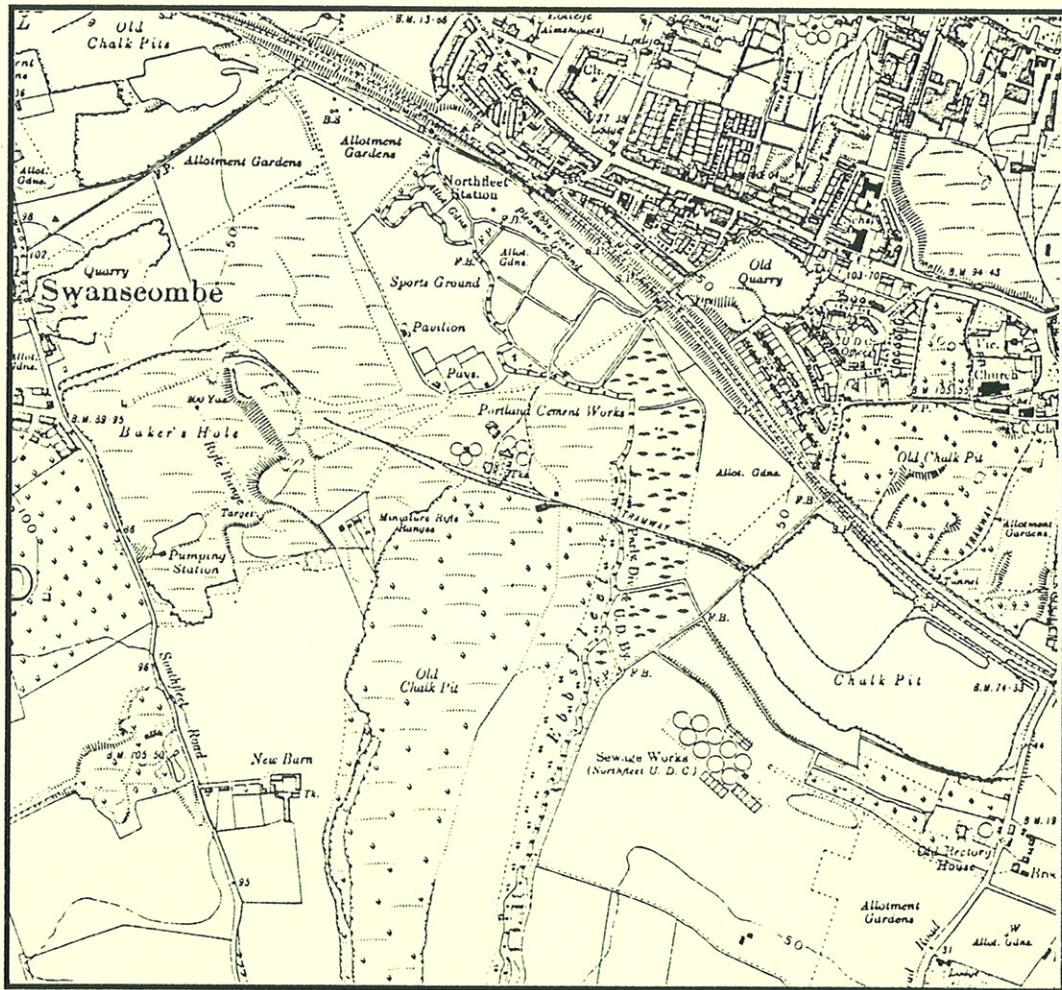


Blue Circle Industries plc
Proposed Ebbsfleet Development
(Northfleet Rise Area)

Archaeological Evaluation Report



Extract from 1931 O.S. map

Oxford Archaeological Unit

August 1997

NORTHFLEET RISE AREA:
BLUE CIRCLE SPORTS GROUND COMPLEX

EBBS 97

ARCHAEOLOGICAL EVALUATION

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SUMMARY

A two stage archaeological evaluation was undertaken by the Oxford Archaeological Unit between 25th June and 2nd July 1997 and 16th July and 22nd July 1997 on behalf of Blue Circle Industries plc on the Sports Ground at Ebbsfleet, Kent. The evaluation forms part of an investigation aimed at providing information for outline planning consent for the Ebbsfleet development.

Eleven boreholes were drilled and three test pits excavated within the study area in order to determine the nature of the sub-surface stratigraphy and the location of archaeologically sensitive deposits. The data obtained from the investigation was used to construct a series of transects across the study area.

The evidence indicated that late-Pleistocene (pre-10,000 years Before Present) chalk solifluction sediments and river gravels form a wedge of sediment thinning and sloping from west to east within the study area. These deposits are overlain by soft, unconsolidated Holocene (dating to the last 10,000 years) sediments that thin to the west and south. The Holocene sediments consist of four major elements:

- Made ground*
- Upper Clay-Silt*
- Organic complex (including an upper reed peat and a lower wood peat)*
- Lower Clay-Silt*

Archaeological material was recovered from one of the test pits within or below the wood peat and in two boreholes from within the Lower Clay-Silt. This information indicates that the organic sediments, known to contain archaeology to the south of the study area, continue northwards across the study area. In addition older sediments, lying stratigraphically below the organic complex, have also been demonstrated to have an archaeological component.

1 BACKGROUND

1.1 Introduction

1.1.1 The Oxford Archaeological Unit undertook a two stage archaeological evaluation between 25th June and 2nd July 1997 and 16th July and 22nd July 1997 on behalf of Blue Circle Industries PLC on, and adjacent to, the Sports Ground at Ebbsfleet, Kent (Figure 1). The evaluation forms part of an investigation aimed at providing information for outline planning consent for the Ebbsfleet development.

1.1.2 The work was carried out in accordance with a Written Scheme of Investigation (WSI), detailing the scope and method of the evaluation. Previous work in the area indicates that later Prehistoric archaeology may be found within the alluvial deposits potentially to be impacted on by the proposed development.

1.2 Reasons for the Project

1.2.1 Previous work in the Ebbsfleet area has indicated that important, waterlogged later Prehistoric archaeological remains may be preserved within the sediments lying beneath the Sports Ground Complex at Ebbsfleet.

1.2.2 Development plans exist, formulated by Blue Circle Industries PLC, for extensive construction activity adjacent to the proposed site of the rail corridor and station on the Channel Tunnel Rail Link (CTRL).

1.2.3 The area under consideration represents an area that is poorly known archaeologically but within which archaeological material may be expected. In order to advance planning applications for outline consent, further work was required to establish more clearly the potential and significance of this area for archaeological and palaeoenvironmental research. In particular it was necessary to establish the subsurface topography of alluvial and peat deposits in relation to the edges of drier ground, so that the distribution of any archaeological remains can be considered in relation to this.

1.3 Geology, landscape and landuse

1.3.1 The Sports Ground Complex lies in the valley bottom of a small tributary of the Thames (the Ebbsfleet). Extensive sequences of Pleistocene sands and gravels exist to the west of the study area (Wenban-Smith 1995) and dip eastwards into the area of investigation. Valley bottom sediments consist of unconsolidated sands, silts, clays and peats overlying basal valley bottom gravels. These unconsolidated sediments are thought to date to the Holocene or last 10,000 years.

1.3.2 Development of the area in the past has resulted in the infilling of the low lying, river-marginal areas of the Sports Ground, by 'made ground' in

order to raise the ground surface above common flood datums and provide a firm footing for cricket pitches. A narrow strip of ground exists, adjacent to the river, that remains unmodified. The area east of the river has also been raised by a layer of made ground.

1.4 Archaeological background

- 1.4.1 The Ebbsfleet area is well known for its archaeological record from the Pleistocene sands and gravels present on the valley sides (Wenban-Smith 1995). Less well known is the rich later prehistoric and Roman archaeological record of the valley base (Burchell 1938; Sieveking 1960; Steadman 1913).
- 1.4.2 Recent evaluation work for Kent County Council (South Thameside Development Route 4 - Barham and Bates 1995) and Union Railways indicates that prehistoric material and Roman artefacts occur in the alluvial sequences. This evidence confirms previous, largely unpublished, observations.
- 1.4.3 Later prehistoric flint artefacts and debitage have been recovered from both Union Railways evaluation work and STDR 4 (Barham and Bates 1995) "geotechnical" works between depths of 1.7m and 3.8m below ground surface in the area immediately south of the current study area. Typically artefacts have been associated with a woody peat or the surface of the underlying sands and gravels.
- 1.4.4 Romano-British material has recently been recovered from contexts interbedded with alluvium towards the edge of the wet ground region, south of the area of investigation in this study.

2 OBJECTIVES AND APPROACH

2.1 The work outlined here is directed to evaluate and clarify, at a strategic level the archaeological potential of the Northfleet Rise area and seek to establish:

- whether there is likely to be highly significant archaeology that could warrant preservation *in situ*
- where the archaeology is most likely to occur
- whether it is likely to be so extensive that it would limit the area available for development
- where, given overall capacity and flexibility within the whole Ebbsfleet development proposal, it would be easy to find alternative capacity in a non-sensitive area

2.2 The method of investigation was undertaken in two parts consisting of an initial borehole survey to inform the location of the second phase test pit excavations.

2.3 The approach agreed with Kent County Council was to:

- drill eight shell and auger boreholes across the area of the sports ground (Figure 2) to provide data on the sequence of estuarine/peat and colluvial sediments to define the dry ground-wet ground transition zone, which is considered most likely to be of significant archaeological potential
- to drill one shell and auger borehole west of borehole ST 1200 in order to fill a gap in the distribution of historical boreholes in the area
- as a contingency to drill up to three additional boreholes in order to clarify the sequence
- to excavate eight test pits, with a contingency for an additional two test pits to investigate a larger volume of deposit, to check for archaeological presence within areas deemed from the borehole survey to be of high archaeological potential

2.4 By agreement with KCC (OAU/KCC telephone conversation and correspondence 16 July 1997) the number of test pits was reduced to three in the light of the borehole results, which indicated that for most of the area the depths of made ground and alluvium made it impractical to reach deposits recognized as being of archaeological potential. Because of the current use of the Sports Ground for cricket, only limited areas of the shallow deposits could be tested.

- 2.5 Another modification to the approach was to undertake an exploratory resistivity transect (undertaken by Dr Richard Bates, University of St. Andrews) to provide additional information about the sedimentary stratigraphy.

3. METHODS

3.1 Borehole investigation

- 3.1.1 A shell and auger percussion drill rig capable of drilling and casing to depths of *c.*20m below ground surface through a variety of sediment types including sands and gravels, was used in the evaluation.
- 3.1.2 The rig was suitable for the recovery of undisturbed U4/U100 core samples 450mm long, disturbed samples and bulk samples.
- 3.1.3 The sub-contracted drillers were familiar with the requirements of geoscientists/geoarchaeologists, where the recovery of semi-continuous undisturbed samples is the objective of the exercise.
- 3.1.4 All boreholes were drilled through the alluvium until gravel was attained, where possible drilling continued until bedrock was attained.
- 3.1.5 All boreholes, where requested, were backfilled and capped with bentonite based concrete.
- 3.1.6 The sub-contracted drillers were familiar with the range of Quaternary deposits (i.e. unconsolidated superficial deposits such as gravels, silts and sands) likely to be present in South East England.
- 3.1.7 The sub-contracted drillers had a minimum of 10 years experience and/or British Drilling Association accreditation and worked to BS 5930:1981 Code of Practice for Site Investigation.
- 3.1.8 All boreholes were logged in accordance with geological descriptive standards commonly in use by the Geoarchaeological Service Facility, University College London. These also accord with, or extend, the standards used by the Museum of London Archaeological Service.
- 3.1.9 All samples were labelled using self-adhesive waterproof labels and two labels were applied to each sample (outside and inside sample container).
- 3.1.10 All bulk samples were taken and stored in 10 litre plastic buckets.
- 3.1.11 The depths at which samples were taken were clearly shown and integrated with the field stratigraphic log.
- 3.1.12 All borehole positions are shown on Figure 2.

3.2 Geophysical investigation

- 3.2.1 Surface direct current (DC) electrical soundings were taken along a line between two of the boreholes (BH3 and BH5) (Figure 2).

3.2.2 Eight DC soundings were made in total spaced at approximately 15-18m intervals. At each sounding location, an expanding Wenner Electrode configuration (Figure 3) was employed with the $ab/3$ electrode spacing at 1, 1.2, 1.5, 2, 3, 4, 5, 6, 8, 10, 12, 15, 20, 25, 30, 35, 40, 50m.

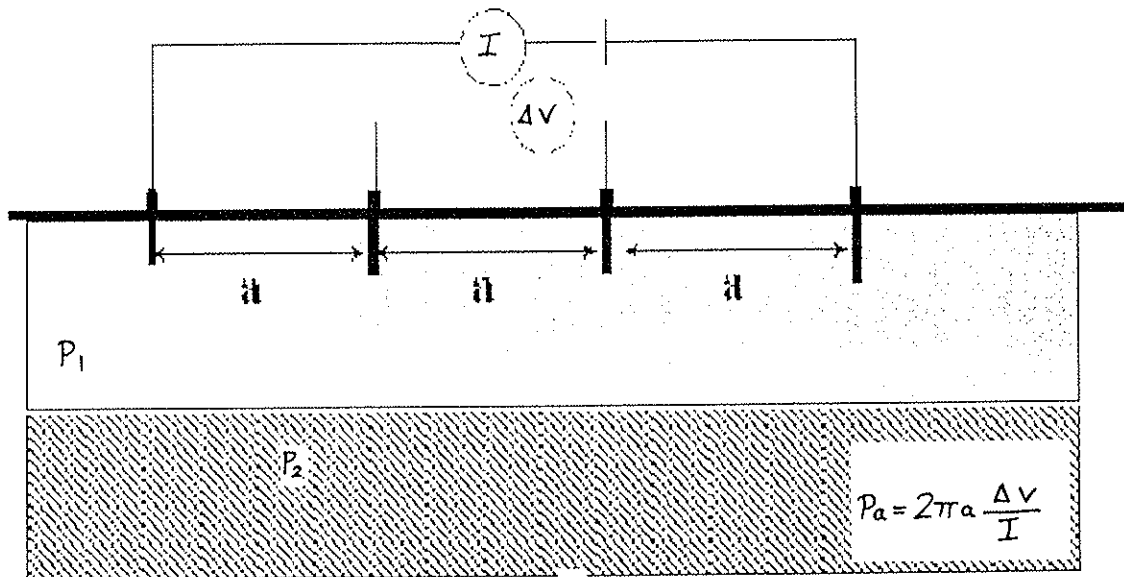


Figure 3. Geophysical surveying Wenner Electrode configuration.

3.2.3 A Syscal R4 resistivity meter was used for this survey and all measurements were made with surveyor's tape and tied into borehole locations.

3.2.4 A Mt. Sopris logging tool was used for borehole work.

3.2.5 Following the surface survey, the boreholes were logged using a borehole electrical induction tool and a gamma emission tool. An adapted Geonics EM39 probe was used for the downhole conductivity logging.

3.2.6 The borehole logged results were used to calibrate the surface DC soundings.

3.3 Test pit investigation

3.3.1 Test pits were dug to a maximum depth of 4m, were 3-4m long and 1.5m wide (Figure 2).

3.3.2 Excavation of the test pits was undertaken in 0.25m thick spits (where possible) in the alluvial sediments below the made ground. Each spit was numbered separately and the spoil hand sorted for artefacts.

3.3.3 On completion of the excavation shoring was inserted to allow direct observation of the sequences.

- 3.3.4 The sequences were recorded with context records, stratigraphic logs and a single, representative section of one face of the test pit was drawn. Colour and black-white photographs were taken of this section.
- 3.3.5 Where relevant, units were sampled with bulk samples and monolith blocks.

4 RESULTS: BOREHOLE INVESTIGATION

4.1 Borehole 1 (Transect 1, Figure 4)

4.1.1 Stratigraphy

4.1.1.1 This borehole was drilled to a maximum depth of 8.5m below ground level. Ground level was 3.36m O.D.

4.1.1.2 A total of 7 U4 samples and 5 disturbed samples were taken from the borehole, the detailed stratigraphic log is presented in Table 1.

4.1.1.3 Topsoil and made ground extend to a depth of 2.66m (0.7m O.D.).

4.1.1.4 Immediately below the made ground a sequence of clay-silt units interbedded with organic rich horizons occur. These exist between depths of 2.66m and 5.3m (0.7m and -1.94m O.D.). Organic sediments below 5.3m occur as a structureless, probably reed dominated peat between 5.3m and 5.9m (-1.94 and -2.54m O.D.) and a wood peat to a depth of 7.5m (-4.14m O.D.). A thin clay-silt units exists below the wood peat (7.50 - 8.1m, -4.14 to -4.74m O.D.) that in turn lies on a silty sand.

4.1.1.5 Flint gravel was encountered at a depth of 8.5m (-5.14m O.D.). This basal gravel was too dense to drill with the available equipment.

Borehole Number	1 (BCI)		
Sheet 1 of	2		
Date	25/6/97	Recorded by	MRB
Surface datum	3.36m O.D.	Total depth	8.5m
Depth below surface (metres)	Lithostratigraphy		
0.00 - 0.20	Topsoil ---sharp contact---		
0.20 - 2.66	Fill/made ground - chalk rubble with flint clasts. ---diffuse contact---		
2.66 - 3.40	5GY 5/1 greenish-grey clay-silt mixed with overlying made ground. Becomes cleaner with depth. Soft and wet. Unoxidised plant fragments (<i>Phragmites</i> sp.) present. No structure. Possible fragments of leather-like organic fragments in patches. With depth rooting <i>in situ</i> is common and diffuse patches of 10YR 4/4 dark yellow colour.		
3.40 - 3.50	10YR 4/2 dark greyish-brown organic silt with common <i>Phragmites</i> sp. remains.		

3.50 - 4.25	5GY 5/1 greenish-grey clay-silt mixed with overlying made ground. Becomes cleaner with depth. Soft and wet. Unoxidised plant fragments (<i>Phragmites</i> sp.) present. No structure. With depth rooting <i>in situ</i> is common and diffuse patches of 10YR 4/4 dark yellow colour.
4.25 - 4.80	As above but very well preserved plant fragments present. Occasional molluscs noted (freshwater types, e.g. <i>Lymnaea</i> sp.). Remains soft and unconsolidated.
4.80 - 5.20	7.5YR 5/4 dark brown clay-silt and peat. Common unoxidised plant remains. No structure.
5.20 - 5.30	5GY 5/1 greenish-grey clay-silt. No organic material. Soft and unconsolidated.
5.30 - 5.95	5YR 3/2 very dark reddish-brown peat. Well preserved organic remains. No structure and friable. Roots common. Strong odour. Molluscs noted in places. Possibly exhibits bedding.
5.95 - 6.85	5YR 3/2 very dark reddish-brown woody peat. Very common wood fragments. Similar to above and contains molluscs in some areas. Fibrous and dry. Possibly exhibits parallel layering. Strong odour.
6.85 - 7.50	As above twig fragments common.
7.50 - 8.10	Mid grey clay-silt with common very well preserved root fragments. Molluscs are common. Cohesive and structureless. Becomes dark grey silty-sand with depth. Unit contains organic fragments throughout and flint clasts (<4cm, sub-angular) appear and become more common with depth.
8.10 - 8.50	Light grey sand with some slit. Rare organic fragments.
8.50 -	Flint gravel. Well sorted at top becoming poorly sorted with depth. Clasts are sub-rounded at top but sub-angular clasts appear with depth. ---base of borehole 8.5m---
Notes	Samples: 7 U4/U100 samples 5 bulk/disturbed samples

Table 1. Lithological description of borehole 1.

