excavations at Peacock's Farm in the 1930's established that the pre-fen ground surface lies at *ca*. -6 m OD; at this location peat formed early in the deep channels of the Little Ouse with radiocarbon dates of 8620±160 BP to 4800±120 BP (8015-7305 and 3930-3340 cal BC). Recent archaeological investigations at the Main Drain close to Peacock's Farm established that peat growth continued until around 2195-2785 cal BC before marine flooding reached this area. This marine inundation continued until *ca*. 2400 BC. Overlying the alluvial unit that was deposited during this marine transgression, an upper peat formed in the area during the Saxon and Medieval periods.

2.2 Previous palynological studies in the wider region include those of Waller and Alderton (1993) at Pymore (NGR TL 4975 8515), Godwin *et al*. (1935) at Wood Fen (NGR TL 560 840) and Wheeler (1992), also at Wood Fen (NGR TL 5562 8433).

Seale (1975) mapped the Holocene deposits of the Ely region and showed the 'Fen Clay' sediments to the west of Littleport to be split into two lobes, divided by high ground extending from Little Downham to Pymore. The sediments in the western lobe were investigated by Waller and Alderton (1993), during the Fenland Project, when part of the Main Drain near Pymore was cleaned.

At the site chosen for palynological analysis at Pymore a black, disturbed, highly humified upper peat layer was recorded between -0.97 and -1.47m OD. This was underlain by a blue-grey silty clay ('Fen Clay') to a depth of -3.02m OD, below which dark grey clayey peat with abundant *Phragmites* occurred to -3.06m OD. Dark reddish brown humified peat containing *Phragmites* and some wood was present to a depth of -3.465m OD, followed by very dark grey organic clayey silt with *Phragmites* and *Corylus avellena* nuts to -3.55m OD. This was underlain by a pre-Flandrian deposit of dark blue sandy clay (Waller and Alderton 1993). The sedimentary sequence generally conforms to the four-part stratigraphic division of Fenland Flandrian deposits described by Godwin and Clifford (1938), although the upper silt layer is absent at this site.

The basal peat unit at Pymore was investigated palynologically and the pollen sequence was split into three local pollen assemblage zones. On a local scale, high proportions of *Alnus glutinosa* pollen indicated that fen carr was present between 4300 ±100 and 4190 ±70 BP. After 4190 ±70 BP the fen carr seems to have been replaced by reedswamp, which persisted until the end of the sequence. Towards the end of the sequence a more brackish influence is indicated by the pollen assemblages, perhaps indicating the presence of coastal reedswamp or saltmarsh prior to the transgressive contact with the 'Fen Clay' (Waller and Alderton 1993).

In general, at the regional scale, the low proportions of herbaceous pollen taxa at the base of the sequence at Pymore, at *ca.* 4300 ±100 BP, in conjunction with high percentages of *Tilia* pollen, are typical of the basal peat profiles investigated by the Fenland Project (Waller and Alderton 1993). There seems to have been little human impact on the woodland prior to peat formation, and the subsequent low frequencies of *Tilia* pollen are interpreted by Waller and Alderton (1993) as reflecting its local disappearance and of the poor dispersal of lime pollen. However Godwin *et al*. (1935) recorded high (*ca.* 10%) *Tilia* pollen percentages in both the lower and upper peats at Wood Fen, suggesting that this taxon persisted in drier areas. Corresponding declines in the percentages and concentrations of arboreal pollen taxa after 4190 ±70 BP probably indicate a decline in woodland cover at this time (Waller and Alderton 1993).

The radiocarbon dates from Pymore differ significantly from the chronologies previously proposed for the 'Fen Clay' deposits of this region. Previous studies (e.g. Willis 1961; Shennan 1980, 1986) suggested that the upper peat had begun to form before 4000 BP, perhaps as early as 4500 BP, whereas the contact between the basal peat with 'Fen Clay' at Pymore was radiocarbon dated to 3955 ±70 BP.

2.3 Palaeoenvironmental investigations of sediments in the eastern 'Fen Clay' lobe are represented by the studies at Wood Fen. Godwin *et al*. (1935) identified a phase of acidification at Wood Fen, with peaks in both *Pinus sylvestris* pollen and *Sphagnum* spores. This material was subsequently radiocarbon dated to *ca.* 4195 ±110 BP and was thought to represent renewed peat growth after the 'Fen Clay' phase (Godwin and Willis 1961).

Taxa indicative of acidic conditions are scarce or absent from the sites investigated by the Fenland Project in the south-eastern fens (Waller 1993), making the site at Wood Fen particularly interesting from a palaeoecological perspective. Although the deposits at this site were not re-examined palynologically as part of the Fenland Project, such an investigation was subsequently undertaken by Wheeler (1992).

2.4 During a re-examination of the perimarine deposits at Wood Fen by Wheeler (1992) pollen analysis was undertaken on a 0.75m peat sequence. The base of the sequence was dominated by *Quercus*, *Tilia*, *Corylus avellana*-type, *Taxus* and *Ulmus* pollen, interpreted by Wheeler (1992) as components of the pre-fen woodland. A rise in water table caused peat accumulation which has been correlated with the deposition of a marine or brackish clay in the west of the Wood Fen basin between 4150 and 3800 BP (Wheeler 1992). Following this event, an increase in the frequencies of pollen and spores of acidophilous taxa including *Betula* and *Sphagnum* occurred and has been radiocarbon dated to 3615 ±90 BP. The peat was subsequently colonised by *Pinus sylvestris*, although sedimentological evidence indicates that this colonisation was interrupted by a short-lived episode of flooding, and was eventually terminated by a major rise in the regional water table. This event was inferred by Wheeler (1992) to have occurred between 3300 and 3000 BP, although it was not radiocarbon dated. An acidophilous flora seems to have persisted at the site, although the high water table apparently prevented the development of a raised bog, until the establishment of eutrophic alder carr occurred at the top of the sequence (Wheeler 1992).

3. Methodology

3.1 In the current study three boreholes (BH2, BH9 and BH11) were assessed and sub-sampled in order to facilitate a palaeoenvironmental assessment of the biogenic deposits present. The computer programme TSPPlus (Waller *et al*. 1995) was used to display lithostratigraphic data for the sequence (Figure 1).

