

**A REPORT ON THE GEOARCHAEOLOGICAL DEPOSIT
MODELLING ON LAND AT THE
TEESIDE RENEWABLE ENERGY PLANT SITE**

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INTRODUCTION

This report summarises the findings arising out of the geoarchaeological deposit modelling undertaken by Quaternary Scientific (University of Reading) in connection with the proposed development at the Tees Renewable Energy Plant Site (National Grid Reference: centred on NZ 54280 23180; Figure 1). During recent geotechnical investigations carried out by RPS Planning & Development, a total of eight boreholes and sixteen test-pits were put down across the site. The main aim of the geoarchaeological deposit modelling exercise is to reconstruct the sub-surface stratigraphy and environs of the site, and in particular to identify (1) any organic-rich horizons (e.g. peat) which may be suitable for further environmental archaeological investigations, (2) the original topography of the site and (3) the nature of the reclamation process. In order to accomplish these aims, the following objectives were formulated:

- (1) To carry out a systematic desk-based review of the new RPS geotechnical records put down across the site
- (2) To carry out a systematic and detailed review of previous British Geological Society (BGS) records nearby to the site
- (3) To produce 2-Dimensional models of the surfaces and thicknesses of the main stratigraphic units across the site
- (4) To provide recommendations for further work (if necessary)

SITE CONTEXT

The site currently lies at an elevation around 5 to 6m OD and is beside the artificially embanked and dredged channel of the River Tees on its south side and originally formed part of the intertidal mud and sand flats that occupied the broad estuary of the river. The British Geological Survey (1:50,000 Sheet 33 Stockton) shows the site underlain by the alluvium of the river, resting on Triassic Mercia Mudstone bedrock. Coastal features of palaeoenvironmental/archaeological interest in the broader area around the estuary of the River Tees include a submerged forest to the north of the estuary, near Hartlepool (NZ 520 315) with associated evidence of Mesolithic occupation; and salt mounds, probably of various age, on Coatham Marsh on the south side of the estuary mouth.

In early maps of the estuarine River Tees, from the 16th century (Lucas Janszoon Waghenaeer 1584) up to the mid-19th century (Henry Cross 1843; OS 1857) the approximate position of the site lies in the middle of the broad Tees estuary. However by the second half of the 18th century some maps (e.g. Joseph Dobson 1762) show the site occupying tidal flats immediately adjacent to the south side of a navigable channel of the Tees, termed the South Channel in the map of James Johnson (1849). In later maps this channel appears as the principal navigable channel of the river (as it is today) while the whole of the site remained an area of tidal flats, described as 'Mud and Sand'. Reclamation proceeded to landward of the site between 1857 and 1878, when the upper part of the intertidal flats was embanked. The site and its immediate hinterland remained in this state until sometime between 1905 and 1921, when a small part of the landward end of the site was reclaimed. However most of the site was still intertidal in 1946. In an aerial photograph of that date, the large unreclaimed area is seen to be completely submerged, and in 1948 in another aerial photograph the site is still sand or mud flats and drained by a typical intertidal dendritic network of shallow channels (possibly the distributive network of the Kinkerdale Beck (see below). A major phase of reclamation appears to have taken place between 1948 and 1955, by which time more than half the southern side of the site had been reclaimed, with the remainder being fully reclaimed by 1966, the year in which the Tees Dock was completed. Drainage across the site was maintained in an open channel regarded as part of the Kinkerdale Beck. In 1994 the course of the Beck across the site was culverted.

Boreholes to the north of Tees Dock (PD Ports 2009) proved up to 7.0m of Made Ground, described as 'slag, brick, sandstone and cinder'. Other borehole records (Tees Rep Arch Ch 14, quoting Mouchel Parkman 2006) indicate a lower layer of Made Ground comprising 'loose black sandy silt' up to 15m thick, thought to comprise material dredged from the channel of the river, and an upper layer consisting of iron working residue or slag, up to 3.0m thick. The 1946/1948 aerial photographs indicate the tipping of waste from wagons running on tracks extending out from nearby industrial premises onto the site across the mud and sand flats.