4.1.2 *Interpretation*

- 4.1.2.1 The sedimentary sequence present commences with the deposition of the flint gravels under probable high energy fluvial conditions. Up-profile these fine to silty sands and mollusc rich organic silts reflect a shift towards lower energy environments of deposition.
- 4.1.2.2 The presence of the wood peat suggests that a possible alder carr woodland developed in the area as water levels declined. Rising water levels probably resulted in the later inundation of the woodland by wetter ground situations and the development of a herb fen.
- 4.1.2.3 Further increases in water levels finally resulted in submergence of the area and the deposition of the clay-silt units. Temporary, periodic emergence episodes may be indicated by the presence of organic rich units in these upper clay-silts.

4.2 **Borehole 2 (Transect 1, Figure 4)**

4.2.1 *Stratigraphy*

- 4.2.1.1 This borehole was drilled to a maximum depth of 11.85m below ground level. Ground level was 3.35m O.D.
- 4.2.1.2 A total of 8 U4 samples and 10 disturbed samples were taken from the borehole, the detailed stratigraphic log is presented in Table 2.
- 4.2.1.3 Topsoil and made ground extend to a depth of 1.70m (1.65m O.D.).
- 4.2.1.4 Immediately below the made ground a sequence of clay-silt units interbedded with organic rich horizons occur. These exist between depths of 1.70m and 4.70m (1.65m and -1.35m O.D.). Organic sediments below 4.70m occur as a greyish-brown carbonate rich silt with common mollusc fragments. Common rootlets occur in this unit. Wood peat was recorded between 5.70m and 6.75m depth (-2.35m and -3.4m O.D.) that graded downwards into an organic silt.
- 4.2.1.5 A lower grey silt occurred at a depth of 7.73m (-4.38m O.D.).
- 4.2.1.6 Flint gravels appeared at 11.30m depth (-7.95m O.D.).

Borehole Number	2 (BCI)		
Sheet 1 of	2		
Date	25-26/6/97	Recorded by	MRB
Surface datum	3.35m O.D.	Total depth	11.85m
Depth below surface (metres)	Lithostratigraphy		
0.00 - 0.20	Topsoil ---sharp contact---		
0.20 - 1.70	Fill/made ground ---abrupt contact---		
1.70 - 2.90	5GY 5/1 greenish-grey dense clay-silt. Firm and compact. Occasional organic fragments. Mixed with made ground at top of unit. Occasional small, sub-angular chalk clasts (<0.5cm) and well rounded Tertiary flints.		
2.90 - 4.70	5G 5/1 greenish-grey clay-silt. Soft and unconsolidated with layers of 2.5Y N2 black reduced organic fragments. Probably bedded. With depth 10YR 5/6 yellowish brown organic material (unoxidised) appears. Network of fine rootlets also noted.		
4.70 - 5.30	5G 5/1 greenish-grey clay-silt with 2.5Y 4/2 dark greyish-brown organic fragments. Root/stem material is vertically aligned and <i>in situ</i> . Upper parts of unit contain very fine organic fragments. Some evidence of possibly crude bedding. Soft and unconsolidated.		
5.30 - 5.70	10YR 4/2 dark greyish-brown, dry and friable carbonate rich silt. Common small (<2mm) white flecks of carbonate precipitate. Common molluscs. No visible structure. Molluscs include <i>Cepaea</i> and <i>Arianta</i> sp. Small black rootlets noted.		
5.70 - 6.75	7.5YR 4/2 dark brown woody peat. Loose and unconsolidated, possibly with voids in peat. Common large stem/twig fragments. Molluscs are present. Matrix of peat between wood fragments consists of fine rootlets. Molluscs appear to be terrestrial species. No structure although wood/twigs may be lying parallel to each other and sub-horizontal.		
6.75 - 7.73	10YR 4/2 dark greyish-brown silt bedded with 10YR 5/1 grey silt. Bedding is wavy and undulating and dips across core. Wood still present but considerably reduced in frequency. Occasional molluscs present. <i>Phragmites</i> sp. stem fragments are present, vertically aligned. Occasional diffuse carbonate patches. Possible freshwater molluscs present here. Soft and unconsolidated.		
7.73 - 8.30	5Y 5/1 grey organic silt with reduced organic material and fragmentary molluscs. Soft and unconsolidated.		

8.30 - 9.05	5G 5/1 greenish-grey clay-silt with some wood fragments. Occasional freshwater molluscs and <i>Phragmites</i> sp. material.
9.05 - 11.30	As above but unit is laminated in thin wavy, sub-parallel laminae. <i>In situ</i> rooting. This unit becomes denser and more compact with depth.
11.30 -	Dense, compact well sorted flint gravel rich in Tertiary flints. Mixed with overlying sandy-silts. Becomes more poorly sorted with depth. Clasts are sub-angular to sub-rounded and rolled. Occasional chalk clasts are noted. ---base of borehole 11.85m---
Notes	Samples: 8 U4/U100 samples 10 bulk/disturbed samples

Table 2. Lithological description of borehole 2.

4.2.2 Interpretation

- 4.2.2.1 The sedimentary sequence present commences with the deposition of the flint gravels under probable high energy fluvial conditions.
- 4.2.2.2 Up-profile these fine to silty sands and mollusc rich organic silts reflecting a shift towards lower energy environments of deposition. Thick clay-silt units exist here that probably represent sediments deposited in low energy water bodies below the water-line (possibly under saline or brackish water conditions).
- 4.2.2.3 The presence of the wood peat suggests that a possible alder carr woodland developed in the area as water levels dropped. Increasing water datums probably resulted in the inundation of the woodland, the development of wetter ground conditions and the development of a herb fen. The presence of extensive molluscan material in these units indicates that this was a calcareous wetland.
- 4.2.2.4 Further increases in water level datums finally resulted in submergence of the area and the deposition of the clay-silt units. Temporary, periodic emergence episodes may be indicated by the presence of organic rich units in these upper clay-silts.

4.3 Borehole 3 (Transect 2, Figure 4)

4.3.1 Stratigraphy

- 4.3.1.1 This borehole was drilled to a maximum depth of 10.20m below ground level. Ground level was 3.57m O.D.
- 4.3.1.2 A total of 5 U4 samples and 6 disturbed samples were taken from the borehole, the detailed stratigraphic log is presented in Table 3.
- 4.3.1.3 Topsoil and made ground extend to a depth of 1.60m (1.97m O.D.).
- 4.3.1.4 Interbedded clay-silts and organic sediments were present to a depth of 2.40m (1.17m O.D.).
- 4.3.1.5 Two organic rich peaty sedimentary units were observed below the clay-silt units. The uppermost deposit, extending to a depth of 2.95m (0.62m O.D.) consisted of a reed peat. A woody peat was present below to a depth of 3.35m (0.22m O.D.).
- 4.3.1.6 Beneath the peat an organic silt with some sand was present to a depth of 4.0m (-0.43m O.D.). These deposits became coarser with depth and flint and chalk clasts appeared in the matrix (4.0m to 6.0m, -0.43m to -2.43m O.D.).
- 4.3.1.7 Chalk and flint rich gravel, underlain by sand, exist between depths of 6.0m and 7.3m (-2.43m to -3.73m O.D.).
- 4.3.1.8 The lowest unit encountered consisted of angular chalk clasts mixed with Tertiary flints (small, very well rounded black flints pebbles reworked from Tertiary sediments) that extended down to a depth of 9.5m (-5.93m O.D.).

Borehole Number	3 (BCI)		
Sheet 1 of	2		
Date	30/6/97	Recorded by	MRB
Surface datum	3.57m O.D.	Total depth	10.2m
Depth below surface (metres)	Lithostratigraphy		
0.00 - 0.20	Topsoil ---sharp contact---		
0.20 - 1.60	Fill/made ground - predominantly chalk and flint gravel with silt matrix.		
1.60 - 1.75	7.5YR 3/2 dark brown organic silt with 7.5YR N3 very dark grey patches. Occasional sand grains noted. Roots are present, unoxidised, and probably <i>in situ</i> . No structure, moderately dense and compact. Firm and dry.		

1.75 - 2.00	5GY 5/1 blue-grey clay-silt with abundant organic material (predominantly <i>Phragmites</i> sp.).
2.00 - 2.15	7.5YR 3/2 dark brown organic silt with 7.5YR N3 very dark grey patches. Occasional sand grains noted. Roots are present, unoxidised, and probably <i>in situ</i> . No structure, moderately dense and compact. Firm and dry.
2.15 - 2.40	10YR 5/1 grey clay-silt. Soft and pliable with 10YR 3/1 very dark grey flecks/patches (oxidized organics?). Some 10YR 5/8 brownish-yellow unoxidised plant fragments (roots).
2.40 - 2.95	7.5YR 4/2 brown organic silt with common flints, <i>in situ</i> roots, evidence of <i>Phragmites</i> sp. stem material. No structure. Firm, compact and dry.
2.95 - 3.35	7.5YR 4/2 dark brown woody peat. Loose and unconsolidated, possibly with voids in peat. Common large stem/twig fragments. Molluscs are present. Matrix of peat between wood fragments consists of fine rootlets. Molluscs appear to be terrestrial species. No structure although wood/twigs may be lying parallel to each other and sub-horizontal.
3.35 - 4.00	10YR 5/1 grey sandy-silt. Cohesive and damp. No apparent structure. Evidence of major roots penetrating from above. Occasional small, angular flint clasts and rounded flint clasts (<1cm). Occasional black reduced organic patches.
4.00 - 5.00	5GY 4/1 dark greenish-grey silty sand. Plastic and prone to deformation. Some unhumified plant material (<i>in situ</i>). Occasional rounded Tertiary flint clasts and sub-angular, rolled flints (<1cm). Structureless.
5.00 - 5.50	As above but sub-angular chalk clasts present (<3cm).
5.50 - 5.60	5GY 4/1 dark greenish-grey silt with some clay and sand. Very little flint gravel. Occasional small flint and chalk chips. No structure. Plastic. Coarsens with depth to sand.
5.60 - 6.00	2.5Y 6/4 light yellowish-brown and 2.5Y 4/4 strong brown bedded sand with clay clasts (2-6mm), Tertiary shell fragments (as thin beds or stringers of shell) and occasional very small (<5mm) rounded flint chips.
6.00 - 6.20	Chalk and flint gravel. Poorly sorted (<1cm - >5cm), sub-angular to sub-rounded flints and rolled sub-angular chalk clasts.
6.20 - 7.30	Very fine sand with some silt. Bedded as at 5.5m, with occasional sub-angular flint clasts. Occasional stringers of chalk.

7.30 - 9.50	2.5Y 7/4 pale yellow cohesive chalk gravel with clay-silt matrix. Matrix supported. Clasts are poorly sorted, sub-angular and rolled. No structure. Occasional angular flint clasts (2-6cm) and occasional 7.5YR 4/4 dark brown soft silt patches. Tertiary flints present.
9.50 -	As above but no Tertiary flints. --- base of borehole 10.2m---
Notes	Samples: 5 U4/U100 samples 6 bulk/disturbed samples

Table 3. Lithological description of borehole 3

4.3.2 Interpretation

- 4.3.2.1 The sequence preserved consists of a basal chalk rich sediment interpreted as a solifluction deposit. The unit is similar to other chalk dominated solifluction deposits noted elsewhere in the area.
- 4.3.2.2 Flint and chalk rich gravels, with associated sands, above the basal unit probably represent fluvial sediments laid down in a high energy river channel. Upwards these grade into sandy-silts probably also deposited in fluvial conditions. The upper part of this sequence, containing organic material may have formed a former landsurface that was vegetated.
- 4.3.2 The two organic units present indicate that a woodland development, possibly an alder carr formed over the possible landsurface that gave way to a reed swamp as a result of rising water levels.
- 4.3.2.4 Inundation of the former reed swamp occurred when clay-silt deposits were laid down over the remains of the reed swamp. This may have occurred due to a further rise in water levels and the creation of a flooded basin.

4.4 Borehole 4 (Transect 2, Figure 4)

4.4.1 Stratigraphy

- 4.4.1.1 This borehole was drilled to a maximum depth of 6.50m below ground level. Ground level was 3.42m O.D.

- 4.4.1.2 A total of 4 U4 samples and 3 disturbed samples were taken from the borehole, the detailed stratigraphic log is presented in Table 4.
- 4.4.1.3 Topsoil and made ground extend to a depth of 1.80m (1.62m O.D.).
- 4.4.1.4 Interbedded clay-silt units with peat traces occur between the base of the made ground and a depth of 3.4m (0.02m O.D.). A pronounced peat unit was noted immediately below the base of the made ground. The basal part of this sequence consisted of a highly organic silt.
- 4.4.1.5 The peat complex consisted of an upper reed dominated peat, with rare shell fragments and of variable humification between depths of 3.4m and 3.75m (0.02m and -0.33m O.D.), and a lower wood peat present to a depth of 4.80m (-1.38m O.D.).
- 4.4.1.6 Sandy-silts with common root traces exists immediately below the peats. These deposits contain rare flint clasts and are dense and compact. They extent to a depth of 5.0m (-1.58m O.D.).
- 4.4.1.7 Poorly sorted flint gravels are present at the base of the borehole.

Borehole Number	4 (BCI)		
Sheet 1 of	1		
Date	1/7/97	Recorded by	MRB
Surface datum	3.42m O.D.	Total depth	6.50m
Depth below surface (metres)	Lithostratigraphy		
0.00 - 0.10	Topsoil ---sharp contact---		
0.10 - 1.80	Fill/made ground		
1.80 - 2.00	Dark brown friable peat . Firm and dry.		
2.00 - 3.15	Mid grey clay-silt with some organic and peat traces. Plant fragments seen in places.		
3.15 - 3.40	Light brown to mid brown peaty coarse silt with some sand.		
3.40 - 3.75	Mid to dark reddish-brown fibrous peat with rare shell fragments. Strong odour. Firm and compact.		
3.75 - 4.80	Mid to dark brown woody peat with molluscs fragments. Variably humified in places. Can be dense and very compact.		
4.80 - 5.00	Grey clay-silt with sand. Firm and compact. Vertically orientated root traces. Rare flint clasts (<1cm).		

5.00 -	Poorly sorted flint gravels. Coarse with sub-angular to angular flint clasts. Rare sub-rounded flint clasts. ---base of borehole 6.50m---
Notes	Samples: 4 U4/U100 samples 3 bulk/disturbed samples

Table 4. Lithological description of borehole 4.

4.4.2 *Interpretation*

- 4.4.2.1 Basal sediments consist of poorly sorted flint gravels probably laid down in a high energy fluvial environment. Poor sorting perhaps indicates rapid deposition.
- 4.4.2.2 The stratigraphy fines upwards into the sandy-silts typical of lower energy, fluvial environments. The upper surface of these deposits may have been vegetated and colonized by plants and may represent a landsurface at 4.80 below ground level.
- 4.4.2.3 The organic units testify to the development of a alder carr environment that gave way over time to a herb fen, possibly in response to rising water levels.
- 4.4.2.4 A return to more substantial water bodies responsible for the deposition of the overlying clay-silts indicates the possible presence of a large, relatively low energy, fluvial or estuarine situation. Temporary emergence of the sedimentation front may have resulted in the development of organic horizons within this sequence.

4.5 **Borehole 5 (Transect 2, Figure 4)**

4.5.1 *Stratigraphy*

- 4.5.1.1 This borehole was drilled to a maximum depth of 12.50m below ground level. Ground level was 3.03m O.D.
- 4.5.1.2 A total of 13 U4 samples and 13 disturbed samples were taken from the borehole, the detailed stratigraphic log is presented in Table 5.

- 4.5.1.3 Topsoil and made ground extend to a depth of 2.20m (0.83m O.D.).
- 4.5.1.4 Bedded silts and organic units were recorded to a depth of 4.40m (-1.37m O.D.). Within this sequence clearly defined horizons of organic rich sediments can be noted.
- 4.5.1.5 A dry reed peat is noted to a depth of 5.8m (-2.77m O.D.). This unit contains shell fragments and thin beds of a soft carbonate material with a granular appearance. *Phragmites* sp. material dominates this deposit. A wood peat containing a thin clay-silt band occurs between depths of 5.8m and 7.40m (-2.77m and -4.37m O.D.).
- 4.5.1.6 The peat grades down into an organic silt that rests on grey clay-silt units between depths of 7.5m and 7.95m (-4.47m and -4.92m O.D.). An anomalous feature, with straight sides and filled with peat exists at a depth of 7.8m (-4.77m O.D.) (Plate 1).
- 4.5.1.7 Sandy-silts with traces of organic material exist below 7.95m and flint gravel occurs at a depth of 8.30m (-5.27m O.D.). The basal parts of the gravel contain large numbers of soft chalk clasts.
- 4.5.1.8 Bedrock was present at a depth of 12.0m (-8.97m O.D.).

Borehole Number	5 (BCI)		
Sheet 1 of	2		
Date	30/6/97	Recorded by	MRB
Surface datum	3.03m O.D.	Total depth	12.50m
Depth below surface (metres)	Lithostratigraphy		
0.00 - 0.10	Topsoil ---sharp contact---		
0.10 - 1.10	Fill/made ground		
1.10 - 2.20	Mid grey-brown coarse silt with chalk pellets and sub-rounded to sub-angular flint pebbles. Becomes mid to light grey clay sit with depth. Chalk pellets and rare flint clasts persist.		
2.20 - 2.20	Mid to dark brown silt with organic peaty traces becoming dark brown peat with some clay-silt. Peat is moderately humified and moist.		
2.50 - 2.65	5GY 5/1 mid grey peaty clay-silt with increasing organic content. <i>Phragmites</i> sp. present.		
2.65 - 2.75	Mid to dark brown silt with organic peaty traces becoming dark brown peat with some clay-silt. Peat is moderately humified and moist.		