3.2 The sub-samples were sealed in plastic bags in the field and stored in a cooler bag until they were returned to the laboratory, where all samples were stored in the dark at 5 ^{o}C to prevent desiccation or oxidation (Moore *et al*. 1991).

3.3 Sub-samples of 1 cm^3 were prepared for pollen analysis following standard methods (e.g. Moore *et al*. 1991), including treatment with hot 40% hydrofluoric acid, 5% sodium pyrophosphate and fine sieving as appropriate in order to remove any mineral component. Tablets containing a known concentration of *Lycopodium clavatum* spores were added to the samples before chemical treatment to allow pollen concentrations to be calculated (Stockmarr 1971). Residues were stained using aqueous safranin and mounted on microscope slides in silicon oil.

3.4 Slides were counted at a magnification of ×400, with ×1000 magnification and oil immersion used for critical identifications. A minimum of 300 pollen grains and spores were counted per sample in order to reduce statistical errors (Maher 1972).

3.5 Pollen and spores were identified using the keys of Moore *et al*. (1991) and Beug (2004) and the reference collections of the Department of Geography, University of Hull, and pollen taxonomy follows Bennett *et al*. (1994). A list of Latin and English botanical names is presented in Appendix 3.

3.6 The pollen data are presented as proportions (Figure 2) with the values of different taxa expressed as percentages of a pollen sum. The sum consists of all terrestrial pollen and spores, excluding bryophytes. Aquatic species and bryophytes are left out of the pollen sum as they reflect local rather than regional conditions (Birks and Birks 1980). In order to avoid problems associated with interpreting pollen types with very high percentage values, for which small changes in proportions may reflect substantial differences in the amount of pollen actually present, pollen concentrations (grains cm^{-3}) were also calculated (Figure 3). Percentage and concentration diagrams were plotted using psimpoll 4.25 (Bennett 2005).

3.7 Pollen diagrams were subdivided into local pollen assemblage zones in order to simplify their description and aid in their discussion and interpretation. This was carried out using a function of psimpoll 4.25 (Bennett 2005) which generates zonation schemes based on both binary and optimal splitting, using either sum-of-squares or information content criteria (Birks and Gordon 1985), and on agglomeration using constrained cluster analysis (Grimm 1987). Zonation using this function was carried out on a subset of the pollen data from each site containing all main sum taxa that constituted 2% or more of at least one sample.

4. Results

4.1 The stratigraphic sequence from Borehole 2 (Figure 1) comprises dark brown peaty ploughsoil from -2.185 to -2.405m OD. This is underlain by blue-grey Fe-mottled clays and fine sands with some fine orange-brown sandy partings to -3.115m OD. Underneath this unit blue-grey clays with occasional fine sands occur to -4.735m OD, and below this depth red-brown humified peat is present to -5.705m OD. The peat is underlain by blue-grey fine-medium sands which are present to the base of the sequence at -5.905m OD (see Appendix 1 for detailed borehole description).

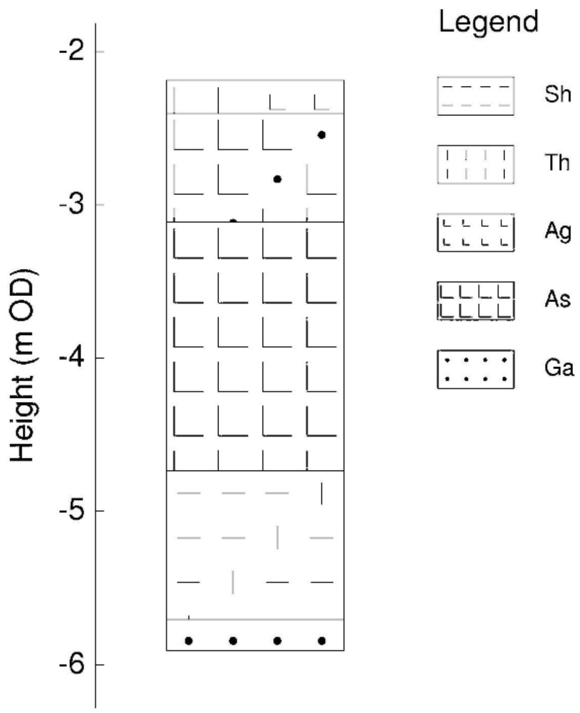

Figure 1: Stratigraphy of the sequence recovered from BH2 (NGR 559770.56 287435.74) at May Farm (see Appendix 2 for key to Troels Smith symbols used in stratigraphic recording).

4.2 Ten samples from various intervals throughout the unit of red-brown humified peat were analysed for pollen. A percentage pollen diagram from the peat sequence is shown in Figure 2. The zonation scheme is based on all taxa with values greater than 2% in at least one sample, which included *Pinus sylvestris*, *Ulmus*, *Quercus*, *Betula*, *Alnus glutinosa*, *Corylus avellana*-type, *Tilia*, *Salix*, *Fraxinus excelsior*, *Ranunculus acris*-type, *Filipendula*, Rosaceae undiff., Apiaceae undiff., Cyperaceae, *Phragmites*-type, Poaceae undiff., *Polypodium* and Pteropsida (monolete) undiff. A pollen concentration diagram for the sequence is shown in Figure 3. Each of the four local pollen assemblage zones is described individually below, and the trends described in the percentage diagram are reflected by the concentration data unless otherwise stated.