Thus the site seems likely to be underlain everywhere by a substantial thickness of variable Made Ground. Nearby borehole records (Tees Rep Arch Ch 14 quoting Mouchel Parkman 2006) describe the underlying alluvium as 'soft greyish brown, slightly organic, very silty clay with brown sand pockets, occasional wood fragments and occasional pockets of organic matter', varying in thickness from *ca.* 2.75m to *ca.* 5.5m. Beneath the alluvium, borehole records indicate the presence of glacial till up to *ca.* 20m thick, described as 'stiff reddish

brown and grey boulder clay with occasional sand pockets'. The alluvial deposits, especially the upper part, should perhaps be regarded as semi-natural in character, bearing in mind the management of the river channel since at least the mid-18th century, and the early industrialisation of the hinterland and immediate sediment source areas, both beside the estuary and further upstream.

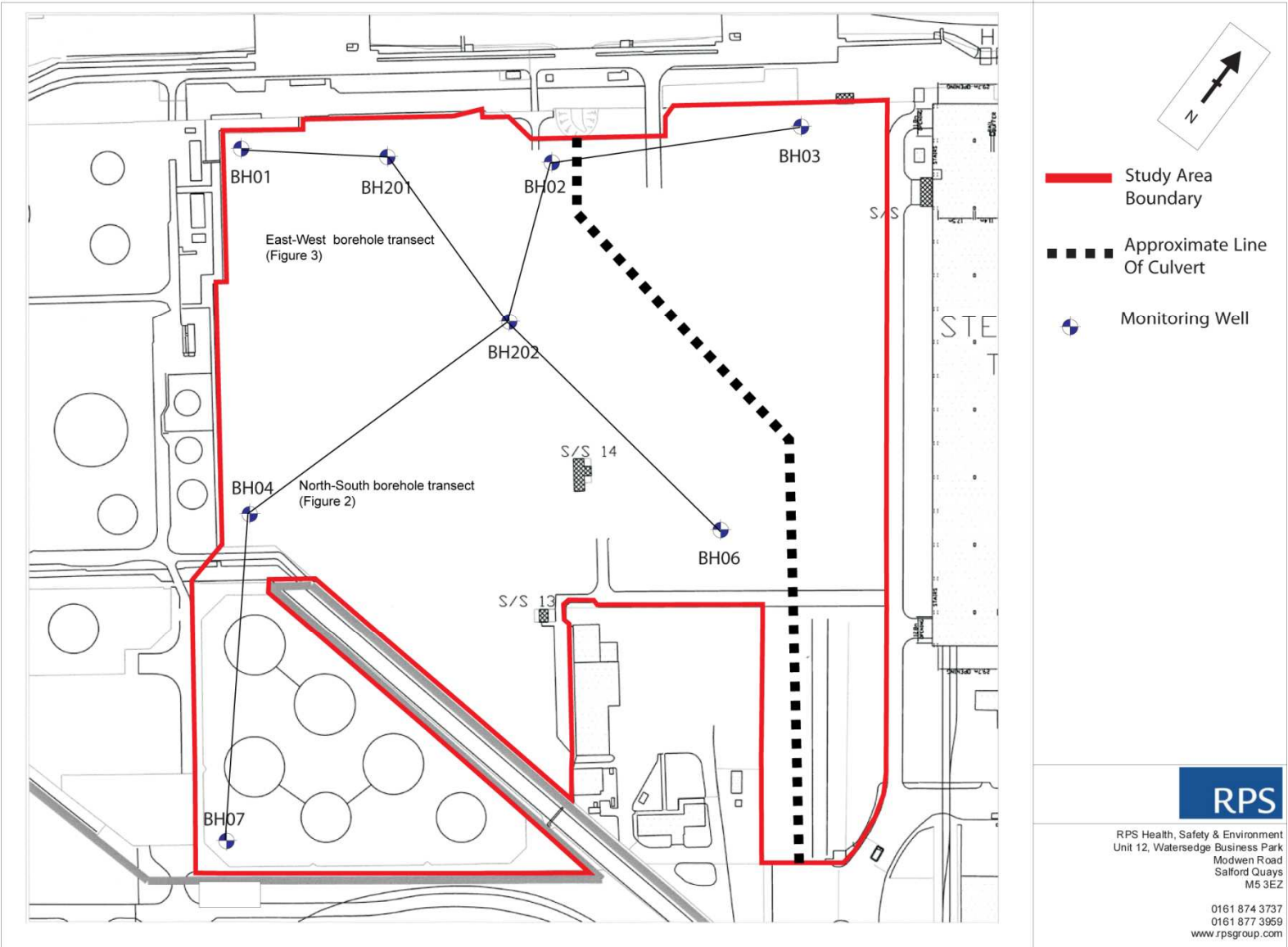


Figure 1: Tees Renewable Energy Plant Site and location of the geotechnical boreholes