2.75 - 3.60	5GY 5/1 mid grey peaty clay-silt with increasing organic content. <i>Phragmites</i> sp. present.
3.60 - 3.70	Mid to dark brown silt with organic peaty traces becoming dark brown peat with some clay-silt. Peat is moderately humified and moist.
3.70 - 4.40	5GY 5/1 mid grey peaty clay-silt with increasing organic content. <i>Phragmites</i> sp. present.
4.40 - 4.80	Peaty clay-silt. Peat is dry and friable. Shell fragments clearly visible. Peat appears to be bedded with thin carbonate beds of granular appearance that contain shell fragments.
4.80 - 5.80	As above but becoming more fibrous with depth. Common <i>Phragmites</i> sp. present.
5.80 - 6.45	Dark brown wood peat containing abundant plant and wood fragments. Appears possibly laminated. <i>Phragmites</i> sp. present.
6.45 - 6.50	5GY 5/1 grey clay-silt horizon. Organic rich at top with organic content decreasing towards base of unit.
6.50 - 7.40	Dark brown wood peat containing abundant plant and wood fragments. Appears possibly laminated. <i>Phragmites</i> sp. present.
7.40 - 7.50	Dark brown silty-peat. Peat is more humified than the overlying peat. Becomes mid grey clay-silt with depth containing plant fragments.
7.50 - 7.95	Grey clay-silt with common organic traces and roots present. Laminae occur towards base of unit. At 7.8m a vertical sided, peat filled feature was noted in the centre of the core. Feature was c.7cm deep and 6-7cm wide. The top of the feature was missing but has been interpreted as a possible post hole.
7.95 - 8.30	Mid grey well sorted sandy clay-silt with evidence of rooting. Roots are vertically orientated. Firm and compact. Flint clasts (sub-angular to sub-rounded) appear in units.
8.30 - 11.00	Flint gravel. Clasts up to cobble size are present. Clasts are sub-angular to sub-rounded with occasional well rounded flints. Matrix of mid grey coarse sand.
11.00 - 11.80	As above but chalk pebbles appear.
11.80 - 12.00	Soft putty chalk with clasts of sub-rounded to sub-angular characters. Becomes more compact and denser with depth.
12.00 -	Bedrock.

---base of borehole 12.50m---	
Notes	Samples: 13 U4/U100 samples 13 bulk/disturbed samples

Table 5. Lithological description of borehole 5.

4.5.2 *Interpretation*

- 4.5.2.1 Flint gravel with chalk clasts exists at the base of the borehole above bedrock. This gravel is likely to be of fluvial origin, deposited in a high energy river channel. The sequence fines upwards into a sandy-silt with organic material that probably represents sedimentation in a lower energy fluvial system.
- 4.5.2.2 A thin laminated silt unit is present above the sandy-silts. This probably represents deposition under low energy conditions in a slow moving water body. It is likely that this may have been under estuarine conditions.
- 4.5.2.3 The peat complex consists of a basal woody peat, perhaps indicative of alder carr that gives way upwards to a herb fen. This sequence is indicative of an initial drying of the environment followed by rising water levels.
- 4.5.2.4 A return to deposition of clay-silts, under probable estuarine conditions is noted above the organic complex. The organic horizons probably represent accumulations of plant detrital material at times of temporary emergence of sediments.

4.6 **Borehole 6 (Transect 3, Figure 4)**

4.6.1 *Stratigraphy*

- 4.6.1.1 This borehole was drilled to a maximum depth of 5.00m below ground level. Ground level was 3.51m O.D.
- 4.6.1.2 A total of 1 U4 sample and 7 disturbed samples were taken from the borehole, the detailed stratigraphic log is presented in Table 6.
- 4.6.1.3 Topsoil and made ground extend to a depth of 1.60m (1.91m O.D.).
- 4.6.1.4 Interbedded clays and silts with organic horizons occur to a depth of 2.35m (1.16m O.D.).

- 4.6.1.5 A thin peaty unit exists between 2.35m and 2.60m depth (1.16m to 0.91m O.D.). No discernible plant fragments could be observed in this deposit.
- 4.6.1.6 The organic sediments lay on sandy-silts containing organic material that extend to a depth of 3.0m (0.51m O.D.). These sediments contain occasional flint clasts.
- 4.6.1.7 Flint gravel was encountered below 3.0m and extended to the base of the borehole at 5.0m.

Borehole Number	6 (BCI)		
Sheet 1 of	1		
Date	29/6/97	Recorded by	MRB
Surface datum	3.51m O.D.	Total depth	5.0m
Depth below surface (metres)	Lithostratigraphy		
0.00 - 0.10	Topsoil ---sharp contact---		
0.10 - 1.60	Fill/made ground		
1.60 - 1.90	Mid grey clay-silt with some sub-rounded to well rounded flint clasts (<4cm). Some traces of rooting.		
1.90 - 2.20	Mid grey clay-silt with light brown flecks.		
2.20 - 2.30	5GY 5/1 grey clay-silt.		
2.30 - 2.35	Dark grey brown clay-silt with plant fragments. Flint clasts are present (>0.5cm) and are angular. Occasional small (<1cm), sub-angular chalk clasts occur here.		
2.35 - 2.60	Dark grey brown organic clay-silt with flint clasts. Organic material occurs in pockets. Occasional pockets of light grey fine sandy-silt.		
2.60 - 3.00	Mid grey sandy-silt with plant fragments (roots) and flint clasts.		
3.00 -	Flint gravel ---base of borehole 5.0m---		
Notes	Samples: 1 U4/U100 7 bulk/disturbed samples		

Table 6. Lithological description of borehole 6.

4.6.2 Interpretation

- 4.6.2.1 Flint gravel exists above bedrock. This gravel is likely to be of fluvial origin, deposited in a high energy river channel. The sequence fines upwards into a sandy-silt with organic material that probably represents sedimentation in a lower energy fluvial system.
- 4.6.2.2 The overlying peat consists of a thin amorphous unit that is highly humified and probably represents organic accumulation in a damp, wetland marginal situation (relative to those situations elsewhere on the site where well developed peat is present).
- 4.6.2.3 Deposition of clay-silts, under probable estuarine conditions is noted above the organic complex. The organic horizons probably represent accumulations of plant detrital material at times of temporary emergence of sediments.

4.7 Borehole 7 (Transect 3, Figure 4)

4.7.1 Stratigraphy

- 4.7.1.1 This borehole was drilled to a maximum depth of 5.0m below ground level. Ground level was 3.51m O.D.
- 4.7.1.2 A total of 3 U4 samples and 5 disturbed samples were taken from the borehole, the detailed stratigraphic log is presented in Table 7.
- 4.7.1.3 Topsoil and made ground extend to a depth of 1.40m (2.11m O.D.).
- 4.7.1.4 Interbedded clays and silts with organic horizons occur to a depth of 2.80m (0.71m O.D.).
- 4.7.1.5 A thin peat complex consisting of an upper, probable reed peat exists between 2.80m and 2.85m depth (0.71m to 0.66m O.D.) and a lower woody peat down to a depth of 3.25m (0.26m O.D.).
- 4.7.1.6 The organic sediments lay on sandy-silts containing organic material that extend to a depth of 3.7m (-0.19m O.D.). These sediments contain occasional flint clasts.
- 4.7.1.7 Flint gravel was encountered below 3.7m and extended to the base of the borehole at 5.0m.

Borehole Number	7 (BCI)		
Sheet 1 of	1		
Date	28/6/97	Recorded by	MRB
Surface datum	3.51m O.D.	Total depth	5.00m
Depth below surface (metres)	Lithostratigraphy		
0.00 - 0.10	Topsoil ---sharp contact---		
0.10 - 1.40	Fill/made ground		
1.40 - 1.85	Light brown sandy-silt with chalk pellets becoming mid to light grey clay-silt with depth. Rare organic fragments. Structureless. Soft and unconsolidated. Upper part of unit mixed with overlying made ground. Grades downwards into dark greyish brown organic silt with some evidence of rooting. Firm and compact.		
1.85 - 2.80	5GY 5/1 grey clay-silt with black reduced organic fragments. Soft and unconsolidated.		
2.80 - 2.85	Brown moderately well humified peat with clearly visible plant fragments. Becomes increasingly silty with some fine sand with depth. Occasional flint pellets <1cm appear towards base.		
2.85 - 3.25	7.5YR 4/2 dark brown woody peat. Loose and unconsolidated, possibly with voids in peat. Common large stem/twig fragments. Molluscs are present and appear to be dominated by terrestrial species. A network of fine rootlets was noted. No structure.		
3.25 - 3.70	Mid to light grey sandy-silt with plant fragments (wood material). Sub-rounded to well rounded flint clasts present. With depth becomes mid dark grey sandy-silt with some clay. Flint clasts are present. Occasional plant fragments.		
3.70 -	Sandy flint gravel with some clay-silt matrix.. Gravel is poorly sorted. Clasts are angular to sub-angular and occasional well rounded clasts. ---base of borehole 5.0m---		
Notes	Samples: 3 U4/U100 samples 5 bulk/disturbed samples		

Table 7. Lithological description of borehole 7.

4.7.2 Interpretation

- 4.7.2.1 Flint gravel exists at the base of the sequence. This gravel is likely to be of fluvial origin, deposited in a high energy river channel. The sequence fines upwards into a sandy-silt with organic material that probably represents sedimentation in a lower energy fluvial system.
- 4.7.2.2 The peat complex consists of a basal woody peat, perhaps indicative of alder carr that gives way upwards to a herb fen assemblage. This sequence is indicative of an initial drying of the environment followed by rising water levels.
- 4.7.2.3 A return to deposition of clay-silts, under probable estuarine conditions is noted above the organic complex. The organic horizons probably represent accumulations of plant detrital material at times of temporary emergence of sediments.

4.8 Borehole 8 (Transect 3, Figure 4)

4.8.1 Stratigraphy

- 4.8.1.1 This borehole was drilled to a maximum depth of 9.30m below ground level. Ground level was 3.26m O.D.
- 4.8.1.2 A total of 4 U4 samples and 11 disturbed samples were taken from the borehole, the detailed stratigraphic log is presented in Table 8.
- 4.8.1.3 Topsoil and made ground extend to a depth of 2.50m (0.76m O.D.).
- 4.8.1.4 Interbedded clays and silts with organic horizons exist immediately below the made ground. These deposits extend to a depth of 3.5m (-0.24m O.D.). Individual horizons within these deposits contain higher organic content.
- 4.8.1.5 A complex of organic sediments occurs between 3.5m and 5.10m depth (-0.24m and -1.84m). These deposits consist of an upper peat containing common carbonate patches and molluscs and a lower peat with common woody root fragments.
- 4.8.1.6 A coarsening downwards unit consisting of sandy-silt with organic material at the top becoming sandier with gravel clasts towards the base exists between 5.10m and 7.20m (-1.84m and -3.94m).
- 4.8.1.7 The lowermost unit consists of chalky gravel supported in a clay-silt matrix. This unit coarsens with depth and overlies fragmentary, angular chalk at a depth of 8.1m (-4.84m O.D.).

Borehole Number	8 (BCI)		
Sheet 1 of	2		
Date	26-28/6/97	Recorded by	MRB
Surface datum	3.26m O.D.	Total depth	9.30m
Depth below surface (metres)	Lithostratigraphy		
0.00 - 0.25	Topsoil ---sharp contact---		
0.25 - 2.50	Fill/made ground		
2.50 - 3.00	5G 5/1 greenish-grey clay-silt mixed with overlying made ground at top. Soft and structureless with black reduced and unreduced organic material.		
3.00 - 3.50	As above but interbedded/mixed with 7.5YR 4/2 dark brown organic rich silt. Soft and pliable. Common unoxidised plant remains, molluscs including <i>Lymnaea</i> sp., are present. With depth colour change to 5YR 3/3 dark reddish-brown organic silt with molluscs. Occasional large sub-angular chalk clasts (2-3cm).		
3.50 - 3.95	7.5YR 3/4 dark brown bedded amorphous peat with carbonate patches and beds containing molluscs. Variably humified.		
3.95 - 4.55	7.5YR 3/4 dark brown firm organic silt with unoxidised organic material. Soft and friable when dry. Interbedded with carbonate silt of a granular appearance. Carbonate bands contain fragmentary molluscs.		
4.55 - 5.10	7.5YR 4/2 dark brown organic silt. Strong odour. Well preserve root fragments (<i>in situ?</i>). No structure, dry and friable. Occasional small white flecks and small, sub-rounded flints (<1cm).		
5.10 - 7.00	Light grey sandy-silt with pockets of organic silt/peat. Colour becomes blue-grey with depth. Rare plant material. Grain size possibly coarsens downwards. With depth flint clasts appear and become increasingly more common.		
7.00 - 7.20	As above but chalk pellets and some patches of chalky silt clay are present.		
7.20 - 8.10	Light yellowish brown matrix supported chalk gravel. Clay-silt matrix with sub-angular to sub-rounded clasts. Clasts become larger and more angular with depth.		
8.10 -	Angular fragmentary chalk. ---base of borehole 9.30m---		

Notes	Samples: 4 U4/U110 samples 11 bulk/disturbed samples
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Table 8. Lithological description of borehole 8.

4.8.2 *Interpretation*

- 4.8.2.1 The basal deposit consists of a chalk rich sediment interpreted here as a solifluction gravel. Similar sediments have been noted in other boreholes and this material is similar to sediments exposed in quarry sections elsewhere in the Ebbsfleet area.
- 4.8.2.2 Coarse sand and flint gravel deposits overlying the basal solifluction units are probably of fluvial origin, deposited in a medium to high energy river channel. The sequence fines upwards into a sandy-silt with organic material that probably represents sedimentation in a lower energy fluvial system. These deposits are typically finer grained than those elsewhere in the area.
- 4.8.2.3 The peat complex consists of a basal woody peat, perhaps indicative of alder carr that gives way upwards to a herb fen assemblage. This sequence is indicative of an initial drying of the environment followed by rising water levels.
- 4.8.2.4 Deposition of clay-silts, under probable estuarine conditions is noted above the organic complex. Temporary emergence of the sedimentation front may have resulted in the development of organic horizons within this sequence.

4.9 **Borehole 9 (Transect 3, Figure 4)**

4.9.1 *Stratigraphy*

- 4.9.1.1 This borehole was drilled to a maximum depth of 7.80m below ground level. Ground level was 3.19m O.D.
- 4.9.1.2 A total of 7 U4 samples and 7 disturbed samples were taken from the borehole, the detailed stratigraphic log is presented in Table 9.
- 4.9.1.3 Topsoil and made ground extend to a depth of 1.50m (1.6m O.D.).
- 4.9.1.4 A sequence of interbedded clays and silts exist immediately below the made ground. These deposits lie between 1.50m and 4.30m depth (1.60m

and -1.11m O.D.). A number of organic rich units were noted within this sequence.

4.9.1.5 Organic rich peats exist between 4.3m and 7.6m depth (-4.41m O.D.). These units consist of an upper reed dominated peat to a depth of 5.55m (-2.36m O.D.). This part of the sequence, while dominated by reed peat contains small amounts of wood in the upper part of the profile. Mollusc rich calcareous beds also exist within this part of the sequence. Wood peat exists below the reed peat. Mollusc rich horizons are also noted in this part of the sequence and some reed penetration is noted here. Flint gravel clasts are noted within the peat towards the base.

4.9.1.6 The basal part of the sequence consists of a silty sand with gravel clasts that gives way rapidly to a flint rich gravel.

Borehole Number	9 (BCI)		
Sheet 1 of			
Date	16/7/97	Recorded by	MRB
Surface datum	3.19m O.D.	Total depth	7.8m
Depth below surface (metres)	Lithostratigraphy		
0.00 - 1.50	Topsoil and fill/made ground ---sharp contact---		
1.50 - 1.75	7.5YR 3/2 dark brown organic silt with common small rootlets, wood and common <i>Phragmites</i> sp. material present. Soft and unconsolidated.		
1.75 - 1.85	5GY 5/1 dark greenish-grey clay-silt with strong odour. Soft and unconsolidated.		
1.85 - 2.50	7.5YR 3/2 dark brown organic silt with common small rootlets and common <i>Phragmites</i> sp. material present. Soft and unconsolidated.		
2.50 - 3.80	5GY 4/1 dark greenish-grey clay -silt with some organic material. Soft and unconsolidated. Fine network of unoxidised rootlets present.		
3.80 - 4.30	As above but becoming more compact and firmer with depth. Organic content increases with depth.		
4.30 - 4.45	5YR 3/3 dark reddish-brown peat. Common well preserved wood fragments (root or branch). Common molluscs present. Some silt. Strong odour. Common reed stem fragments. No structure, dry and firm. Interbedded with carbonate patches and thin beds.		

4.45 - 5.55	10YR 5/3 brown peat. As above but wood absent. Unit is well bedded with carbonate patches containing molluscs (including <i>Planorbis</i> sp.). Soft and unconsolidated. <i>Phragmites</i> sp. material seen <i>in situ</i> and as thin parallel bedded horizontal layers of leaf/stem material.
5.55 - 6.25	10YR 5/3 brown carbonate rich silt with molluscs interbedded with 5YR 3/4 dark reddish brown peat. Common molluscs, both freshwater and terrestrial. Wood present including material with bark. Many reed fragments still present.
6.25 - 7.00	5YR 3/4 dark reddish brown wood peat. Very well preserved wood fragments. No carbonate patches/beds. Dry and firm, Strong odour.
7.00 - 7.40	10YR 5/3 brown bedded calcareous peat with common molluscs. Molluscs include freshwater and terrestrial species. Firm and dry. Occasional sub-angular, rolled flints (1-3cm). Common wood fragments.
7.40 - 7.60	As above but common flint clasts are present. Clasts are poorly sorted, sub-angular and less than 1cm to greater than 3cm.
7.60 -	5Y 5/1 grey silty sandy matrix to flint gravel. Very poorly sorted (<2cm to >10cm), angular/sub-angular and rolled. Firm and very compact. Matrix material decreases with depth. Common Tertiary flints present. ---base of borehole 7.8m---
Notes	Samples: 7 U4/U100 samples 7 bulk/disturbed samples

Table 9. Lithological description of borehole 9.

4.9.2 Interpretation

- 4.9.2.1 Coarse sand and flint gravel deposits exist at the base of the sequence and were probably of fluvial origin, deposited in a medium to high energy river channel. The sequence fines upwards into a sandy-silt that probably represents sedimentation in a lower energy fluvial system.
- 4.9.2.2 The peat complex consists of a woody peat, perhaps indicative of alder carr interbedded with carbonate deposits. This sequence is indicative of a drying of the environment. This is replaced up-profile by a herb fen assemblage indicative of increasing water levels. The presence of mollusc

rich horizons suggests this was a calcareous environment with possible dry and wet ground habitats.

- 4.9.2.3 Deposition of clay-silts, under probable estuarine conditions is noted above the organic complex. Temporary emergence of the sedimentation front may have resulted in the development of organic horizons within this sequence.