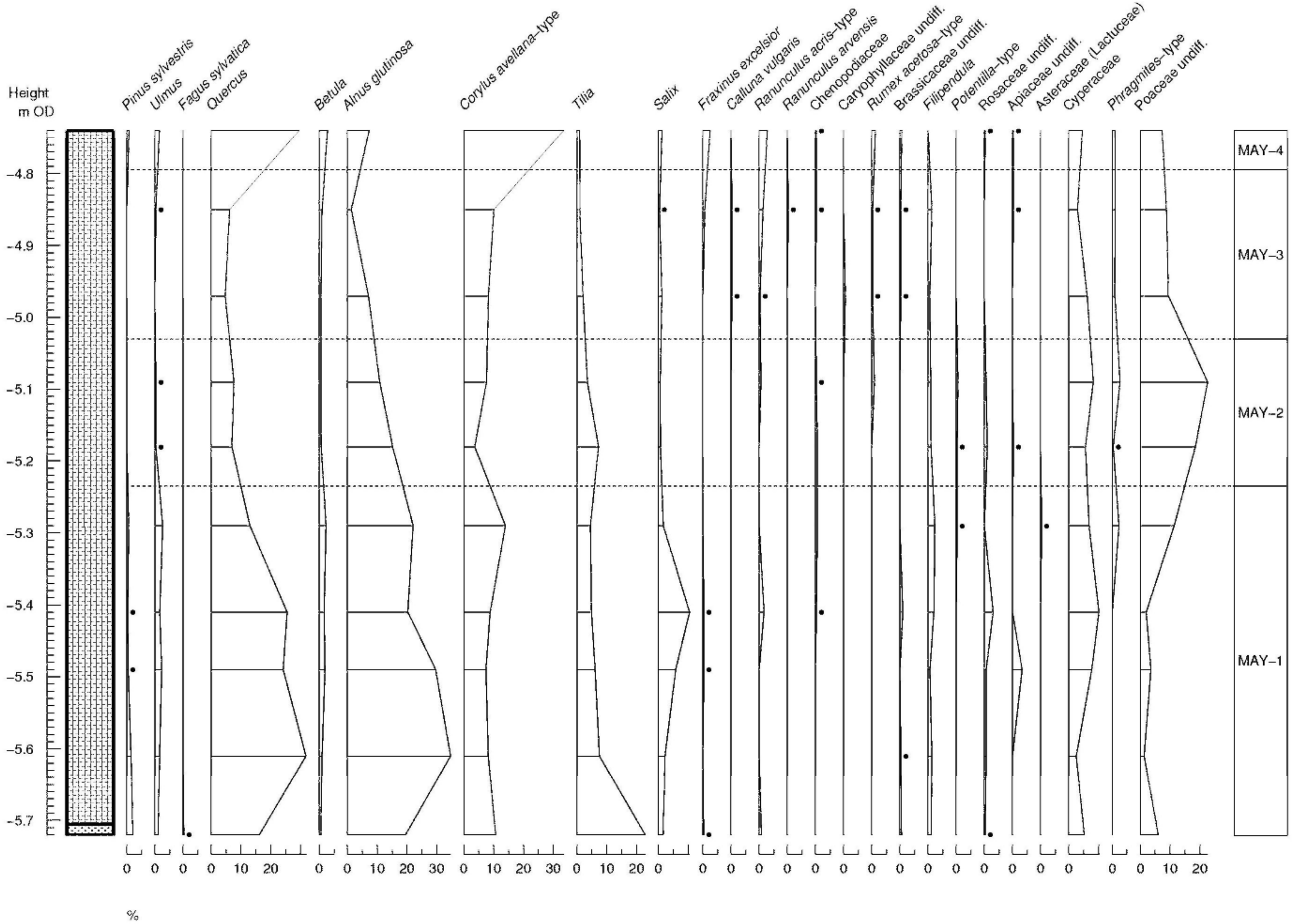

Figure 2: Percentage pollen and spore diagram from Borehole 2.

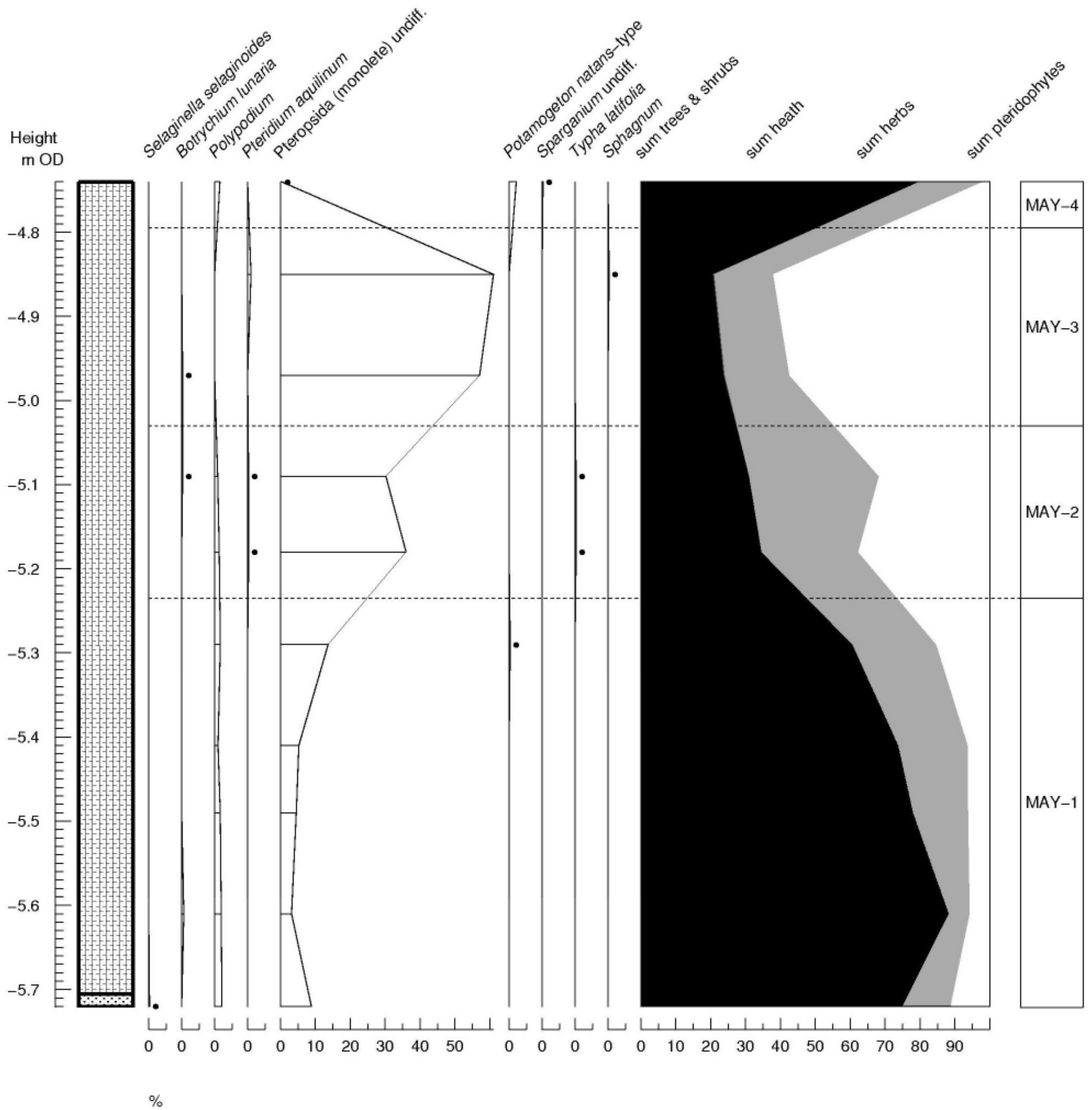

Figure 2 (continued): Percentage pollen and spore diagram from Borehole 2.