METHODS

Fieldwork

Eight geotechnical boreholes (<12m from surface) and sixteen test-pits (<4m from surface) were put down across the site by RPS Planning & Development. The thickness of Made Ground exceeded 4m rendering the test-pit records unusable within this geoarchaeological investigation. Similarly, the nature of the Made Ground meant that multiple attempts were required at some of the borehole locations (e.g. BH04 & BH07). The spatial co-ordinates of each borehole were not recorded, but have been estimated using georeferencing software and recent topographic surveys of the site (Table 1; Figure 1). Each borehole was described by the geotechnical team undertaking the drilling, the results of which are recorded in Tables 2 to 9. In addition, two borehole transects were produced orientated approximately north-south and west-east across the site (Figures 2 & 3).

Table 1: Tees Renewable Energy Plant Site borehole locations

Borehole number	Easting	Northing	Depth (m OD)
BH01	454046	523163	5.22
BH02	454158	523267	4.91
BH03	454232	523366	4.96
BH04	454175	523039	5.20
BH06	454345	523198	5.23
BH07	454282	522918	6.90
BH201	454099	523211	5.00
BH202	454199	523197	5.27

RESULTS AND INTERPRETATION OF THE DEPOSIT MODELLING

The geotechnical field-based descriptions are presented in Tables 2 to 9. In addition, two the two ca. north-south and west-east orientated borehole transects were displayed in Figures 2 & 3. The boreholes indicate a thick horizon of Made Ground consisting of gravels, cobbles, boulders and steel-making slag. This unit extends down to between -0.50 and -1.00m OD in the northern half of the site, nearest to the River Tees and Tees Dock (boreholes BH01, BH02, BH03, BH06, BH201 and BH202; Tables 2-4, 6, 8 & 9). Towards the south of the site, the base of the Made Ground appears more variable, reaching -2.10m OD in borehole BH04 (Table 5) but only 1.70m OD in borehole BH07 (Table 7).

Beneath the Made Ground, inorganic silt- and/or sand-sized sediment is recorded in all boreholes. This sediment may all be natural alluvium, but some may be redeposited material, dredged from the channel of the river and introduced during the reclamation of the site. In boreholes BH02, BH201 and BH202 (Tables 3, 8 & 9), a strong hydrocarbon odour was noted, suggesting contamination. The base of the Alluvium was recorded in only two of the boreholes; BH02 at -7.29m OD, indicating a thickness of 6.3m (Table 3) and BH03 at -5.54m OD, indicating a thickness of 4.70m (Table 4). Some of the other boreholes, only just penetrated the upper surface of the Alluvium (e.g. 60cm in BH06; Table 6, 25cm in BH07; Table 7). Thus the borehole records provide insufficient information to map the thickness of the alluvium across the site, or the contours of its upper and lower bounding surfaces.

In Boreholes BH02 and BH03, the lowermost unit was orange brown gravelly clay, interpreted as Glacial Till. The surface of the till was recorded at -7.29m OD in BH02 and -5.54m OD in BH03, whilst in BH202, the same surface had not been reached at -6.97m OD (Table 9). Thus as noted above, the borehole records provide insufficient information to map the contours of the contact between the Glacial Till and the overlying Alluvium.