4.10 Borehole 10 (Transect 1, Figure 4)

4.10.1 Stratigraphy

- 4.10.1.1 This borehole was drilled to a maximum depth of 10.6m below ground level. Ground level was 3.39m O.D.
- 4.10.1.2 A total of 7 U4 samples and 9 disturbed samples were taken from the borehole, the detailed stratigraphic log is presented in Table 10.
- 4.10.1.3 Topsoil and made ground extend to a depth of 1.20m (2.19m O.D.).
- 4.10.1.4 Interbedded clays and silts with organic horizons exists immediately below the made ground. These deposits extend to a depth of 4.33m (-0.94m O.D.). Individual horizons within these deposits contain higher organic content.
- 4.10.1.5 A complex of organic sediments occurs between 4.33m and 5.85m depth (-0.94m and -2.46m). These deposits consist of woody peat alternating with amorphous peat containing common carbonate patches and molluscs.
- 4.10.1.6 A coarsening downwards unit consisting of sandy-silt with organic material at the top becoming sandier with gravel clasts towards the base exists between 5.85m and 6.60m (-2.46m and -3.21m).
- 4.10.1.7 A sandy gravel with some chalk clasts was recorded between 6.60m and 9.00m (-3.21m and -5.61m O.D.). The basal part of this unit consisted of a silty-sand with clastic material. Chalk clasts become common towards the base.
- 4.10.1.8 The lowermost unit consists of chalky gravel supported in a clay-silt matrix. This unit was not bottomed.

Borehole Number	10 (BCI)		
Sheet 1 of			
Date	2/7/97	Recorded by	MRB
Surface datum	3.39m O.D.	Total depth	10.6m
Depth below surface (metres)	Lithostratigraphy		
0.00 - 0.20	Topsoil ---sharp contact---		
0.20 - 1.20	Fill/made ground		
1.20 - 1.40	5YR 3/2 dark reddish brown peat with common rootlets. Soft and unconsolidated. Friable and structureless.		
1.40 - 2.50	5Y 4/1 dark grey stiff and dense clay-silt. Occasional possible flint gravel clasts and chalk granules. No structures		
2.50 - 2.60	Dark greyish-brown organic silt with common small roots. Firm and compact.		
2.60 - 3.12	10YR 3/4 dark yellowish brown organic silt with extensive <i>Phragmites</i> sp. stem and root material <i>in situ</i> . No structure. Large fractured flint recorded.		
3.12 - 3.25	Dark greyish-brown organic silt with common small roots. Firm and compact. Grades down into underlying unit.		
3.25 - 4.33	5Y 5/1 grey clay-silt with <i>in situ</i> rooting. Unit is laminated. Becoming 2.5Y 6/4 light yellowish brown clay-silt with depth. Laminated to fine bedded and contains roots penetrating from above.		
4.33 - 4.55	7.5YR 3/4 dark brown organic silt with top part of unit made of fine detrital plant material. Dry and firm.		
4.55 - 4.85	As above but common wood fragments seen. Interbedded with carbonate beds and patches of carbonate material. Variably humified.		
4.85 - 5.35	7.5YR 4/6 strong brown organic silt with strong odour. Common carbonate patches forming distinct beds or laminae. Common molluscs present - fragmented or crushed. Friable. Occasional large roots. Wood fragments disappear at 5.05m.		
5.35 - 5.85	2.5Y 3/2 dusky red woody peat. Strong odour. Root and twig fragments visible. Dry and friable. Occasional mollusc fragments and shells. No structure.		

5.85 - 6.60	5GY 5/1 greenish-grey very fine sand to very coarse silt. Mottled with 10YR 4/4 dark yellowish brown. Plastic and damp. <i>In situ</i> rooting from above. Structureless. Occasional angular flint clasts (<1cm).
6.60 - 7.50	5GY 5/1 dark greenish-grey sandy-gravel with some silt. Cohesive. Gravel clasts are <1-3cm, sub-angular to sub-rounded. Predominantly flint with some chalk clasts. Poorly sorted. Matrix supported. Flint clasts increase in size with depth.
7.50 - 8.50	2.5Y 4/4 olive brown stiff fine silty-sand with some clay. Dense and compact. Flint gravel still present - matrix supported. Clasts are angular to well rounded and poorly sorted. Occasional rounded chalk clasts are present.
8.50 - 9.00	As above but chalk clasts are very common
9.00 -	2.5Y 6/4 light yellowish brown matrix supported chalk gravel. Poorly sorted, clasts <0.5 to >4cm, sub-angular to sub-rounded and rolled. Silt matrix. Firm and compact. ---base of borehole 10.6m---
Notes	Samples: 7 U4/U100 samples 9 bulk/disturbed samples

Table 10. Lithological description of borehole 10.

4.10.2 Interpretation

- 4.10.2.1 The basal deposit consists of a chalk rich sediment interpreted here as a solifluction gravel. Similar sediments have been noted in other boreholes and this material is similar to sediments exposed in quarry sections elsewhere in the Ebbsfleet area.
- 4.10.2.2 Coarse sand and flint gravel deposits overlying the basal solifluction units are probably of fluvial origin, deposited in a medium to high energy river channel. The sequence fines upwards into a sandy-silt with organic material that probably represents sedimentation in a lower energy fluvial system. These deposits are typically finer grained than those elsewhere in the area.
- 4.10.2.3 The peat complex consists of a woody peat, perhaps indicative of alder carr interbedded with carbonate deposits. This sequence is indicative of a drying of the environment.

4.10.2.4 Deposition of clay-silts, under probable estuarine conditions is noted above the organic complex. Temporary emergence of the sedimentation front may have resulted in the development of organic horizons within this sequence.

4.11 Borehole 11 (Transect 2, Figure 4)

4.11.1 Stratigraphy

4.11.1.1 This borehole was drilled to a maximum depth of 10.10m below ground level. Ground level was 2.92m O.D.

4.11.1.2 A total of 12 U4 samples and 3 disturbed samples were taken from the borehole, the detailed stratigraphic log is presented in Table 11.

4.11.1.3 Topsoil and made ground extend to a depth of 0.80m (2.12m O.D.).

4.11.1.4 A complex of organic silts and inorganic clay-silt units exist below made ground to a depth of 4.60m (-1.68m O.D.).

4.11.1.5 Organic sediments exist between 4.60m and 8.25m depth (-1.68m and -5.33m O.D.). These consist of an upper reed peat (to a depth of 6.6m or -3.68m O.D.), and a lower wood peat. Carbonate patches and beds containing molluscs are present within both parts of the sequence.

4.11.1.6 Beneath the peat a sequence of clay-silts exist to a depth of 10.05m (-7.13m O.D.). These deposits are similar to the clay-silts immediately below the made ground. A thin sequence of highly organic rich sediments occurs between 9.0m and 9.15m depth (-6.08m and -6.23m O.D.). These deposits contain burnt flint, debitage and charcoal.

4.11.1.7 The base of the sequence consists of a flint gravel.

Borehole Number	11 (BCI)		
Sheet 1 of			
Date	17/7/97	Recorded by	MRB
Surface datum	2.92m O.D.	Total depth	10.10m
Depth below surface (metres)	Lithostratigraphy		
0.00 - 0.80	Topsoil and fill/made ground ---sharp contact---		
0.80 - 0.85	10YR 3/2 very dark greyish-brown organic silt. Soft and unconsolidated with carbonate patches, molluscs and possible small chalk clasts (<0.5cm).		
0.85 - 2.55	5GY 4/1 dark greenish-grey clay-silt. Soft and unconsolidated. Common black, reduced organic fragments including <i>Phragmites</i> sp. material.		

2.55 - 2.60	10YR 3/2 very dark greyish-brown organic silt to peat with black reduced organic material. Firm and compact. Rooting from above noted. Some molluscs and carbonate patches.
2.60 - 2.80	5GY 4/1 dark greenish-grey clay-silt. Soft and unconsolidated. Common black, reduced organic fragments including <i>Phragmites</i> sp. material.
2.80 - 3.00	5GY 4/1 dark greenish-grey clay-silt. Soft and unconsolidated. Common black, reduced organic fragments including <i>Phragmites</i> sp. material. Common small (2-3mm) angular chalk clasts.
3.00 - 4.05	2.5Y 4/4 olive brown organic rich silt. Many fine root traces. Soft and unconsolidated. Many reed fragments (<i>in situ</i>). Appears to be interbedded with 5GY 4/1 dark greenish-grey clay-silt with very little organic matter.
4.05 - 4.60	7.5YR 4/2 dark brown organic silt to peat. Strong odour. Network of fine root trances. Soft and unconsolidated. Becomes 10YR 8/4 very pale brown and carbonate rich with depth.
4.60 - 6.60	5YR 3/4 dark reddish brown peat. Dominated by reed material (<i>in situ</i>). No structure, dry and friable. Black organic material lies horizontal in unit. Molluscs are present. Thin carbonate rich beds present.
6.60 - 8.25	5YR 3/4 dark reddish brown peat. Very common wood fragments - well preserved. In paces unit is interbedded with carbonate rich units containing molluscs.
8.25 - 8.70	5GY 4/1 dark greenish-grey soft clay-silt with strong odour. Common wood and root fragments. Soft and unconsolidated.
8.70 - 9.00	As above but only occasional roots present. Possibly bedded or fine laminated.
9.00 - 9.07	10YR 5/2 greyish-brown organic silt with fine roots present. Structureless and massive.
9.07 - 9.15	10YR 4/1 dark grey slightly sandy-silt. Structureless. Burnt flint fragments and some possible debitage. Charcoal possibly present.
9.15 - 10.05	10YR 2/1 black sandy-silt coarsening downwards to silty-sand. Black reduced organic fragments. Becomes 5GY 4/1 dark greenish-grey with depth.
10.05 -	2.5Y N6 grey slightly sandy silt matrix to angular flint gravels. Clasts (<0.5cm to >5cm), angular. Dense and compact. With depth becomes slightly better sorted.

---base of borehole 10.10m---	
Notes	Samples: 12 U4/U100 samples 3 bulk/disturbed samples

Table 11. Lithological description of borehole 11.

4.11.2 *Interpretation*

- 4.11.2.1 The sedimentary sequence present commences with the deposition of the flint gravels under probable high energy fluvial conditions.
- 4.11.2.2 Up-profile these are replaced by clay-silt units that probably represent sediments deposited in low energy water bodies below the water-line (possibly under saline or brackish water conditions). The presence of potential archaeological material within these deposits suggests temporary drying of the environment or the location nearby of an archaeological site.
- 4.11.2.3 The presence of the wood peat suggests that a possible alder carr woodland developed in the area as water levels dropped. Increasing water levels probably resulted in the inundation of the woodland by wetter ground situations and the development of a herb fen, the presence of extensive molluscan material in these units indicates that this was a calcareous wetland.
- 4.11.2.4 Further increases in water levels finally resulted in submergence of the area and the deposition of the clay-silt units. Temporary, periodic emergence episodes may be indicated by the presence of organic rich units in these upper clay-silts.

5 RESULTS: GEOPHYSICAL SURVEY

5.1 Transect 1

5.1.1 An example of the raw data for apparent resistivity and inverted resistivity section with depth are shown in Figure 5. The results of the surface DC resistivity soundings are shown in Figure 6. Approximate ranges of resistivity are presented in Table 12.

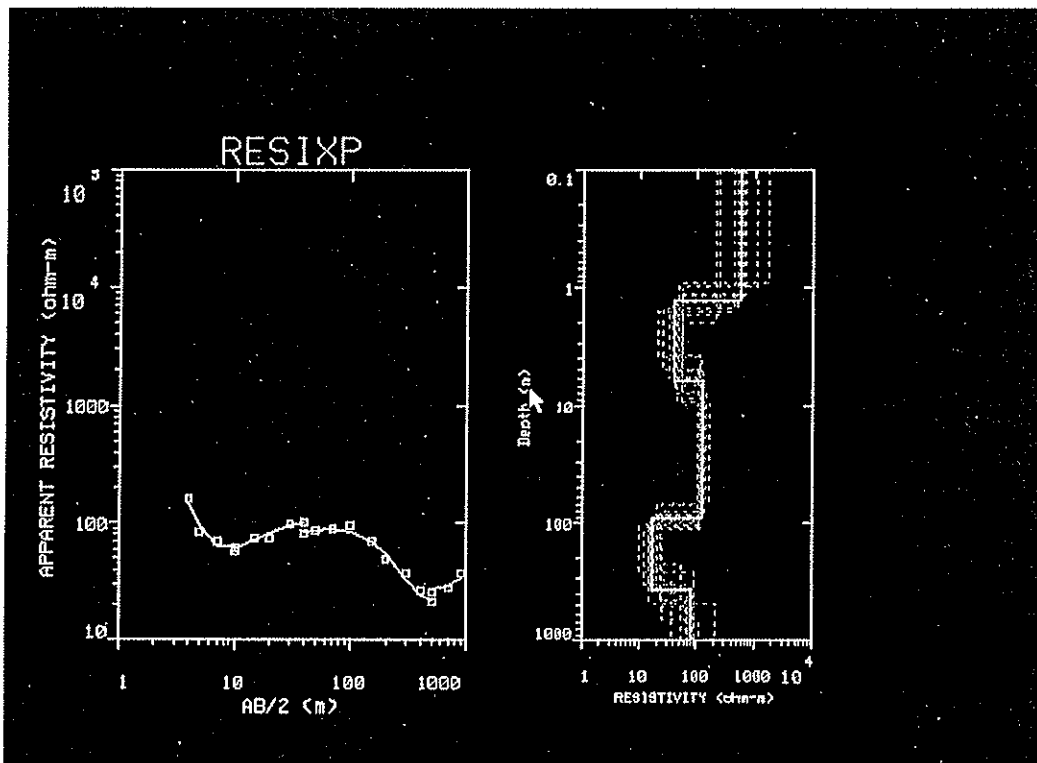


Figure 5. Geophysical raw data for apparent resistivity and inverted resistivity section with depth.

Lithology	Resistivity Range (ohm-m)
Made ground/fill	20-45
Peat (saline saturated)	5-7
Silty Clay	7-10
Gravel	20-60

Table 12. Resistivity range results from geophysical transect 1.

5.1.2 The results of the down hole logging are shown in Figure 7. These results represent the averaged values for a minimum of three logging runs per hole with logging run both in down-going mode and up-going.

5.1.3 Noteworthy on these results (Figure 7) is the extremely high conductivity shown in borehole 5. Values of this magnitude are typically associated with a conductor or high salinity. These results are interpreted as due to the latter.

- 5.1.4 High gamma counts were observed to correlate with the clay rich horizons. Of particular note is a high gamma count and interpreted clay layer immediately below the high conductivity layer (interpreted to be high salinity in the peat layer). This clay could have acted as a barrier to downward migration or flushing of the salts from the peat in to the gravel below.
- 5.1.5 The resistivity profile (Figure 6) is resolved as a 4 layer model where the lower boundary of the lowest layer is unresolved. Values from the made ground (20-40 ohm-m) indicate a maximum depth of c.2.7m that is consistent with depths inferred from the boreholes (Transect 2, Figure 4). Clay-silt units, with values of 7-10 ohm-m exist below the made ground. A peat unit (values 5-7 ohm-m) is shown to thicken towards the east and thin westwards (this is consistent with the stratigraphic information in transect 2 (Figure 4). The basal conducting unit, with values from 20-60 ohm-m, conforms to the gravel surface topography (seen in Transect 2, Figure 4). Higher resistance values are noted at the western end of the transect possibly indicating different sub-surface ground conditions at the western end of the profile.

6 RESULTS: TEST PIT INVESTIGATION

6.1 Test pit 1 (Transect 3, Figures 4 and 8)

6.1.1 Stratigraphy

- 6.1.1.1 This test pit was excavated to a maximum depth of 3.6m below ground level. Ground level was 3.51m O.D.
- 6.1.1.2 No samples were taken from this test pit. The detailed stratigraphic log is presented in Table 13.
- 6.1.1.3 Topsoil and made ground extend to a depth of 1.60m (1.91m O.D.).
- 6.1.1.4 A complex of organic silts and inorganic clay-silt units exist below made ground to a depth of 2.80m (0.71m O.D.). These units were variably peaty and contained visible reed fragments in most organic dominated sediment units. Molluscs appeared in a number of these units.
- 6.1.1.5 A complex of peat units were noted below the interbedded sequence consisting of a reed dominated peat between 2.8m and 3.0m (0.71m and 0.51m O.D.) and underlying wood peat to a depth of 3.6m (-0.09m O.D.). Wood remains in the lower peat were well preserved.
- 6.1.1.6 The organic sediments rested on a dense sandy gravel that appears to have been rooted into from the overlying sediments.
- 6.1.1.7 This sequence accords well with that recorded in borehole 7.

Test Pit Number	1		
Sheet 1 of			
Date	22/7/97	Recorded by	MRB
Surface datum	3.51m O.D.	Total depth	3.60m
Depth below surface (metres)	Lithostratigraphy		
0.00 - 0.20	Topsoil. [101] ---diffuse contact---		
0.20 - 0.50	Chalk rubble with common flint clasts. Firm and compact. Poorly sorted (<1cm to >5cm). Modern roots. ---sharp contact---		
0.50 - 0.60	Dark greyish-brown silt with common chalk flecks and small clasts (1-2cm). Firm and compact. Structureless. ---sharp contact---		
0.60 - 1.00	Yellowish-red clay-silt with some sand. Firm and compact. Occasional small chalk clasts. No structure. [102] ---sharp/dipping contact---		
1.00 - 1.20	White chalk rubble with angular chalk clasts, poorly sorted (<1cm to >10cm) and occasional large angular flint cobbles. [103]		

1.20 - 1.60	<p>---sharp/dipping contact---</p> <p>Yellowish-red clay-silt with some sand becoming sandier with depth. Soft and structureless and unconsolidated. Occasional large flints and chalk clasts. Modern roots present. [104]</p>
1.60 - 1.75	<p>---sharp contact---</p> <p>Dark greyish-brown organic silt. Mixed at top with chalk grains and clasts. Freshwater molluscs present. Chalk clasts disappear with depth. Soft and apparently structureless. Organic rich at top, contains <i>Phragmites</i> sp. [105]</p>
1.75 - 2.30	<p>---sharp contact---</p> <p>Dark blue-grey clay-silt. Dense and compact with common fibrous plant remains including <i>Phragmites</i> sp. Network of <i>in situ</i> roots (reddish brown staining along roots). [106]</p>
2.30 - 2.50	<p>---diffuse contact---</p> <p>Blue-grey clay-silt with common <i>Phragmites</i> sp. stem material, <i>in situ</i>, but less common than above. Common black reduced organic fragments. Occasional well rounded Tertiary pebbles. [107]</p>
2.50 - 2.70	<p>---sharp contact---</p> <p>Dark brown organic silt. Very fibrous with crisp breakage. Common fine root/stem material (predominantly <i>Phragmites</i> sp.). Dry and firm. [108]</p>
2.70 - 2.80	<p>---sharp contact---</p> <p>Blue-grey clay-silt with common <i>Phragmites</i> sp. stem material, <i>in situ</i>, but less common than above. Common black reduced organic fragments. Occasional well rounded Tertiary pebbles. [109]</p>
2.80 - 3.00	<p>---sharp contact---</p> <p>Dark greyish-brown to reddish-brown peat. Common root fragments (<i>Phragmites</i> sp.). dry and friable with crisp breakage. Occasional small, sub-angular flint clasts (1-2cm). Some sand grains. No structure. [110]</p>
3.00 - 3.60	<p>---sharp contact---</p> <p>Very dark reddish-brown wood peat. Common large, well preserved wood remains. Strong odour. Dry and friable. Some reed fragments. Occasional small rounded flint clasts. [11] Some worked and burnt flint present.</p>
3.60 -	<p>---sharp contact---</p> <p>Light grey sandy-gravel with some silt. Very common poorly sorted flint clasts (angular to rounded 1->5cm). Wood root fragments present (<i>in situ</i>). Structureless and dense. [112]</p> <p>---base of test pit 3.60m---</p>
Notes	<p>Samples: None</p>

Table 13. Lithostratigraphic description from test pit 1.