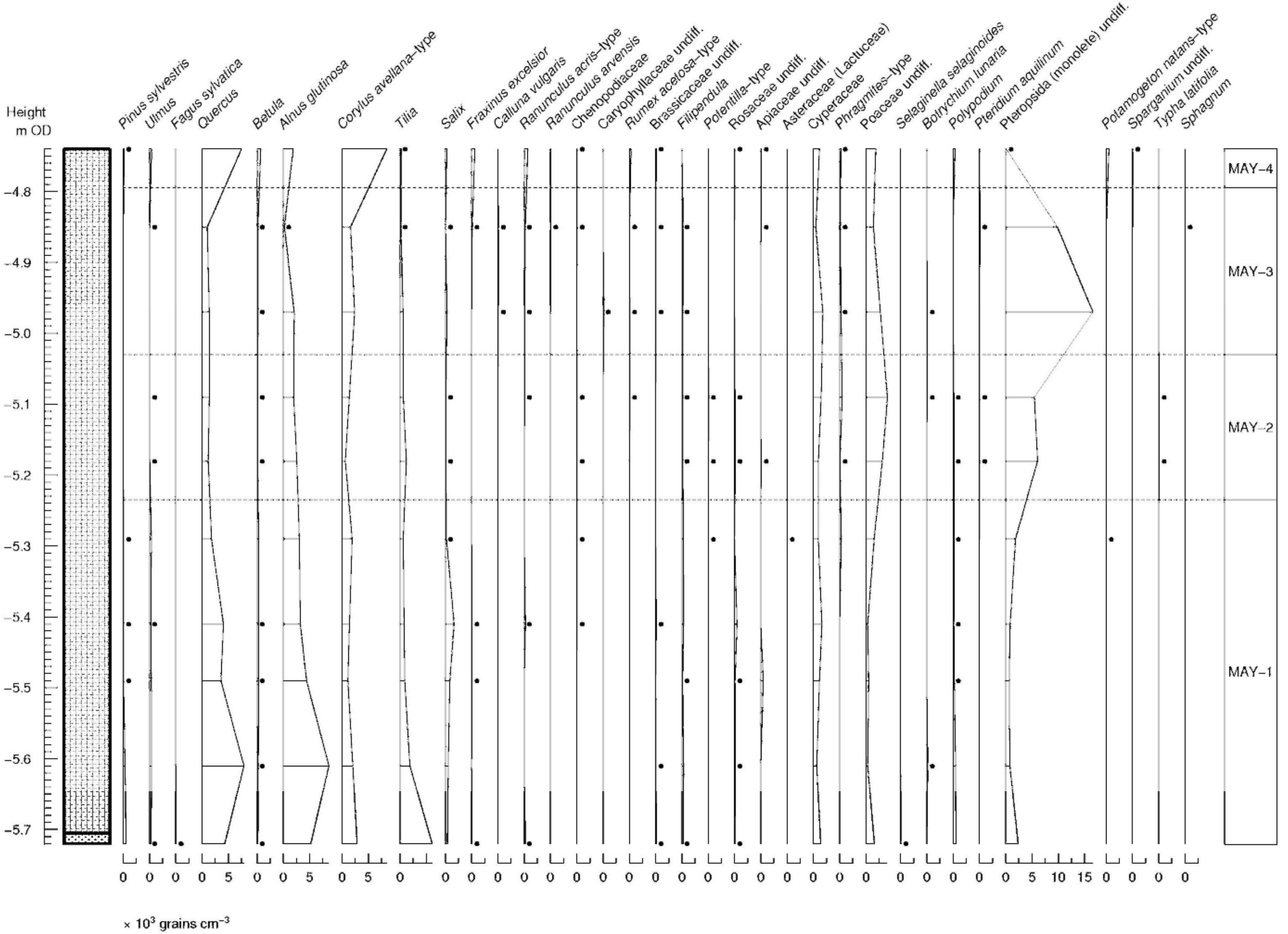

Figure 3: Pollen and spore concentrations from Borehole 2.