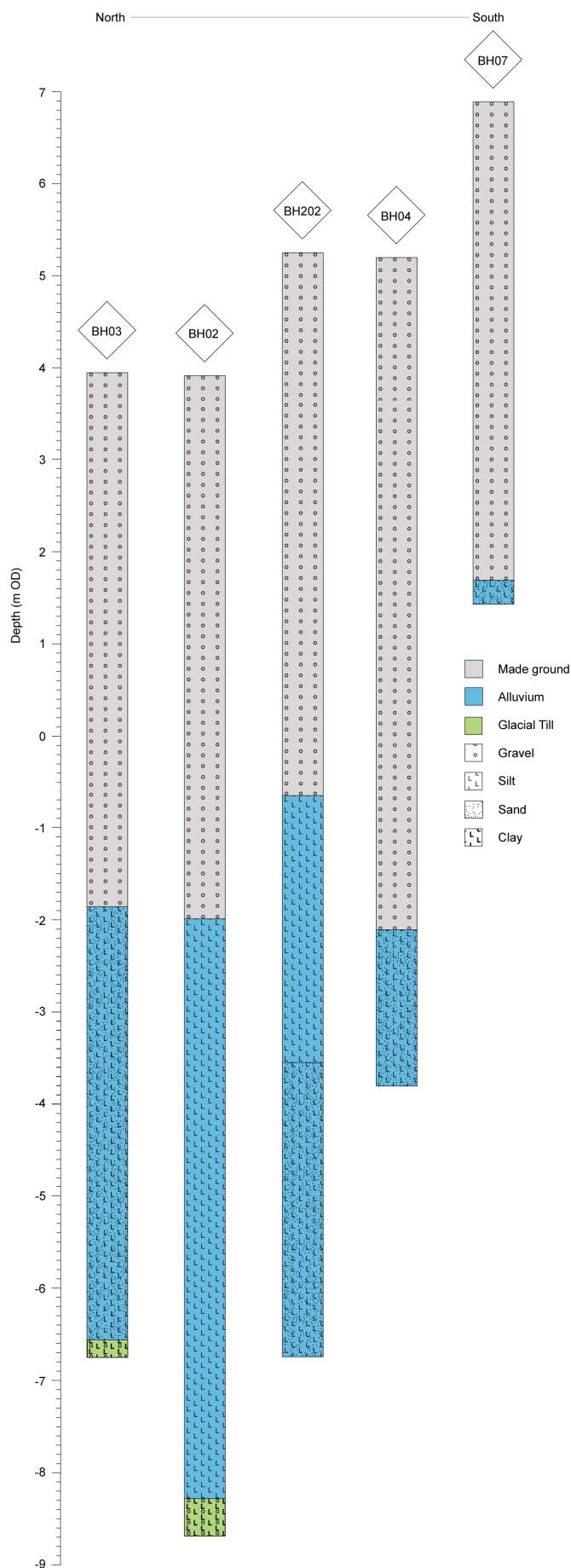


Figure 2: North-South transect borehole transect, Tees Renewable Energy Plant Site