6.1.2 *Interpretation*

- 6.1.2.1 Coarse sand and flint gravel deposits at the base of the sequence are probably of fluvial origin, deposited in a medium to high energy river channel. The upper surface of these deposits represent a sudden change in sedimentary environment and appear to have been rooted into. This surface may form a buried landsurface, and the presence of worked and burnt flint in this layer suggests significant archaeological potential.
- 6.1.2.2 The peat complex consists of a woody peat, perhaps indicative of alder carr that is followed by a reed dominated wetland sequence. This indicates that water datums were probably rising through the sequence leading to the development of increasingly wetter vegetation sequences. The presence of freshwater and terrestrial molluscs in the sequence suggest the proximity of dry ground to the wetground areas.
- 6.1.2.3 Deposition of the uppermost clay-silts, under probable estuarine conditions is noted above the organic complex. Temporary emergence of the sedimentation front may have resulted in the development of organic horizons within this sequence. These may have formed temporary, unstable ground surfaces.

6.2 **Test pit 2 (Transect 3, Figures 4 and 8, Plate 2)**

6.2.1 *Stratigraphy*

- 6.2.1.1 This test pit was excavated to a maximum depth of 4.0m below ground level. Ground level was 3.36m O.D.
- 6.2.1.2 Six monolith samples and 6 bulk samples were taken from this test pit. The detailed stratigraphic log is presented in Table 14, a photographic plate showing the main organic units is presented in Plate 2.
- 6.2.1.3 Topsoil and made ground extend to a depth of 1.70m (1.66m O.D.).
- 6.2.1.4 A complex of organic silts and inorganic clay-silt units exist below made ground to a depth of 2.90m (0.46m O.D.). These units were variably peaty and contained visible reed fragments in most organic dominated sediment units. Molluscs appeared in a number of these units.
- 6.2.1.5 A complex of peat units were noted below the interbedded sequence consisting of a reed dominated peat between 2.9m and 3.0m (0.46m and 0.36m O.D.) and underlying wood peat to a depth of 3.6m (-0.54m O.D.). Wood remains in the lower peat were well preserved.
- 6.2.1.6 The organic sediments rested on a dense sandy-gravel that appears to have been rooted into from the overlying sediments.

Test Pit Number	2		
Sheet 1 of			
Date	23/7/97	Recorded by	MRB
Surface datum	3.36m O.D.	Total depth	4.00m
Depth below surface (metres)	Lithostratigraphy		
0.00 - 0.20	Topsoil [201] ---sharp contact---		
0.20 - 0.80	Mixed greyish-brown to reddish-brown clay-silt with common gravel clasts of flint and chalk. Poorly sorted 2->5cm, sub-angular clasts. Structureless and firm. Many modern roots. Dense layer of chalk clasts near base of unit. [202] ---sharp contact---		
0.80 - 1.70	Yellowish-brown clay-silt with occasional chalk clasts (sub-angular). Mottled with grey brown mottles. Clean, structureless and massive. [203] ---sharp contact---		
1.70 - 1.95	Dark greyish-brown silt with common molluscs (mixed terrestrial and aquatic species). Structureless with some sand. Small empty red-brown stained root canals present. Occasional small (<1.5cm) sub-angular, rolled flint clasts. Soft and unconsolidated. [204] ---sharp contact---		
1.95 - 2.05	Blue-grey clay-silt with evidence of major root canals penetrating from above (currently empty and red-brown stained). Dense, compact and firm. <i>Phragmites</i> sp. present. [205] ---sharp contact---		
2.05 - 2.45	Dark greyish-brown organic silt. Very fibrous in appearance with very common <i>Phragmites</i> sp. stem and root material. <i>In situ</i> network of roots noted. Some very fine sand grains present. Insect remains noted. No structure. [206] -----sharp contact---		
2.45 - 2.55	Blue-grey clay-silt with evidence of major root canals penetrating from above (currently empty and red-brown stained). Dense, compact and firm. <i>Phragmites</i> sp. present. [207] ---sharp contact---		
2.55 - 2.75	Dark greyish-brown organic silt. Very fibrous in appearance with very common <i>Phragmites</i> sp. stem and root material. <i>In situ</i> network of roots noted. Some very fine sand grains present. Insect remains noted. No structure. [208] ---sharp contact---		
2.75 - 2.90	Dark greyish-brown organic silt. Very fibrous in appearance with very common <i>Phragmites</i> sp. stem and root material. <i>In situ</i> network of roots noted. Some very fine sand grains present. Some possible indications of thin bedding/laminae noted. No structure. [209] ---graded contact---		

2.90 - 3.00	Dark brown reed peat with common well preserved reed fragments and molluscs within carbonate rich beds in peat. Carbonate particles are firm possibly micritic type. Clear evidence of bedding in places. Contains some woody root material (possibly reworked?). Molluscs include both freshwater and terrestrial types. Loose and unconsolidated. [210]. One fragment of worked flint recovered. ---diffuse contact---
3.00 - 3.90	Dark reddish-brown wood peat. Very common fresh wood fragments. Dry and friable. Crisp break to peat. No structure. Strong odour. Towards the base peat is layered with layers of wood resting sub-horizontally in core. [211] ---sharp contact---
3.90 -	Light grey sand with some silt and some gravels clasts. Poorly sorted (<2cm to >10cm), sub-angular and rolled. Common roots fragments penetrate this unit. [212] ---base of test pit 4.00m---
Notes	Samples: 6 Monoliths 6 bulk samples

Table 14. Lithostratigraphic description from test pit 14.

6.2.2 Interpretation

- 6.2.2.1 Coarse sand and flint gravel deposits at the base of the sequence are probably of fluvial origin, deposited in a medium to high energy river channel. The upper surface of these deposits represent a sudden change in sedimentary environment and appear to have been rooted into. This surface may form a buried landsurface, and the presence of worked and burnt flint in this layer suggests significant archaeological potential.
- 6.2.2.2 The peat complex consists of a woody peat, perhaps indicative of alder carr that is followed by a reed dominated herb fen wetland sequence. This indicates that water datums were probably rising through the sequence leading to the development of increasingly wetter vegetation sequences. The presence of freshwater and terrestrial molluscs in the sequence suggest the proximity of dry ground to the wetground areas.
- 6.2.2.3 Deposition of the uppermost clay-silts, under probable estuarine conditions is noted above the organic complex. Temporary emergence of the sedimentation front may have resulted in the development of organic horizons within this sequence. These may have formed temporary, unstable ground surfaces.
- 6.2.2.4 The sequence is similar to that recorded in test pit 1 (Table 13) however sequences are slightly thicker and contacts for the upper and lower surfaces of the peat are lower in test pit 2.

6.3 Test pit 3 (Transect 2, Figures 4 and 8)

6.3.1 Stratigraphy

- 6.3.1.1 This test pit was excavated to a maximum depth of 4.0m below ground level. Ground level was 3.42m O.D.
- 6.3.1.2 No samples were taken from this test pit. The detailed stratigraphic log is presented in Table 15.
- 6.3.1.3 Topsoil and made ground extend to a depth of 1.90m (1.52m O.D.).
- 6.3.1.4 A complex of organic silts and inorganic clay-silt units exist below made ground to a depth of 3.70m (-0.28m O.D.). These units were variably peaty and contained visible reed fragments in most organic dominated sediment units. Molluscs appeared in a number of these units. The basal parts of this sequence became increasingly organic rich.
- 6.3.1.5 Only a reed peat was observed in this test pit. The base of the trench at 4m showed further reed peat and test pitting was abandoned due to trench instability and water inflow.
- 6.3.1.6 This stratigraphy was similar to that recorded in borehole 4.

Test Pit Number	3		
Sheet 1 of			
Date	24/7/97	Recorded by	MRB
Surface datum	3.42m O.D.	Total depth	4.00m
Depth below surface (metres)	Lithostratigraphy		
0.00 - 0.20	Topsoil and fill/made ground [301] ---sharp contact---		
0.20 - 1.90	Mixed flint gravel and chalk cobbles. Poorly sorted and with a yellow-brown clay-silt matrix. Dense and compact. [302] ---sharp contact---		
1.90 - 2.10	Dark brown peat or organic silt. Firm and compact. [303] ---graded contact---		
2.10 - 2.60	Blue-grey clay-silt with abundant rooting from above. <i>Phragmites</i> sp. common. Some black reduced organic remains present. firm and plastic. Organic content increase with depth. [304]		
2.60 - 3.00	Interbedded mid-brown organic silts with grey clay-silts. Reed stem fragments present throughout both units and crossing boundaries. Occasional horizontal orientated reed fragments. [305]		

3.00 -	Dark-reddish brown reed peat. Dry and friable. Common carbonate flecks and molluscs present. Occasional small, sub-angular chalk clasts. No apparent structure. [306] ---base of test pit 4.00m---
Notes	Samples: None

Table 15. Lithostratigraphical description from test pit 3.

6.3.2 *Interpretation*

- 6.3.2.1 Reed peat, indicative of herb fen, was present at the base of the trench indicative of a wetland environment.
- 6.3.2.2 Deposition of the uppermost clay-silts, under probable estuarine conditions is noted above the organic complex. Temporary emergence of the sedimentation front may have resulted in the development of organic horizons within this sequence. These may have formed temporary, unstable ground surfaces.

7 SPECIALIST REPORTS

7.1 Waterlogged Macroscopic Plant Remains (Ruth Pelling, Oxford Archaeological Unit)

7.1.1 *Introduction*

7.1.1.1 A sequence of 7 samples were taken from a test pit for the assessment of waterlogged plant remains. A further 5 samples were taken from two bore holes. The bore hole deposits underlie the deposits sampled in the test pit. The purpose of the assessment was to characterize the deposits and to assess the quality of preservation of the material.

7.1.2 *Methods*

7.1.2.1 Each sample was sub-sampled for the purpose of the assessment. Sub-samples of the test pit samples were 0.5kg in weight, while 40 to 200g were taken from the bore hole samples. Each sub-sample was placed in a bucket and processed using a wash over technique. Any organic remains were washed into a stack of sieves. Each fraction was then examined under a binocular microscope at magnification of x10 to x50. Any plant remains were provisionally identified and an estimate of abundance was made.

7.1.2.2 Remains are quantified on a three point scale (+ = 0-10 present; ++ = common; +++ = frequent). Wood fragments were identified by first examining broken fragments in transverse section under magnification of x40. Thin slices of wood taken in tangential section were examined under a high powered microscope at x100 and x400 magnification in order to view spiral thickenings, pits, ray width and perforation plates where present.

7.1.3 *Results*

7.1.3.1 The results are shown in Tables 16 and 17 below. The plant part recorded in the tables is the seed unless otherwise stated. The deposits taken from the test-pit can be divided into two groups. The upper deposits (samples 5 to 8) are characterized by very degraded peat and large quantities of *Phragmites* (reed) type rhizomes. Seed remains are characteristic of wet marshy conditions with species such as *Carex* sp. (Sedges), *Eleocharis palustris* (common spike rush) and *Ranunculus* subgen *Batrachium* (crowfoot). *Ranunculus sceleratus* (celery leaved crowfoot), noted in the upper deposit, is characteristic of mineral rich water.

7.1.3.2 The lower deposits are characterized by fragments of wood and twigs. The wood fragments are generally poorly preserved, although *Alnus* (alder) wood and occasional seeds of *Alnus glutinosa* were identified. Remains of other plant species are very infrequent and include occasional seeds of

Urtica dioica (nettle), *Ranunculus acris/repens/bulbosus* (buttercup) and *Rubus cf. fruticosus* agg. (blackberry/bramble).

7.1.3.3 The bore hole samples were taken from two bore holes. One sample was examined from bore hole 5, taken from a depth of 7.75-8.20m. The sample contained occasional fragments of *Alnus* sp. (alder) wood and seeds of *Alnus glutinosa*. The upper deposit from bore hole 11 contained single stones of *Prunus spinosa* (sloe) and *Crataegus* sp.(hawthorn). The lower three samples were dominated by seeds of *Ranunculus acris/repens/bulbosus* (buttercup). Seeds of *Rumex* sp. (docks) were present in the samples taken from 9.05 to 9.15m. Fragments of charred or semi-charred *Corylus avellana* (hazel) nut shell were present in the lower three samples. Occasional fragments of charcoal were also present, the larger of which were identified as *Quercus* sp. (Oak). The remaining species represented include *Ranunculus sceleratus*, characteristic of mineral rich water, and *Lycopus europaeus* (gipsywort), a species of river or ditch banks and marshes or fens. Fragments of worked flint were recovered from bore hole 11, 9.05 to 9.10m and from 9.15 to 9.20m.

7.1.4 Discussion

7.1.4.1 The upper sequence of samples taken from the test pit are similar in character to deposits recovered from palaeochannels in the vicinity of Northfleet Villa which were suggestive of alder carr giving way to an open reed swamp environment. Seed remains are less numerous from the present samples, although the assemblages would fit a similar succession of alder carr followed by reed swamp.

7.1.4.2 The bore hole samples suggest some human activity within the vicinity of the channels. The occurrence of worked flint, charred remains and waterlogged seeds is of some interest. The hazel nut fragments may have derived from wild collected food resources.

Table 16 Summary of scanning results of the bore hole samples

	Bore-Hole	5	11	11	11	11
	Depth (metres)	7.75-8.20	9.0-9.05	9.05-9.10	9.10-9.15	9.15-9.20
	Weight (g)	40	200	200	200	200
<i>Ranunculus acris/repens/bulbosus</i>	buttercup	-	+	+++	++	++
<i>Ranunculus sceleratus</i>	celery leaved crowfoot	-	-	-	+	-
<i>Rumex</i> sp.	docks	-	-	++	+	-
<i>Urtica dioica</i>	common nettle	-	+	-	-	+
<i>Crataegus</i> sp.	hawthorn seed	-	+	-	-	-
<i>Alnus glutinosa</i>	alder, female catkins	-	-	-	-	+
<i>Alnus glutinosa</i>	alder seed	+	-	-	-	+
<i>Alnus</i> sp.	alder branch wood	+	-	-	-	-
<i>Corylus avellana</i>	hazel nut shell frags. part charred	-	-	+	+	+
<i>Corylus avellana</i>	hazel nut shell frags.	-	-	+	+	-

<i>Lycopus europaeus</i>	gipsywort	-	-	++	+	-
<i>Carduus/Cirsium</i> sp.	thistle	-	-	+	-	-
<i>Quercus</i> sp.	oak charcoal	-	-	+	+	+

Table 17 Summary of scanning results of samples from test pit 2

	Trench	2	2	2	2	2	2	8
	Sample	1	2	3	5	6	7	8
	Context	211	211	211	210	208	206	204
	Weight (kg)	0.5	0.5	0.5	0.5	0.5	0.5	0.5
<i>Ranunculus acris/reprems/bulbosus</i>	buttercup	-	+	-	-	+	-	-
<i>Ranunculus</i> subgen <i>Ranunculus</i>		-	-	-	-	-	+	-
<i>Ranunculus sceleratus</i>	celery-leaved crowfoot	-	-	-	+	-	-	++
<i>Ranunculus</i> subgen <i>Batrachium</i>	crowfoot	-	-	-	-	-	++	++
<i>Stellaria media</i> agg.	chickweed	+	-	-	-	-	-	-
<i>Rubus</i> cf. <i>fruticosus</i> agg.	blackberry/bramble	+	-	-	-	+	-	+
<i>Rubus</i> sp.		-	-	-	+	-	-	+
<i>Potentilla anserina</i>	silverweed	-	-	-	-	+	-	-
<i>Urtica dioica</i>	common nettle	+	+	-	-	-	-	-
<i>Alnus glutinosa</i>	alder, female catkins	++	-	-	-	-	-	-
<i>Alnus glutinosa</i>	alder seed	-	+	+	-	-	-	-
<i>Alnus</i> sp.	alder, branch wood	+++	+++	++	-	-	-	-
<i>Corylus avellana</i>	hazel nut shell frags.	+	-	-	-	-	-	-
<i>Mentha</i> sp.	mint	-	-	-	+	+	-	-
<i>Lycopus europaeus</i>	Gipsywort	-	-	-	-	-	-	-
<i>Sambucus nigra</i>	elder	-	-	-	-	-	+	+
<i>Carduus/Cirsium</i>	thistle	-	-	-	-	-	-	-
<i>Carex</i> sp.	sedges	+	-	-	-	++	++	+++
<i>Eleocharis palustris</i>	common spike rush	-	-	-	-	++	++	++
Cyperaceae		-	-	-	-	+	+	-
<i>Potamogeton</i> sp.	pondweed	-	-	-	-	-	-	+
<i>Zannichella palustris</i>	horned pondweed	-	-	-	-	-	-	++
<i>Juncus</i> sp.	rushes	-	-	-	-	+	-	-
<i>Phragmites</i> type	reed type rhizomes	-	-	-	+++	++	+++	+

7.2 Animal bone

7.2.1 Three fragments of bone were recovered from test pit 1.

7.2.2 Two fragments of rib of a medium sized animal were recovered from context 105 (an organic silt deposit). One animal incisor was recovered from context 112 (light grey sand beneath the wood peat). In both cases the bone was relatively well preserved.

7.3 Radiocarbon dating

7.3.1 Radiocarbon samples were selected from four locations sampled during the field programme. Individual samples were washed and identified prior to submission to Beta Analytic Inc., Florida for analysis.