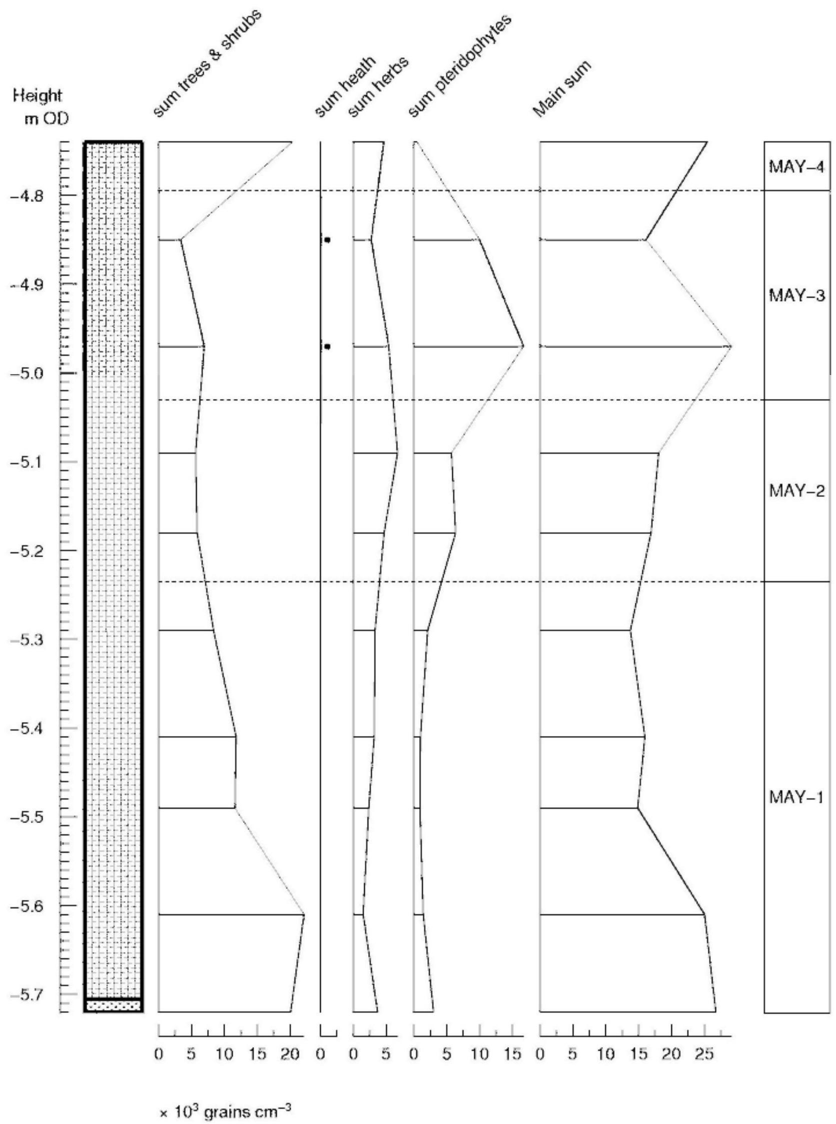

Figure 3 (continued): Pollen and spore concentrations from Borehole 2.

4.3 *Local pollen assemblage zone MAY-1 (-5.72 to -5.235m OD)*
Pollen concentrations are reasonably high at the base of this zone, *ca.* 25,000 grains cm^{-3}, declining towards the top of the zone to value of around 15,000 grains cm^{-3}. The zone is dominated by pollen of aboreal taxa, which forms 60-80% of the total pollen sum throughout. The main arboreal taxa represented are *Quercus* (*ca.* 20%), *Alnus glutinosa* (*ca.* 30%), *Corylus avellana*-type (*ca.* 10%), *Tilia* (*ca.* 20% at the base of the zone, *ca*. 7% for the remainder) and *Salix* (*ca.* 5%). *Pinus sylvestris* pollen is present in very low frequencies (*ca.* 2%) at the base of the zone, and *Ulmus* and *Betula* pollen occur at frequencies of 1-2% throughout.

Frequencies of herbaceous pollen are fairly low (*ca.* 15%) throughout this zone, and the dominant taxa in this group are Cyperaceae and Poaceae, with pollen of each forming around 5-10% of the total sum. Other herbaceous taxa represented at very low pollen frequencies of 1-2% include *Ranunculus acris*-type, Chenopodiaceae, Brassicaceae, *Filipendula*, Rosaceae and Apiaceae. *Phragmites*-type pollen makes up around 3% of the total pollen sum at the top of the zone.

Pteridophyte spores form *ca.* 10% of the total sum at the base of this zone, declining to *ca.* 5% in the middle before increasing to around 15% at the top of the zone. Of the spores that could be identified, the majority were of *Polypodium* (*ca.* 2%). Frequencies of aquatic taxa are negligible.

4.4 *Local pollen assemblage zone MAY-2 (-5.235 to -5.03m OD)*
In this zone total pollen and spore concentration is slightly higher than at the end of the previous zone, being 16-18,000 grains cm^{-3}. Percentages of aboreal pollen decline to *ca.* 30%, with the main taxa affected being *Quercus, Alnus glutinosa* and *Salix*, pollen percentages of which decrease to *ca.* 7%, *ca.* 15% and <1% of the total sum respectively. Frequencies of *Ulmus* and *Betula* pollen decline to <1%, although percentages of *Corylus avellana*-type and *Tilia* pollen also decline slightly to *ca.* 5%.

Frequencies of herbaceous pollen taxa increase to 30-40% in this zone, again dominated by Cyperaceae (*ca.* 8%) and Poaceae (*ca.* 20%). The same range of other herbaceous taxa are present at low values of 1-2% as previously noted, with the addition of *Rumex acetosa*-type and *Potentilla*-type. *Phragmites*-type pollen forms around 2% of the total pollen and spore sum in this zone.

Percentages of pteridophyte spores increase to around 30% in this zone, with *Polypodium* again being the dominant identifiable taxon. *Typha latifolia* is the only aquatic taxon present, at frequencies of <1%.

4.5 *Local pollen assemblage zone MAY-3 (-5.03 to -4.795m OD)*
Pollen and spore concentrations in this zone are high at the base (*ca.* 30,000 grains cm^{-3}) but lower towards the top (*ca.* 16,000 grains cm^{-3}). The zone is dominated by pteridophyte spores, which make up around 60% of the total pollen and spore sum. Most of these spores were indeterminate, but *Botrychium lunaria*, *Polypodium* and *Pteridium aquilinum* were all present at frequencies of <1%.

Aboreal taxa decline further in this zone, forming only *ca.* 20% of the total pollen and spore sum. *Quercus* pollen declines slightly to around 5%, *Alnus glutinosa* declines to *ca.* 10% and *Tilia* to *ca.* 2%. *Ulmus*, *Betula* and *Salix* pollen occur in negligible quantities of <1%. Frequencies of *Corylus avellana*-type pollen increase slightly in comparison to the previous zone to *ca.* 10% of the sum.

Around 15-20% of the total pollen and spore sum in this zone is comprised of herbaceous taxa, mainly Cyperaceae (*ca.* 5%) and Poaceae (*ca.* 10%). The remainder of the herbaceous group is made up of the same assemblage of taxa as previously, still present at frequencies of 1-2%. Frequencies of aquatic taxa are very low, with *Sphagnum* occurring at percentages of <1%.

4.6 *Local pollen assemblage zone MAY-4 (-4.795 to -4.74m OD)*
In this zone total pollen and spore concentration is *ca.* 25,000 grains cm^{-3}. There is a sharp increase in arboreal pollen at the start of this zone to around 80% of the total pollen and spore sum. The major arboreal pollen taxa contributing to this increase are *Quercus* (*ca.* 30%), *Betula* (*ca.* 2.5%), *Alnus glutinosa* (*ca.* 7%), *Corylus avellana*-type (*ca.* 30%) and *Fraxinus excelsior* (*ca.* 2.5%). Pollen of *Ulmus, Tilia* and *Salix* occurs at frequencies of *ca.* 1%.