- 7.3.2 A single sample of hazelnut was selected from test pit 2 (base of wood peat, context 211, sample 1) in order to determine the timing of on-set of peat formation in the near edge-marginal situations, comparable with age estimates from the Upper Basin area.
- 7.3.3 A single sample containing hazelnuts was selected from borehole 11 (9.1-9.2m depth within an organic silt lying within clay-silt units below the main wood peat). This was selected in order to define the age of the earliest and deepest evidence of archaeological activity in the study area.
- 7.3.4 Samples of wood were taken from the base and top of the wood peat unit in boreholes 5 (7.4m depth) and 9 (5.85m depth). These were selected to determine the age of the peat in areas in which the peat was found at the lowest datums in the study area.

7.4 Flintwork report (Dr Theresa Durden, Oxford Archaeological Unit)

- 7.4.1 The only flints recovered from the evaluation were from borehole 11 (9.1-9.2m depth in organic silts), test pit 1 (context 112, a sandy gravel below the wood peat) and test pit 2 (context 210, wood peat), forming a total of 32 pieces.
- 7.4.2 Twenty-six pieces of flint were recovered from borehole 11 (9.1-9.2m depth), which included 17 pieces of burnt unworked flint, mostly tiny fragments, weighing 24g in total. The struck flint was in reasonably fresh condition, although one piece had a worn or rolled appearance. 7 flakes and 2 tiny, broken chips were collected; of these 6 pieces were broken and 1 burnt. The flakes were cortical and trimming flakes apart from one inner flake. Two of the flakes were thin and struck with a soft hammer.
- 7.4.3 Five pieces were recovered from context 112 (test pit 1). These comprised 1 cortical flake of fresh, dark grey, good quality flint with a tin grey cortex, 1 small piece of waste, 2 burnt and broken flakes and a burnt chip.
- 7.4.4 One burnt chip was recovered from context 210 (test pit 2).
- 7.4.5 With so few pieces present it is difficult to estimate a date, but a Neolithic/Early Bronze Age date would seem probable as most of the flakes are broad but relatively regular.

8 SUMMARY OF RESULTS

8.1 General stratigraphic sequence

8.1.1 The stratigraphic sequence constructed for the area consists of three discrete elements (Figure 9):

- Chalk bedrock
- Coarse flint gravels and chalk rich diamicts
- Peats, sands and clay-silts

These sets of deposits are ascribed to the Cretaceous, Pleistocene and Holocene respectively.

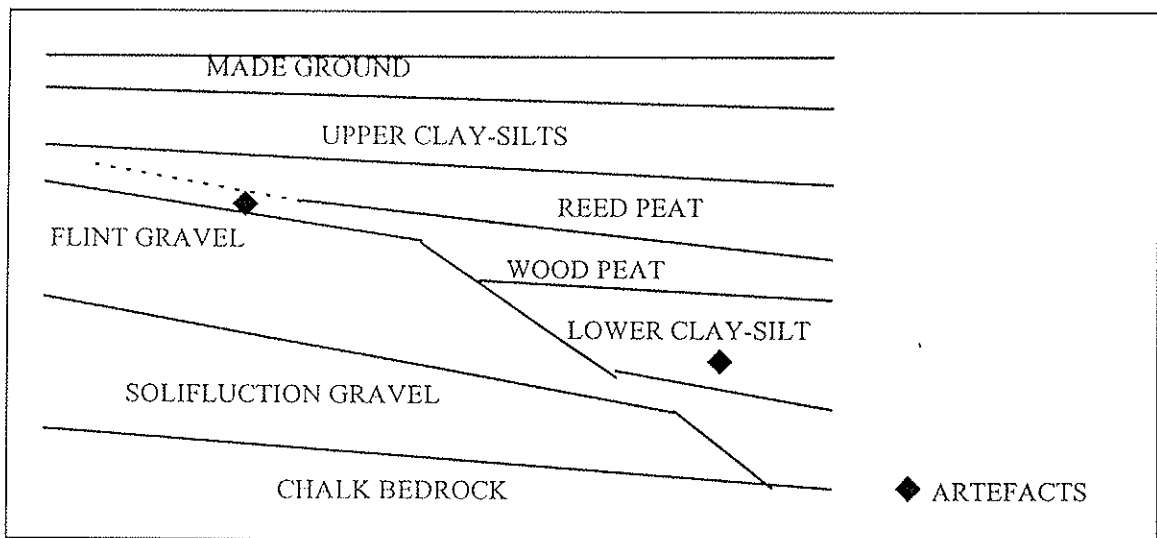


Figure 9. Schematic profile showing main stratigraphic units beneath the Ebbsfleet Sports Ground Complex.

8.1.2 Chalk bedrock was encountered in boreholes 5 and 8 at datums of c.-9.0m and -4.9m O.D. respectively (Transects 2 and 3, Figure 4).

8.1.3 Sediments overlying the bedrock consist of chalk rich deposits (Transects 2 and 3, Figure 4) with a clay-silt matrix. These diamicts can be difficult to distinguish from highly weathered, soft, but *in situ* chalk bedrock. Their similarity with sediments elsewhere in the catchment indicates that they are probably solifluction sediments deposited under cold climate, periglacial conditions. Similar sediments are also found in boreholes 3 and 10. They appear to form a wedge of sediment that thins from west to east into the valley axis. Where present they are directly overlain by coarse flint gravels (see below) (Figures 4, 10 and 11).

8.1.4 Coarse, angular flint gravels are present in all boreholes (Figures 4, 10 and 11). These deposits overlie the chalk solifluction deposits (where present) or directly overlie chalk bedrock. These sediments dip from west to east

(both upper and lower contacts of this unit trend in this direction, Figure 4) and from a south to north direction (Figures 10 and 11). Evidence from Transects 2 and 3 (Figure 4) and the geophysical transect (Figure 6) indicate that a gently sloping or undulating upper gravel surface exists in the western part of the Sports Ground area (Figure 11). No direct evidence on the internal structure of these deposits is available but the height datums indicate that two discrete units may be present in the study area consisting of an upper (probably older sequence at the western end of Transects 2 and 3) and a lower (younger?) sequence preserved within the valley central axis area. A similar 'gravel high zone' is seen south of the study area (Figures 10 and 11). These surfaces define a topography that can be split into two, the Upper and Lower Basins (Figure 11). The gravel units are likely to have been laid down within a high energy fluvial environment, probably under cold climate conditions, and perhaps in a braided river system.

- 8.1.5 The overlying soft, unconsolidated sediments consist of a sequence of clay-silt and organic units.
- 8.1.6 The main feature of the sequence of unconsolidated sediments is a thick organic sequence of wood and reed peats that extend across the site area (Figures 4, 10 and 11). Typically this consists of a basal wood rich peat overlain by a reed dominated peat. This is interpreted as evidence of an alder carr woodland being replaced by a herb fen. Carbonate rich beds within the peat, containing molluscs of freshwater and terrestrial affinities, indicate that this was a carbonate rich environment at times with inwash of material from adjacent dry ground habitats. These deposits thin and rise against the higher gravel units to the west and thicken eastwards. The basal contact of these deposits is approximately 4m lower in the east than the west. At the western margins of Transects 2 and 3 (boreholes 3 and 6) these deposits are replaced by undiagnostic organic rich units. A similar rise in the elevation of these units can be seen south of the area of study (Figure 10, Transect 4), within the Upper Basin. The succession of alder carr to herb fen indicates a rise in water base levels and a progressive increase in wetness of the environment.
- 8.1.7 Beneath the wood peat in the eastern part of the study area (Transects 1 and 2, boreholes 5 and 11) a lower clay-silt unit is present. The characteristics of these deposits suggests deposition in low energy aquatic environments (either estuarine or, less plausibly lacustrine, habitats). An organic rich unit in borehole 11 contained evidence of human activity and more doubtfully a possible post-hole was recovered at similar datums in borehole 5.
- 8.1.8 A complex of interbedded clay-silts and organic units overlay the peat in all boreholes. This set of deposits indicated deposition in a low energy, probably estuarine/sub-tidal, environment that was periodically subjected to emergence and colonization by plants.

- 8.1.9 Made ground was present across the study area to a maximum depth of c.2.5m.

8.2 Biological material

- 8.2.1 The results of the waterlogged plant macroscopic evaluation from samples taken from test pit 2 confirm the inferences made on the basis of the observed lithostratigraphical evidence presented in 8.1. The waterlogged material indicates that a succession of alder carr to reed swamp or herb fen is confirmed by this material.
- 8.2.2 The sediments evaluated from borehole 5 (infilling a possible post-hole) only contained fragments of *Alnus* sp. and seeds of *Alnus glutinosa* and were inconclusive in determining environments of deposition.
- 8.2.3 The remains from borehole 11, from units containing burnt and struck flint, contained a range of material that may have accumulated in a channel edge environment. The presence of oak charcoal and charred or semi-charred hazelnuts reinforce the indications of human activity.
- 8.2.4 No evidence in any samples implied a marine or estuarine influence in these deposits.
- 8.2.5 The evidence provided by this evaluation confirms general trends observed through similar sequences examined to the south of the present study area.
- 8.2.6 The presence of animal bone and molluscs in sediments recovered from the test pits (and in the case of molluscs, from the boreholes) indicates that conditions suitable for the preservation of carbonate based material exist within the peats and organic silts.

8.3 Age estimates

- 8.3.1 The discussion of dating must await the results of the radiocarbon dating programme (see 7.3 above).
- 8.3.2 The dates and their significance will be made available as an addendum to this report at the earliest opportunity possible.

9 CONCLUSIONS

9.1 Landscape evolution

- 9.1.1 Within the study area evidence for late-Pleistocene and Holocene landscape change is present. No age estimates for the late-Pleistocene development of the area exists but age estimates from test pits south of the study area suggest that organic sediments at datums of c.0.0m O.D. may date to the Neolithic period (URL 1997).
- 9.1.2 The earliest evidence obtained from the borehole data indicates that chalk rich solifluction episodes led to the deposition of a wedge of sediments thinning towards the valley axis (Figure 11). At present it is not possible to determine whether these units represent a lateral continuation of sediments noted to the west of the study area (e.g. in the vicinity of the old Baker's Hole sections - URL, 1997) or a more recent event. Following this episode one or more phases of fluvial gravel deposition occurred. The deposition of these deposits formed the early Holocene topography and created an upper shelf area (in the western part of the study area, representing a continuation of the zone noted to the south of the study area in the Upper Basin) and a lower area in the valley centre (Lower Basin) (Figure 11).
- 9.1.3 An early influx of probable estuarine sediments (Lower Clay-Silts) occurred in the valley central area. These deposits extended to a position as indicated on Figure 2. Possible human activity during this time frame led to the formation of the deposits in borehole 11. Edge marginal areas existing around this incursion may have been suitable for human occupation and may therefore be zones of high archaeological potential. Such deposits could be represented by the archaeological material from test pit 1 on the edge of the gravel "high" at a level of c. 5.5m higher than the deposit in borehole 11, but likewise beneath the level of wood peat.
- 9.1.4 Lowering of water levels resulted in the development of the alder carr woodland in the valley axis. Growth of the peat deposits gradually built-up over the adjacent gravel surface and onto the higher shelf areas to the west. Subsequently as a result of increasing water levels this gave way to herb fen development across the valley bottom. It is likely that this took place in a step-wise fashion perhaps resulting in the development of herb fen in the valley axis contemporary with wood peat development at the valley margins (this remains to be demonstrated).
- 9.1.5 Following further water level rises the valley floor area was inundated by water leading to the development of the Upper Clay-Silts (subject to temporary emergence and organic development).

9.2 Nature of the archaeological evidence

- 9.2.1 Unequivocal, direct evidence of human activity within the sequences investigated was only recovered from borehole 11, test pit 1 and test pit 2.
- 9.2.2 Archaeological material including struck flakes and burnt flint were recovered from a depth of 9.1-9.2m depth (-6.13m to -6.23m O.D.) in borehole 11. The assemblage was too small to be diagnostic of either period or activity type but may be of Neolithic/Early Bronze Age date.
- 9.2.3 The discovery of an unusual feature, interpreted as a sectioned post-hole, within drill core U4 25, from borehole 5, may represent structural evidence of a human presence within the Lower Clay-Silt phase. However, the nature of this feature remains equivocal, and a natural origin (eg a void created by the decay of a large root) cannot be ruled out.
- 9.2.4 The presence of archaeological material at this depth within the Ebbsfleet Valley complex is interesting and may indicate that evidence of human activity, within or adjacent to the early inundation phase associated with the Lower Clay-Silt sequence, is preserved at depths of 7.5-9.2m below ground surface within parts of the Lower Basin. An approximation to this distribution is shown by the broken line in Figure 2.
- 9.2.5 A small number of flint artefacts were discovered in association with the surface of the sandy gravel immediately below the peat in test pit 1 and the wood peat in test pit 2 on the gravel high (Figure 2). Elsewhere in the valley (e.g. in a test pit adjacent to borehole 0022SA, Figure 10, Transect 4) artefacts in fresh condition, and ascribed to the Neolithic period, have been discovered in similar sediments. This indicates that human activity noted elsewhere in the valley may extend into the southern part of the Sports Ground complex, on the gravel high.
- 9.2.6 No evidence for later archaeological material (e.g. Roman debris) has been located in any of the boreholes in the western part of the transect. Earlier work (URL 1997) has shown that, adjacent to the villa complex to the south of the current study area, possible construction debris exists within the alluvium.
- 9.2.7 The evidence recovered from this study appears to confirm previous work regarding the distribution and location of archaeologically sensitive sequences.

9.3 Environmental evidence

- 9.3.1 The evaluation of the plant macrofossil remains indicate that material suitable for palaeoenvironmental analysis exist within the study area. Preservation of waterlogged material in the samples varied however, identifiable material was encountered in all samples evaluated.

- 9.3.2 In addition to the presence of waterlogged material charred plant remains (hazelnuts) and oak charcoal were present. These remains suggest that a human presence may be recorded in the plant macrofossil record in locations adjacent to borehole 11 (an inference also derived from the presence of burnt flint and struck flakes/waste).
- 9.3.3 The occurrence of mollusc shell, and to a lesser extent bone, in the organic sediments recovered from both the test pits and the boreholes indicates that these remains are present throughout the area offering additional avenues of research suitable for palaeoenvironmental reconstruction.
- 9.3.4 The results of the evaluation complement and confirm the observations made elsewhere in the Ebbsfleet valley regarding both the nature of the environmental changes and the distribution of sediments containing macroscopic plant remains suitable for analysis.

10 IMPACT ASSESSMENT AND MITIGATION OPTIONS

- 10.1 The evaluation has shown that deposits of potential archaeological significance do exist within the area of the proposed Northfleet Rise part of the Ebbsfleet Development, though further work would be needed to establish their full extent and significance. Nevertheless, the much clearer picture that the evaluation has provided of topographical development of this part of the Ebbsfleet Valley, and the place of these deposits within the sedimentary sequence, allows a generalized assessment to be made of the possible impact of the development.
- 10.2 It is now clear that most of the development area north-east of the CTRL lies over deep alluvial sequences, in which the deposits of greatest archaeological potential lie at depths of as much as 9m below present ground level in Borehole 11, and c. 3.5m in Test Pit 1. On the edge of a gravel "high" on the west side of the Sports Ground, only a very limited part of this area, where deposits of archaeological potential are within 4m of the surface, lie within the development area east of the CTRL works.
- 10.3 On the east side of the river the British Geological Survey maps the edge of alluvium beneath the former railway sidings with a lobe extending into the area between the river and the railway embankment. However, it may be noted that although no information is available east of the line of STDR4, the east ends of transects 2 and 3 are both at the points of deepest deposits. While at the east end of Transect 1, much closer to the railway embankment, the alluvial deposits overlying the peat are still much deeper than the equivalent sequence overlying the gravel 'high'. Extrapolation from the ends of these transects therefore suggests that any shallower marginal deposits on the east side of the river would be deeply buried beneath the embankment for the railway sidings, which is high enough to allow STDR4 and the present access road to be aligned under the railway at or just above ground level.
- 10.4 It may be further noted that virtually the whole area is covered by made ground, typically 1.5 to 2.7m thick.
- 10.5 It is not clear what foundations would be used for roads within the development, but work on STDR4 has already suggested that various options would be possible, some of which need not involve deep disturbance.
- 10.6 Although details of the methods of construction to be used in the development are not clear at this stage, it is safe to assume that any significant structures would be built on piles. Given the depths of made ground and the upper alluvial deposits of low archaeological potential across the site, it is likely that only the piles themselves would be likely to disturb deeper deposits of greater archaeological potential. Pile caps, ground beams, services, drainage etc can reasonably be expected to be accommodated within the upper 3-4m of made ground and alluvium. Only

in the very limited area of the gravel “high” on the western edge of the development area is there a definable risk of greater disturbance, and even that is by no means certain.

- 10.7 It is not anticipated that piling would have any significant effect on the preservation of waterlogged organic deposits. It is therefore expected that the impact of construction of the development on deposits of significant archaeological potential would be largely limited to the physical disturbance caused by the piles themselves. The extent of such disturbance would depend on the size, density and distribution of piles, which would be a matter of detailed design. While this is uncertain at this stage, it is envisaged that an acceptably low level of impact could, if necessary, be built into the design if further archaeological evaluation suggested that this was desirable - for example to minimize disturbance of deposits such as that encountered in Borehole 11.
- 10.8 It is not envisaged that any buildings would have basements extending below the present ground level, except possibly in the case of the railway embankment, where basements dug into the embankment would have no archaeological impact unless they extended below the pre-railway ground level. This is not anticipated.
- 10.9 It would not be practicable to mitigate the limited impact of piling on very deeply buried archaeology by conventional excavation, but the density of material encountered in Borehole 11 suggests that more intensive coring could be used to define the extent and character of such deposits.
- 10.10 In the case of the archaeological deposits that might be disturbed in the area of the gravel “high”, conventional excavation would be feasible if necessary (the deposit as revealed by Test Pit 1 does not obviously warrant preservation *in situ*). If further evaluation showed that this deposit was of much greater significance, it is likely that disturbance could be avoided or minimized in the detailed design process.
- 10.11 It is concluded that while the Northfleet Rise area does have some significant archaeological potential in terms of post-glacial prehistoric activity, the relevant deposits are likely to be at such a depth that any impacts arising from the development could be kept to an acceptably very low level or in some cases avoided, and that any limited residual impact could be mitigated, at least to some extent, by further bore hole investigations, coupled with geophysics for the deeper deposits, or by conventional excavation for the very limited area of shallower deposits potentially affected.
- 10.12 As envisaged in the archaeological strategy, it is anticipated that further evaluation work will be needed to influence as necessary the design of the development in this area, especially with regard to construction methods. Further boreholes, particularly in the vicinity of borehole 11, and geophysics are likely to be the main methods to be adopted.

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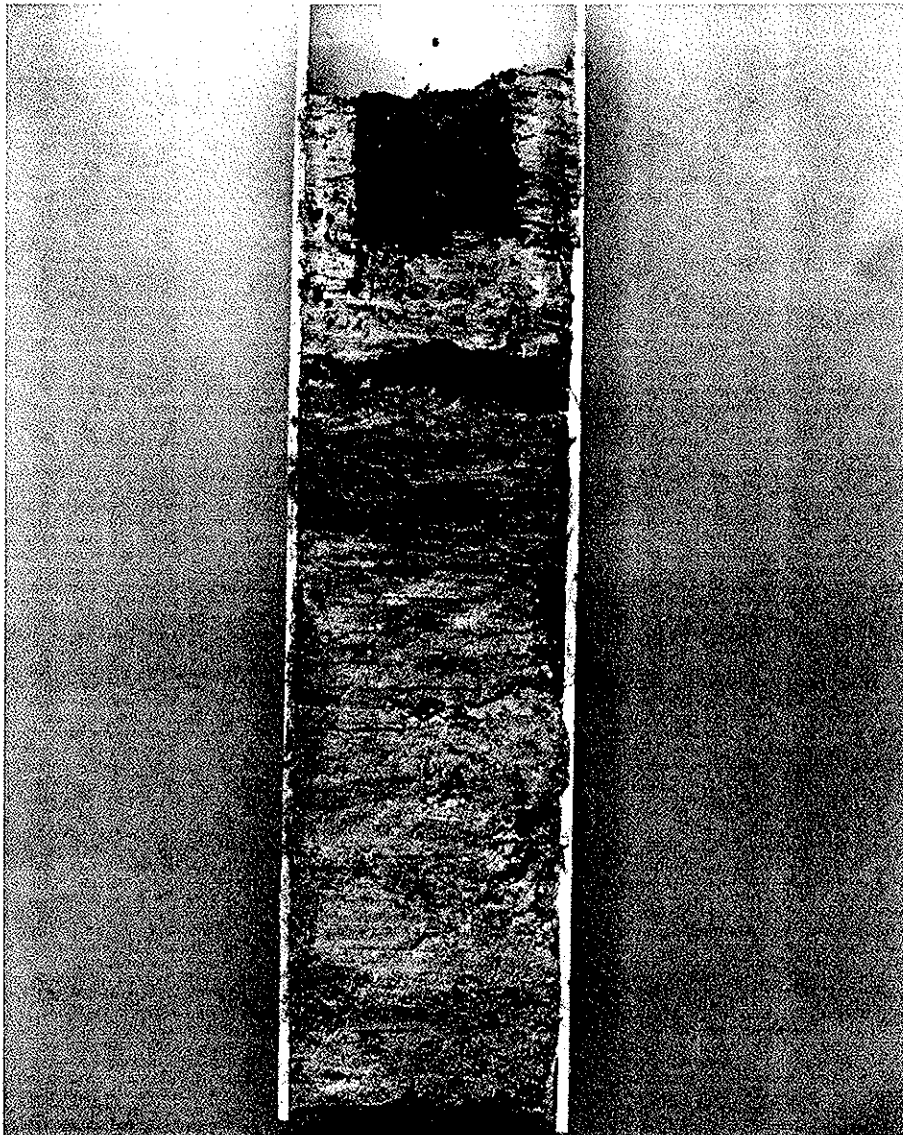
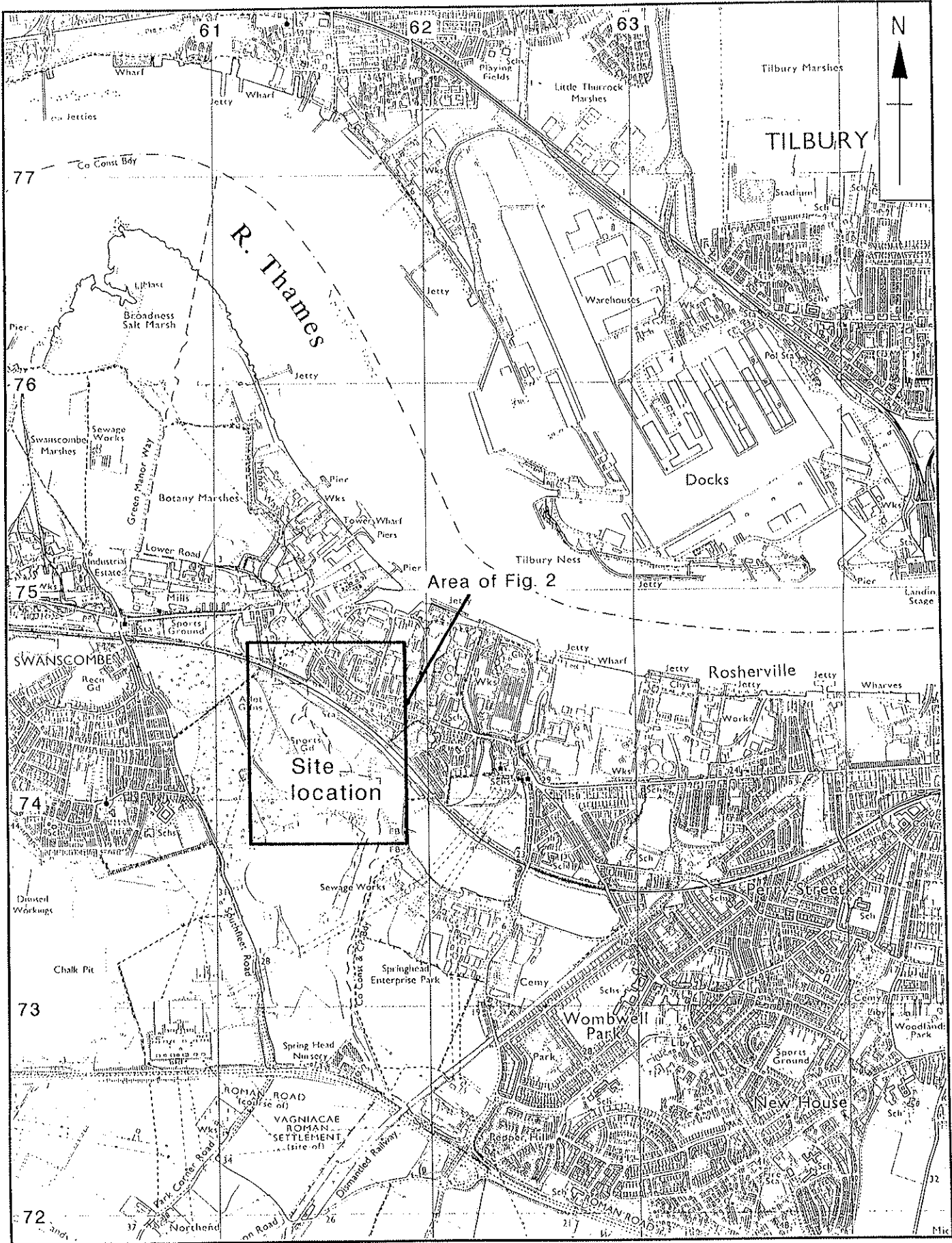


Plate 1. U4 core 25, borehole 5 showing unusual straight sided feature in top of core. This feature may represent a sectioned posthole.



Plate 2. Test pit 2, south facing section showing major organic and inorganic units resting on a basal sandy gravel.

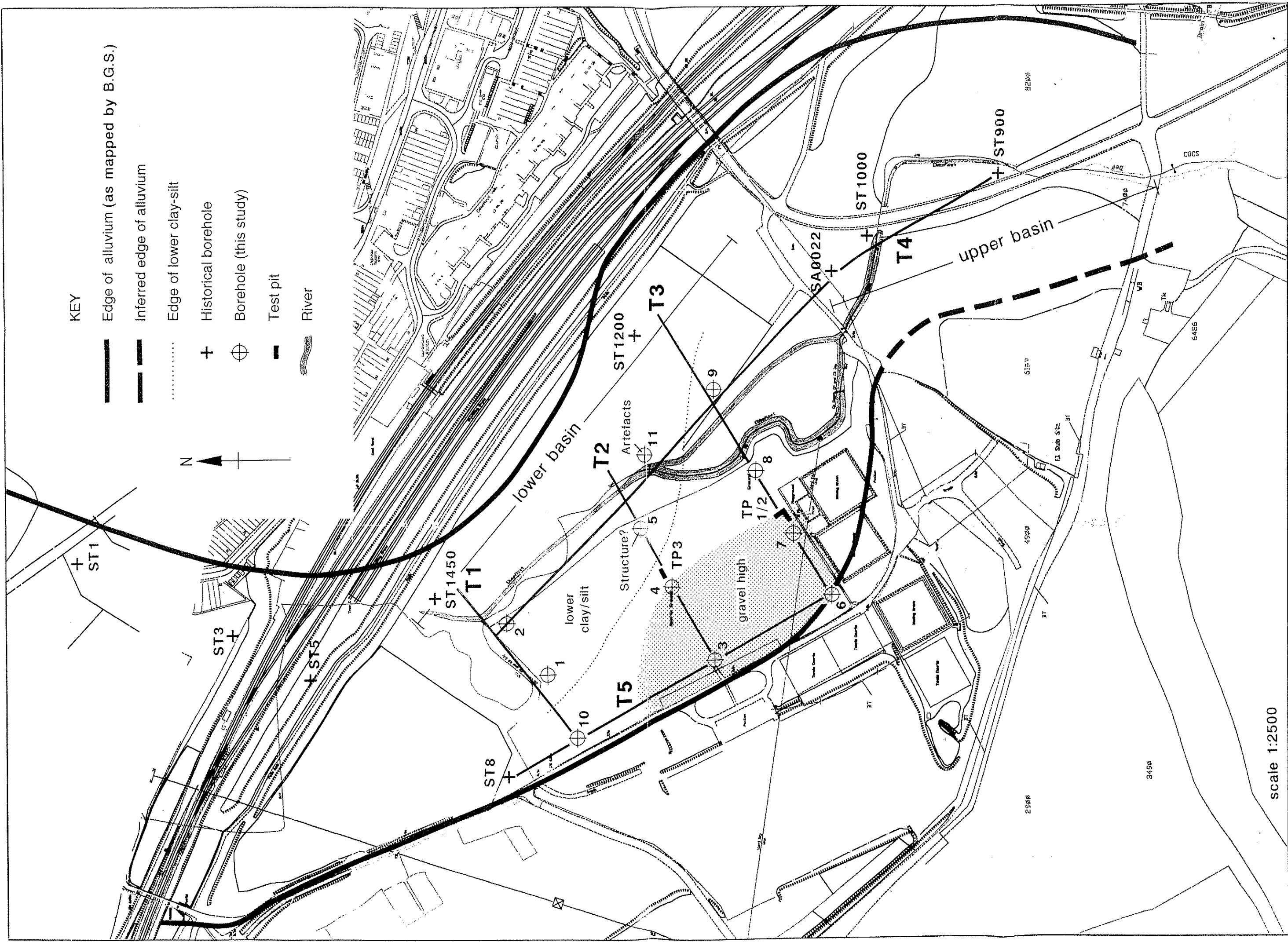


scale 1:25,000

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Figure 1

FIGURE 3 - SEE PAGE 11



KEY

Edge of alluvium (as mapped by B.G.S.)

Inferred edge of alluvium

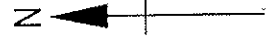
Edge of lower clay-silt

Historical borehole

Borehole (this study)

Test pit

River



scale 1:2500

Figure 2

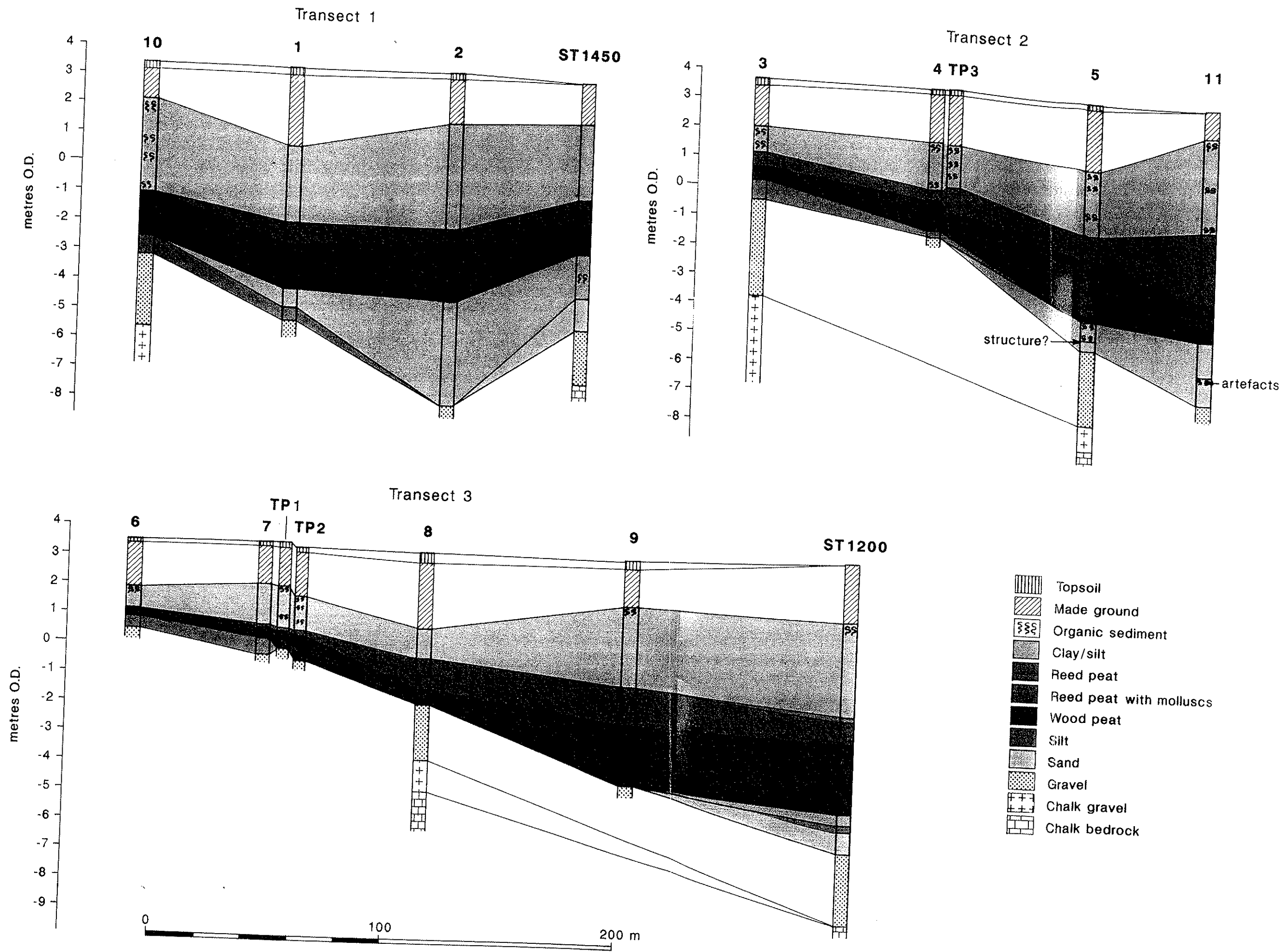
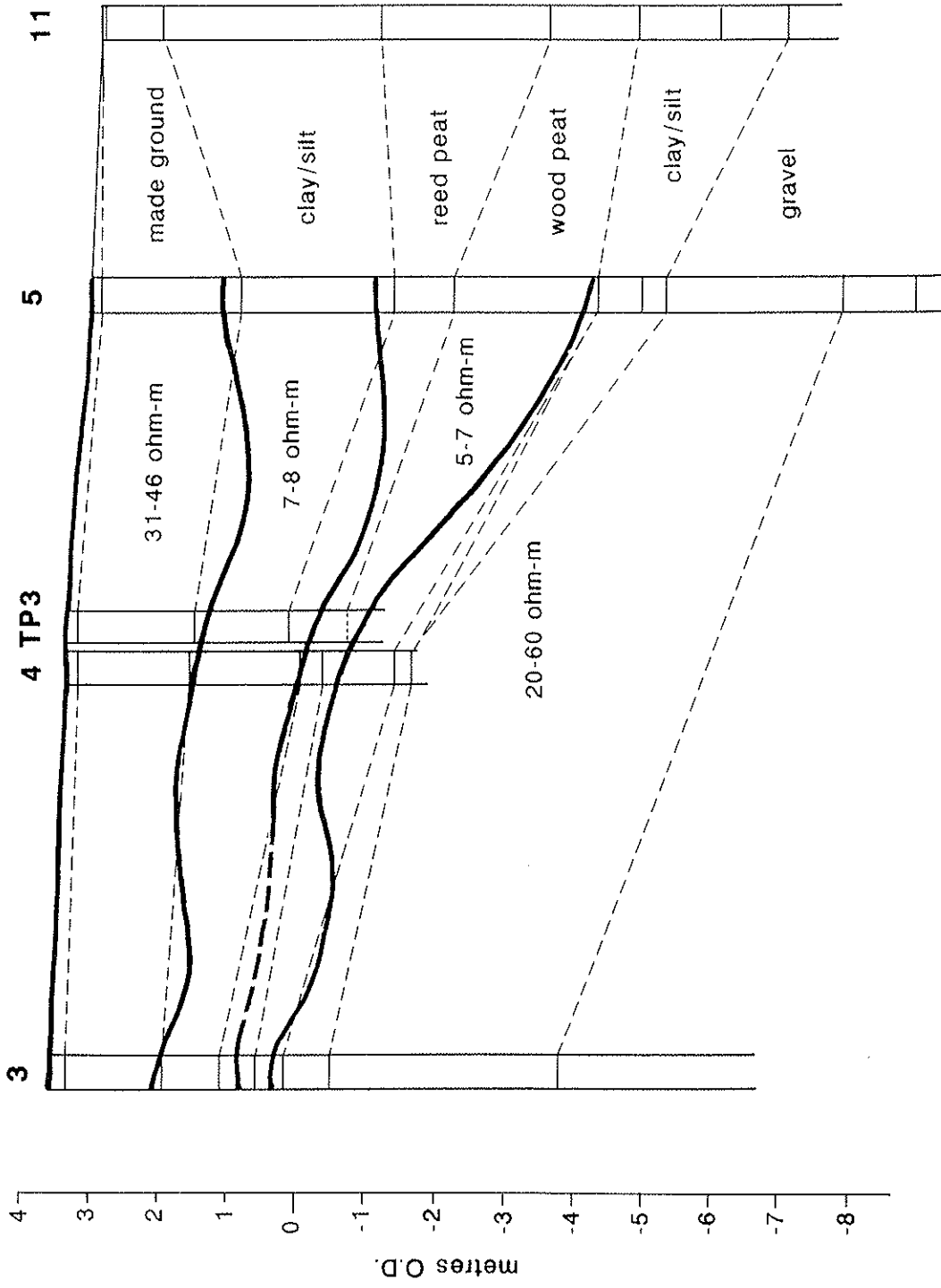