Percentages of herbaceous taxa are around 20% in this zone, again mostly comprised of Cyperaceae (*ca.* 5%) and Poaceae (*ca.* 7%) pollen. The rest of this group of taxa is made up of *Ranunculus acris*-type, Chenopodiaceae, *Rumex acetosa*-type, Brassicaceae, Rosaceae, Apiaceae and *Phragmites*-type pollen, all present at frequencies of 1-2%.

Pteridophyte spores make up just 2% of the total pollen and spore sum in this zone. Most were indeterminate, but some *Polypodium* spores were identified. The aquatic taxa *Potamogeton natans*-type (*ca.* 2%) and *Sparganium* were recorded (<1%) in this zone.

5. Discussion

5.1 The sequence recovered from May Farm Borehole 2 appears to be broadly equivalent to that investigated by Waller and Alderton (1993) *ca.* 10km to the south-west at Pymore. The reddish-brown humified peat unit from May Farm is similar to the basal peat unit at Pymore, with the main difference being in the thickness of the two deposits (0.97m at May Farm and 0.405m at Pymore).

5.2 The pollen assemblages contained within the peat deposits from May Farm and Pymore are also broadly similar. On a local scale, high proportions of *Alnus glutinosa* and *Salix* pollen in zone MAY-1 suggest the presence of fen carr at this time. Waller and Alderton (1993) also suggested that fen carr was present at the time of earliest peat formation at Pymore, radiocarbon dated to between 4300 ±100 and 4190 ±70 BP. It is suggested that the local pollen assemblage zone MAY-1 may cover a similar time period.

The decline in *Alnus glutinosa* pollen and corresponding increase in that of Poaceae, including some grains that fall into the size class for *Phragmites*, in zone MAY-2 may reflect a local shift from fen carr to reedswamp, as inferred by Waller and Alderton (1993) for zone PM-2 at Pymore. However, macrofossil analysis would be necessitated to confirm whether this community was present. Reedswamp may have persisted into zone MAY-3 at May Farm, as high Poaceae pollen percentages are still present, although the signal is somewhat masked by the dominance of pteridophyte spores in this zone. At the onset of zone MAY-4 a rise in *Alnus glutinosa* pollen may indicate that fen carr became established once again, although at this point the sediments change from peat to blue-grey clays with occasional fine sands, so the occurrence of this community at the sampling point was probably short-lived and it cannot be ascertained whether it was able to persist in the immediate vicinity. The re-establishment of alder carr also occurred at Wood Fen (Wheeler 1992) around 5km to the south of May Farm following a phase of acid bog development, although this event has not been radiocarbon dated. There is no evidence for more brackish conditions at the top of the sequence from May Farm, as occurred in the upper levels at Pymore (Waller and Alderton 1993).

5.3 On a more regional scale, it seems that throughout zone MAY-1 woodland was present in the wider landscape, with the dominant species being *Quercus*, *Corylus avellana* and *Tilia*. This is similar to the earliest vegetation recorded by the sequence from Pymore (Waller and Alderton 1993) and Wood Fen (Wheeler 1992). At Pymore, the frequencies of arboreal pollen remain broadly similar throughout the sequence, although *Tilia* pollen percentages decline after 4190 ±70 BP. This is interpreted by Waller and Alderton (1993) as reflecting the local disappearance of this species. A similar decline in *Tilia* pollen also occurs in the sequence from May Farm towards the end of zone MAY-1, and this supports the dating for this zone of *ca.* 4400-4100 BP inferred from the evidence for the presence of alder carr discussed above.

There is evidence for a substantial reduction in woodland cover during zone MAY-2, with declines in *Quercus*, *Corylus avellana*-type and *Tilia* pollen at this time. Declines in these species also occur at Wood Fen, and at this site the event has been radiocarbon dated to 3615 ±90 BP (Wheeler 1992). However it is suggested that a similar date should not necessarily be inferred for this event at May Farm, since the rest of the sequence from Wood Fen is markedly different, with the establishment of acidophilous taxa following the decline in *Quercus*, *Corylus avellana* and *Tilia*. Taxa indicative of acidic conditions are not present in any great quantities in the May Farm sequence, and it would seem that Wood Fen remains the only site in the south-eastern fens with evidence for an acidophilous flora (Godwin *et al* 1935; Wheeler

1992). Zones MAY-2 and MAY-3 appear to reflect a largely open, grassland-dominated landscape in the immediate vicinity of the sampling site at May Farm, although some *Quercus-Corylus avellana* woodland seems to have persisted in the wider landscape. Correlation with zone PM-2 at Pymore (Waller and Alderton 1993) indicates an upper age limit for zone MAY-3 of 4140 ±70 BP.

Woodland seems to have become re-established closer to the May Farm sampling site towards the top of the sequence, with *Quercus* and *Corylus avellana*-type pollen again present in high frequencies in zone MAY-4. However, as at this point in the depositional sequence the sediments change from peat to blue-grey clays with occasional fine sands, the duration of this renewed woodland development cannot be ascertained. An increase in *Corylus avellana*-type pollen occurs in the upper part of zone PM-3 from Pymore and has been radiocarbon dated to 3955 ±70 BP (Waller and Alderton 1993). It is suggested that the increases in pollen of aboreal taxa seen at May Farm in zone MAY-4 may date to a similar time period, and that the 'Fen Clay' deposit at this site was therefore potentially deposited some time after *ca*. 4000 BP, although it should be remembered that the timing of inundation is not synchronous throughout the fens.

There are no indications of human activity from the pollen evidence at any point in the May Farm sequence. No cereal-type pollen was recorded, and no weed floras typically associated with pastoral agriculture were present.

5.4 Although the pollen sequence from May Farm and Pymore (Waller and Alderton 1993) are broadly equivalent, the differences in thickness between the two deposits may reflect asynchronous development. However it is also possible that the two sequences do cover similar time periods, and that the peat at May Farm simply accumulated at a faster rate.

6. Conclusions

6.1 Locally, the site at May Farm appears to have developed in a very similar manner to that at Pymore (Waller and Alderton 1993), with the exception of the top of the sequence which has more in common with that from Wood Fen investigated by Wheeler (1992). The establishment of alder carr at the onset of peat formation is tentatively dated to *ca.* 4500 BP, and the carr woodland was subsequently replaced by reedswamp some time after 4100 BP. Alder carr then seems to have re-established towards the top of the sequence, possibly at *ca.* 4000 BP.

6.2 The regional vegetation depicted by the pollen assemblages appears to have been unmodified by human activity. *Quercus-Corylus avellana-Tilia* woodland dominated the landscape in the earlier part of the sequence, possibly between 4500 and 4100 BP. After this time the landscape seems to have become more open for a brief period before *Quercus-Corylus avellana* woodland became established again towards the top of the sequence, some time around 4000 BP. *Tilia* no longer seems to have been a component of the woodland community at this time.

6.3 The pollen assemblages studied from the humified lower peat unit from Borehole 2 at May Farm are broadly similar to those from the equivalent peat unit at Pymore, *ca.* 10km to the south-west, investigated by Waller and Alderton (1993). There is no evidence to support the presence of acidophilous taxa recorded at Wood Fen *ca.* 5km to the south by Godwin *et al*. (1935) and Wheeler (1992). Furthermore, there is no evidence in the environmental record at May Farm to indicate any anthropogenic activity in the vicinity of the site as the landscape developed from fen carr through to reedswamp, with a second phase of fen carr woodland development prior to marine inundation. As such, whilst interesting in terms of reinforcing the work of Waller and Alderton (1993) and that of Wheeler (1992), the sequence from May Farm adds little to our understanding of palaeoenvironmental conditions in the region and it is suggested that no further palaeonvironmental work needs to be undertaken.

7. References

Bennett, K.D. 2005. Documentation for psimpoll 4.25 and pscomb 1.03: C programs for plotting pollen diagrams and analysing pollen data.

Bennett, K.D., Whittington, G. and K.J. Edwards. 1994. Recent plant nomenclatural changes and pollen morphology in the British Isles. *Quaternary Newsletter* **7**: 41–6.

Beug, H.-J. 2004. *Leitfaden der Pollenbestimmung für Mitteleuropa und angrenzende Gebiete*. Munich: Verlag Friedrich Pfeil.

Birks, H.J.B. and A.D. Gordon. 1985. *Numerical Methods in Quaternary Pollen Analysis*. London: Academic Press.

Birks, H.J.B. and H.H. Birks. 1980. *Quaternary Palaeoecology*. London: Edward Arnold.

Godwin, H. and M.H. Clifford. 1938. Studies of the post-glacial history of British vegetation. I. Origin and stratigraphy of Fenland deposits near Woodwalton, Hunts. II. Origin and stratigraphy of deposits in southern Fenland. *Philosophical Transactions of the Royal Society of London* **B229**: 323-406.

Godwin, H. and E.H. Willis. 1961. Cambridge University natural radiocarbon measurements III. *Radiocarbon* **3**: 60-76.

Godwin, H., Godwin, M.E. and M.H. Clifford. 1935. Controlling factors in the formation of fen deposits, as shown by peat investigations at Wood Fen, near Ely. *Journal of Ecology* **23**: 509-35.

Grimm, E.C. 1987. CONISS: a FORTRAN 77 program for stratigraphically constrained cluster analysis by the methods of incremental sum of squares. *Computers and Geoscience* **13**: 13-35.

Maher, L.J. Jr. 1972. Nomograms for computing 0.95 confidence limits of pollen data. *Review of Palaeobotany and Palynology* **13**: 85-93.

Moore, P.D., Webb, J.A. and M.E. Collinson. 1991. *Pollen Analysis*. Oxford: Blackwell Scientific Publications.

Seale, R.S. 1975. *Soils of the Ely District*. Memoirs of the Soil Survey of England and Wales (Harpenden).

Shennan, I. 1980. *Flandrian sea-level changes in the Fenland*. Unpublished Ph.D. thesis, University of Durham, U.K.

Shennan, I. 1986. Flandrian sea-level changes in the Fenland. II: tendencies of sea-level movement, altitudinal factors, and local and regional factors. *Journal of Quaternary Science* **1**: 155-79.

Smith, R. and M.C. Lillie. 2011. Geo-archaeological Investigation: Land at May Farm, Littleport, Cambridgeshire. Unpublished Report: CgMs Consulting Ltd.

Stockmarr, J. 1971. Tablets with spores used in absolute pollen analysis. *Pollen et Spores* **13**: 615-21.

Waller, M. 1993. *The Fenland Project, No. 9: Flandrian Environmental Change in Fenland.* East Anglian Archaeology Report No. 70. Cambridge: Cambridgeshire County Council.

Waller, M. and A. Alderton. 1993. VI. Pymore. *The Fenland Project, No. 9: Flandrian Environmental Change in Fenland.* East Anglian Archaeology Report No. 70. Cambridge: Cambridgeshire County Council 137-41.

Waller, M., Entwistle, J. and G. Duller. 1995. TSPPlus - A menu driven program for display of stratigraphic data. *Quaternary Newsletter* **77**: 32-9.

Wheeler, A.J. 1992. Vegetational succession, acidification and allogenic events as recorded in Flandrian peat deposits from an isolated Fenland embayment. *New Phytologist* **122**: 745-56.

Willis, E.H. 1961. Marine transgression sequences in the English Fenlands. *Annals of the New York Academy of Sciences* **95**: 368-76.

Appendix 1: Borehole Log

Borehole 2: NGR 559770.56 287435.74 (-2.185 mOD)

Layer 1

Depth: 0.0-0.22 m depth (-2.185 to -2.405 mOD)

Description: Dark brown peaty ploughsoil
As2, Ag2, Gmin+, Nig 3, Strf 1, Sicc 4, Elas2, Lim Supp N/A.

Layer 2

Depth: 0.22-0.93 m depth (-2.404 to -3.115 mOD)

Description: Blue-grey Fe mottled clays and fine sands, with some fine orange-brown sandy partings
As3, Ag+, Gmin1, Nig 2, Strf 1, Sicc 3, Elas 3, Lim Supp 0.

(Note: grades to blue-grey clays, with occasional fine sands (Layer 3)).

Layer 3

Depth: 0.93 – 2.55 m depth (-3.115 to -4.735 m OD)

Description: Blue-grey clays with occasional fine sands and moderate organics
As4, Ag+, Gmin+, Th^2++, Nig 2, Strf 1, Sicc 3, Elas 3, Lim Supp 0.