Figure 4

FIGURE 5 - SEE PAGE 40



Borehole Transect 2 overlain with Geophysical Transect 1

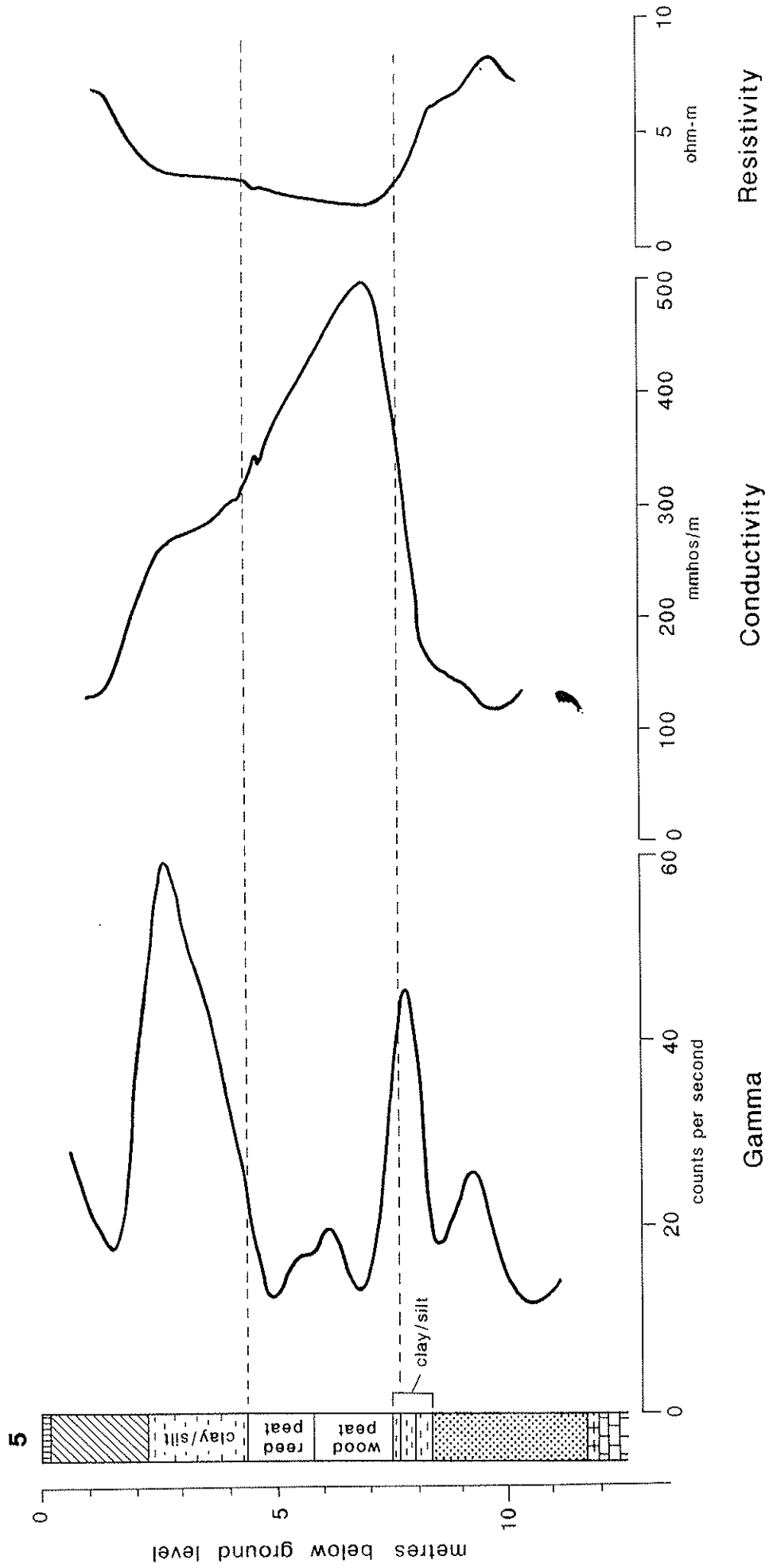


Figure 7

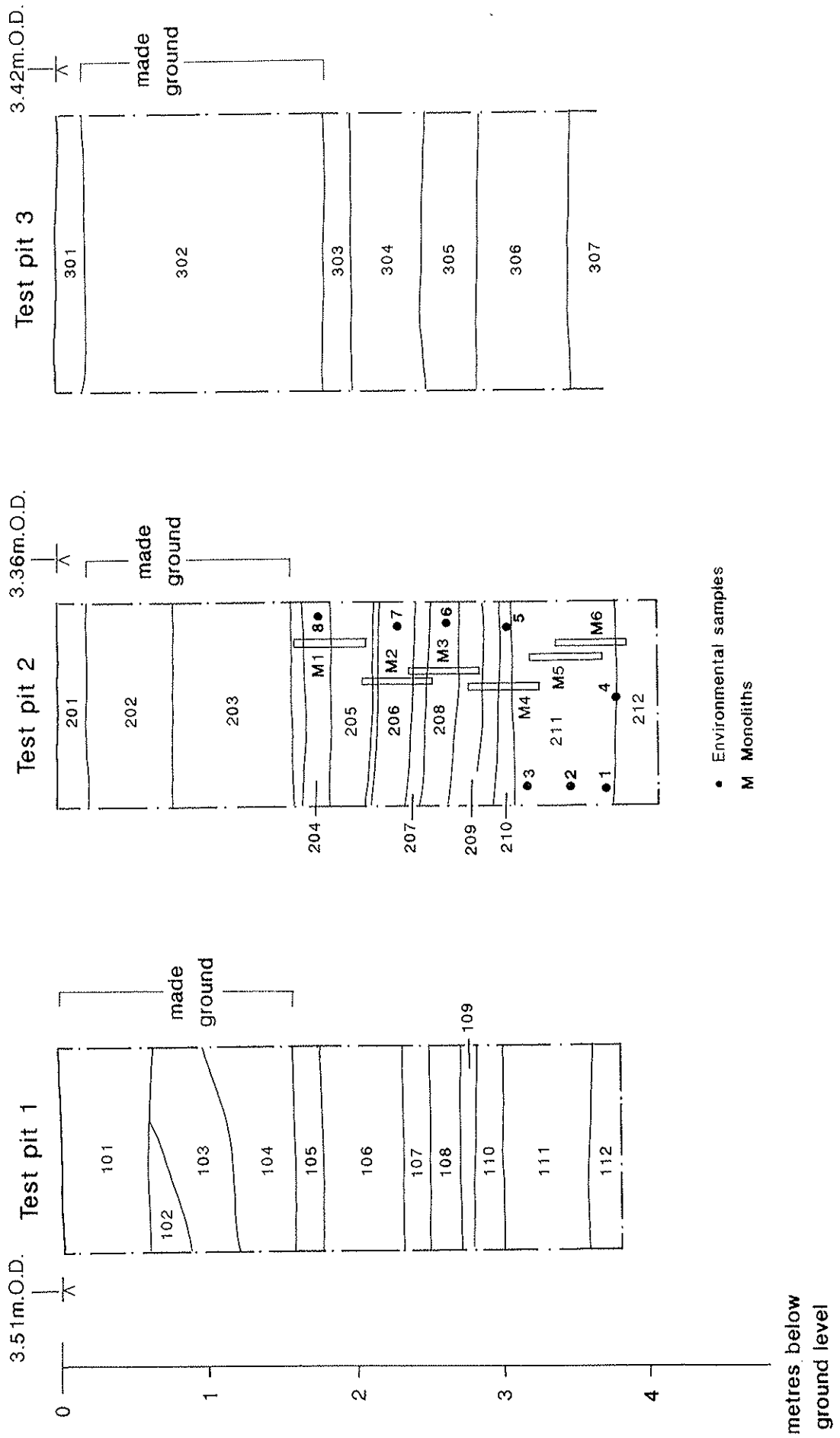
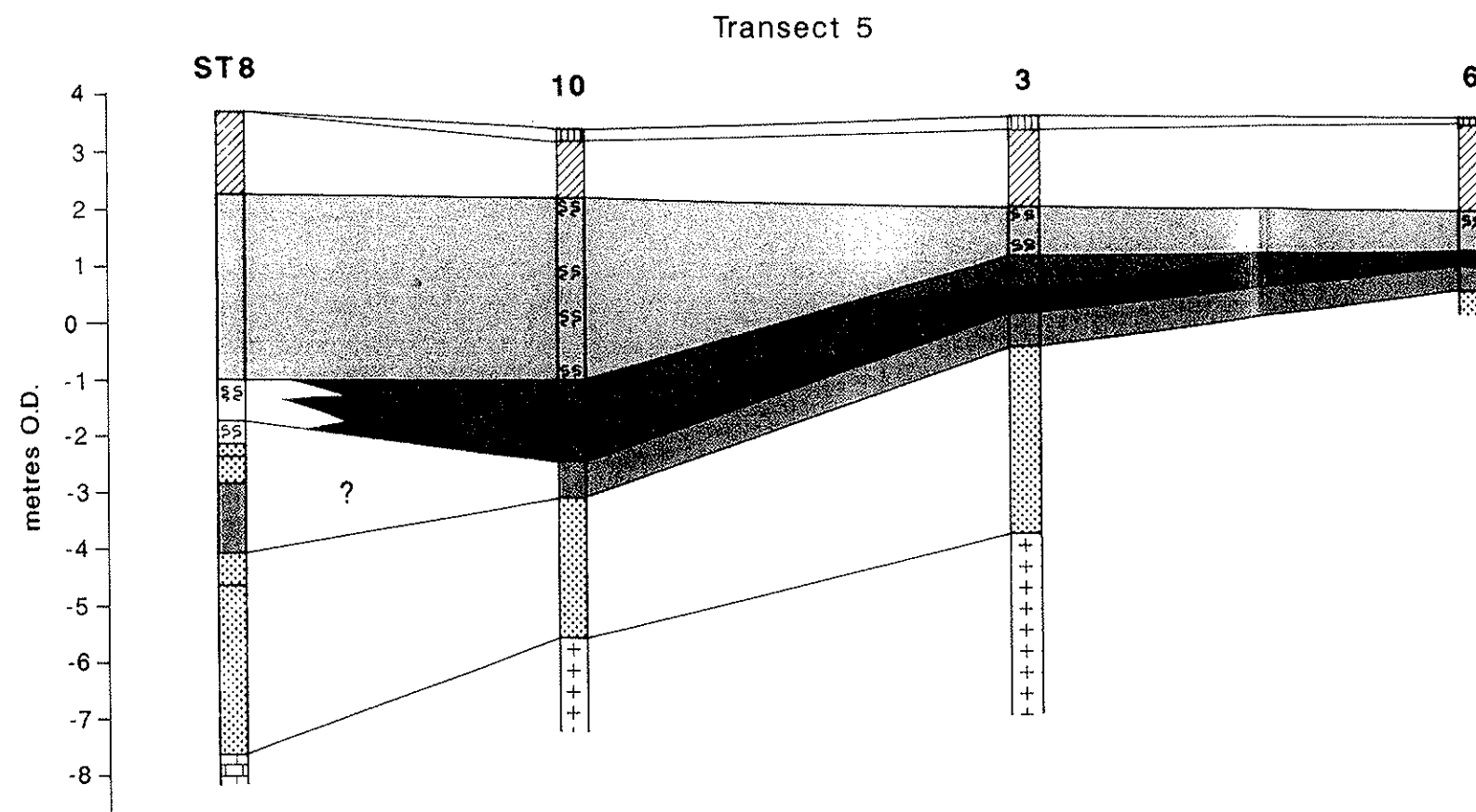
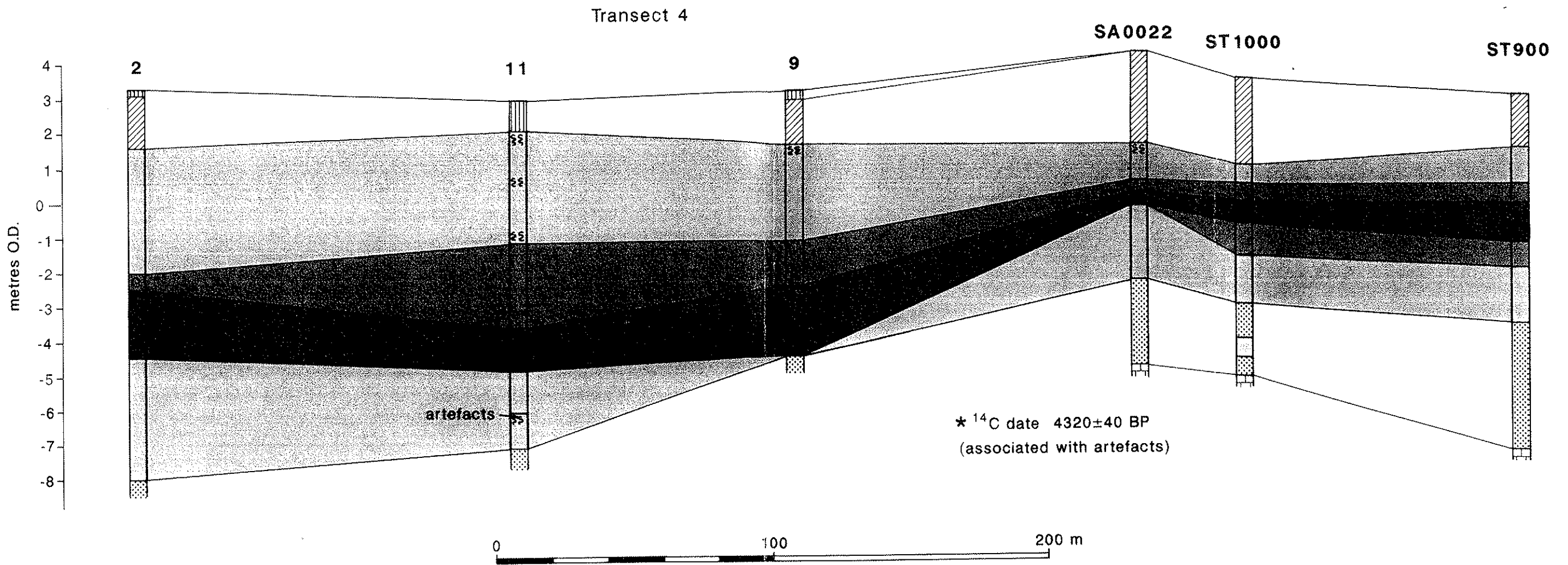


Figure 8

FIGURE 9 - SEE PAGE 53



Key as Figure 4

Figure 10

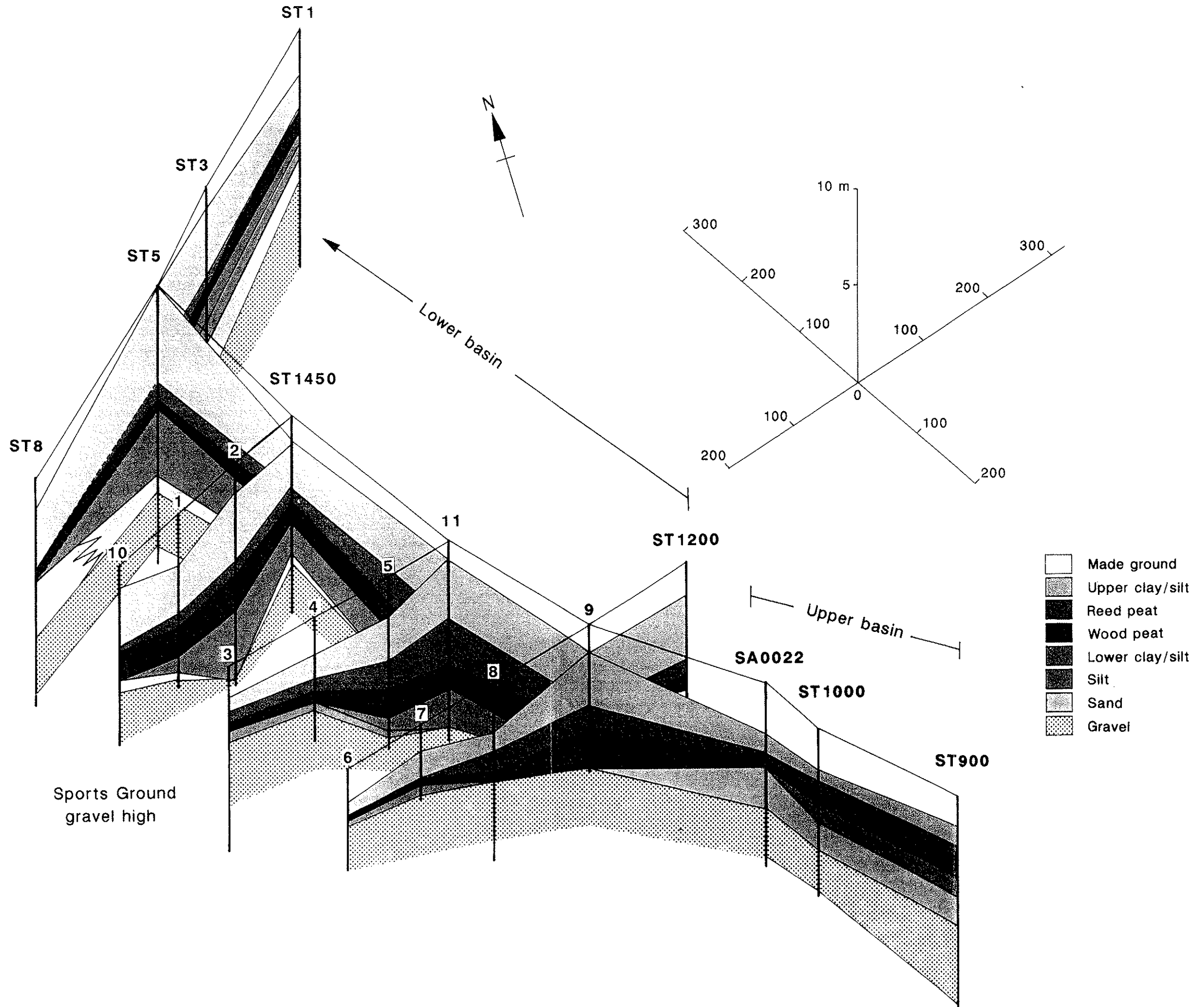


Figure 11



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