(Note: grades at base to peat, from 2.44 to 2.62 – clays dominate to 2.53 m depth)

Layer 4

Depth: 2.55 – 3.52 m depth (-4.735 to -5.705 mOD)

Description: Red-brown humified peat
Sh3, $Th^2$1, Nig 3, Strf 1, Elas 2, Lim supp 0

(Note: increasingly woody below 2.87m depth and grades at 3.52m depth to underlying sands)

Layer 5

Depth: 3.52 – 3.72 m depth (-5.505 to -5.905 mOD)

Description: Blue-grey fine-medium sands
Gmin4, Nig 3, Strf 1, Elas 2, Lim supp 0

Appendix 2: List of Troels-Smith symbols for commonly encountered sediment types (*after* Long *et al.* 1999: 270).

Name	Code	Sediment type	Field characteristics
Argilla steatodes	As	Clay <0.002mm	May be rolled into a thread < or = 2mm diameter without breaking. Plastic when wet, hard when dry.
Argilla granosa	Ag	Silt 0.06-0.002mm	Will not roll into thread without splitting. Will rub into dust on drying (such as on hands). Gritty on back of teeth.
*Grana minora**	Gmin	Fine, medium and coarse sand (0.06-2.0mm)	Crunchy between teeth. Lacks cohesion when dry. Grains visible to naked eye.
*Grana majora**	Gmaj	Fine, medium and coarse gravel (2-60mm)	
Testae (molluscorum)	test.(moll)	Whole mollusc shells	
Particulae testarum (molluscorum)	part. test. (moll)	Shell fragments	
Substantia humosa	Sh	Humified organics beyond identification	Fully distintegrated deposit lacking macroscopic structure, usually dark brown or black.
Turfa herbacea	Th$^{0-4}$	Roots, stems and rhizomes of herbaceous plants	Can be seen vertically aligned or matted within sediment in growth position.
Turfa bryophytica	Tb$^{0-4}$	The protonema, rhizods, stems, leaves etc. of mosses	Can be seen vertically aligned or matted within sediment in growth position.
Turfa lignosa	Tl$^{0-4}$	The roots and stumps of woody plants and their trunks, branches and twigs.	Can be seen vertically aligned or layered within sediment in growth position.
Detritus lignosus	Dl	Detrital fragments of wood and bark >2mm	Non-vertical or random alignment. may be laminated, not in growth position.
Detritus herbosus	Dh	Fragments of stems and leaves of herbaceous plants >2mm	Non-vertical or random alignment. may be laminated, not in growth position.
Detritus granosus	Dg	Woody and herbaceous humified plant remains <2mm >0.1mm that cannot be separated.	Non-vertical or random alignment. may be laminated, not in growth position.
Limus detrituosus	Ld$^{0-4}$	Fine detritus organic mud (particles <0.1mm).	Homogeneous, non-plastic, often becomes darker on oxidation and will shrink on drying. Most shades of colour.
Limus ferrugineus	Lf	Mineral and/or organic iron oxide	Forms mottled staining. Can be crushed between fingers. Often in root channels or surrounding Th.
Anthrax	Anth	Charcoal	Crunchy black fragments
Stirpes	Stirp	Tree stump	
Stratum confusum	Sc	Disturbed stratum	

Appendix 3: List of Latin and English Botanical Names

Latin name	English name
Alnus glutinosa	Alder
Apiaceae undiff.	Carrot family
Asteraceae (Lactuceae)	Dandelions
Betula	Birch
Botrychium lunaria	Moonwort
Brassicaceae undiff.	Cabbage family
Calluna vulgaris	Ling heather
Caryophyllaceae undiff.	Pink family
Chenopodiaceae	Goosefoot family
Corylus avellana-type	Hazel
Cyperaceae	Sedge family
Fagus sylvatica	Beech
Filipendula	Meadowsweet
Fraxinus excelsior	Ash
Phragmites-type	Common reed
Pinus sylvestris	Scots pine
Poaceae undiff.	Wild grasses
Polypodium	Polypody ferns
Potamogeton natans-type	Pondweeds
Potentilla-type	Cinquefoils
Pteridium aquilinum	Bracken
Pteropsida (monolete) undiff.	Ferns
Quercus	Oak
Ranunculus acris-type	Meadow buttercup
Ranunculus arvensis-type	Corn buttercup
Rosaceae undiff.	Rose family
Rumex acetosa-type	Common/sheep's sorrel
Salix	Willow
Selaginella selaginoides	Clubmosses
Sparganium undiff.	Bur-reeds
Sphagnum	Bog moss
Tilia	Lime
Typha latifolia	Common reedmace
Ulmus	Elm

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OASIS ID: cgmslimi1-100625

Project details

Project name	May Farm Littleport. Geo-archaeological survey
Short description of the project	Results of geo-archaeological borehole survey undertaken at May Farm, Littleport, Cambridgeshire. It involved excavation of 14 boreholes to provide a site-wide cross section of the sediments beneath the proposed development site.
Project dates	Start: 08-03-2011 End: 11-03-2011
Previous/future work	Yes / Yes
Any associated project reference codes	ECB3541 - HER event no.
Any associated project reference codes	12405 - Contracting Unit No.
Type of project	Field evaluation
Site status	None
Current Land use	Cultivated Land 3 - Operations to a depth more than 0.25m
Monument type	N/A None
Significant Finds	N/A None
Methods & techniques	'Augering'
Development type	Farm infrastructure (e.g. barns, grain stores, equipment stores, etc.)
Prompt	Direction from Local Planning Authority - PPS
Position in the planning process	Pre-application

Project location

Country	England
Site location	CAMBRIDGESHIRE EAST CAMBRIDGESHIRE LITTLEPORT May Farm Littleport
Study area	10.00 Hectares
Site coordinates	TL 601 872 52.4588370539 0.356667634254 52 27 31 N 000 21 24 E Point

Project creators

Name of Organisation	CgMs Consulting

Project brief originator	Local Authority Archaeologist and/or Planning Authority/advisory body
Project design originator	CgMs Consulting
Project director/manager	Myk Flitcroft
Project supervisor	Robert Smith

Project bibliography 1

Publication type	Grey literature (unpublished document/manuscript)
Title	Geoarchaeological Investigation. Land at May Farm Littleport Cambridgeshire
Author(s)/Editor(s)	Smith, R. and Lillie, M.
Date	2011

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