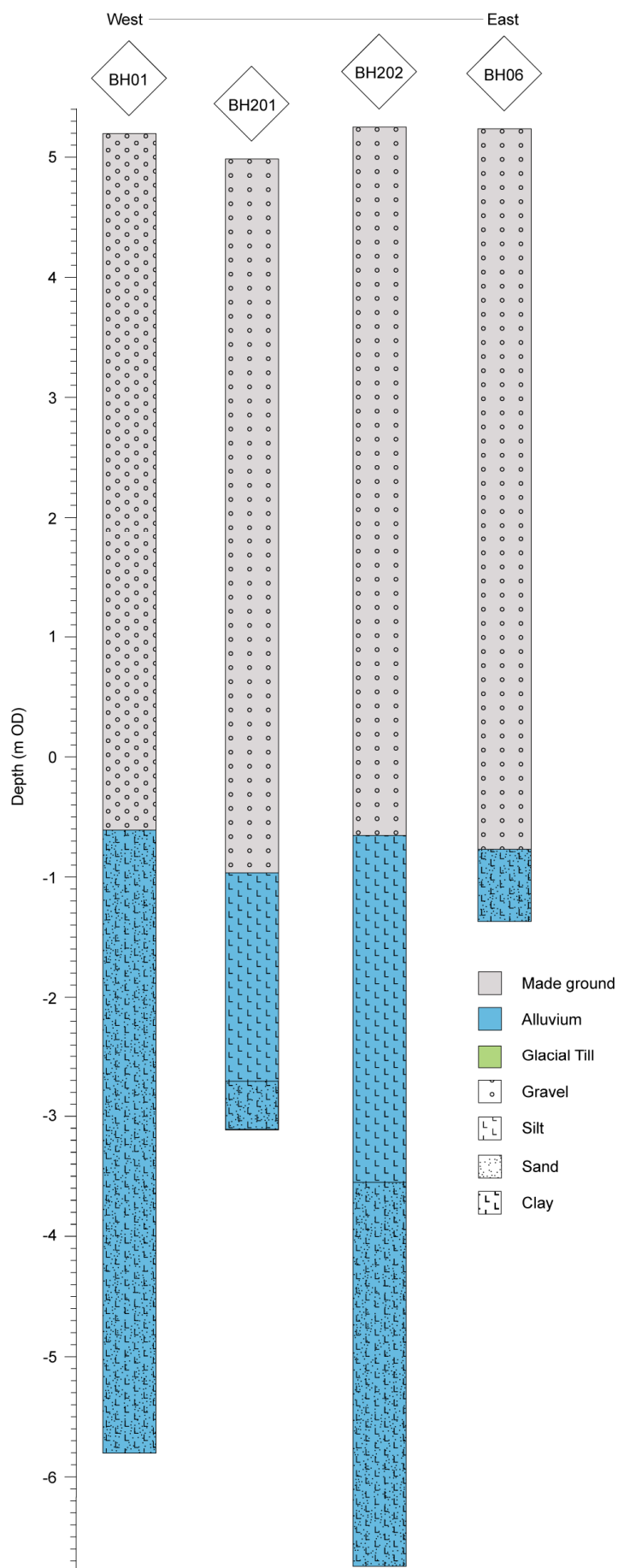


Figure 3: West-East transect borehole transect, Tees Renewable Energy Plant Site

Table 2: Geotechnical description of BH01, Tees Renewable Energy Plant Site

Depth (m BGS)		Depth (m OD)		Geotechnical description	Stratigraphic interpretation
Top	Base	Top	Base		
0	5.90	5.22	-0.68	Grey/brown fine to coarse sub-angular gravel of steel slag with cobbles and boulders up to 300mm in diameter (imported fill). Becomes fine to coarse gravel with occasional cobbles from 1.50m BGS. Becomes dark grey and sandy with strong hydrocarbon odour from 5.50m BGS. Becomes dark grey/black sandy fine to medium gravel with strong hydrocarbon odour from 4.75m BGS.	MADE GROUND
5.90	11.00	-0.68	-5.78	Dark grey/black silty fine to medium sand.	ALLUVIUM

Table 3: Geotechnical description of BH02, Tees Renewable Energy Plant Site

Depth (m BGS)		Depth (m OD)		Geotechnical description	Stratigraphic interpretation
Top	Base	Top	Base		
0	5.90	4.91	-0.99	Grey/brown fine to coarse sub-angular gravel of steel slag with cobbles and boulders up to 300mm in diameter (imported fill). Becomes fine to coarse gravel with occasional cobbles from 1.50m BGS.	MADE GROUND
5.90	12.20	-0.99	-7.29	Very soft to dark grey/black silt. Strong hydrocarbon odour	ALLUVIUM
12.20	12.60	-7.29	-7.69	Firm to stiff orange brown gravelly clay. Gravel is fine to coarse sub-angular to sub-rounded of mixed lithology	GLACIAL TILL

Table 4: Geotechnical description of BH03, Tees Renewable Energy Plant Site

Depth (m BGS)		Depth (m OD)		Geotechnical description	Stratigraphic interpretation
Top	Base	Top	Base		
0	5.80	4.96	-0.84	Grey/brown fine to coarse sub-angular gravel of steel slag with occasional cobbles (imported fill). Becomes increasingly coarse and dense from 3.50m BGS.	MADE GROUND
5.80	10.50	-0.84	-5.54	Dark grey silty fine to medium sand	ALLUVIUM
10.50	10.70	-5.54	-5.74	Firm to stiff orange brown gravelly clay. Gravel is fine to coarse sub-angular to sub-rounded of mixed lithology	GLACIAL TILL

Table 5: Geotechnical description of BH04, Tees Renewable Energy Plant Site

Depth (m BGS)		Depth (m OD)		Geotechnical description	Stratigraphic interpretation
Top	Base	Top	Base		
0	7.30	5.20	-2.10	Grey/brown fine to coarse sub-angular gravel of steel slag with cobbles and boulders up to 300mm in diameter (imported fill). Becomes fine to coarse gravel with occasional cobbles and strong hydrocarbon odour from 4.25m BGS.	MADE GROUND
7.30	9.00	-2.10	-3.80	Dark grey/black silty fine to medium sand	ALLUVIUM

Table 6: Geotechnical description of BH06, Tees Renewable Energy Plant Site

Depth (m BGS)		Depth (m OD)		Geotechnical description	Stratigraphic interpretation
Top	Base	Top	Base		
0	6.00	5.23	-0.77	Grey/brown fine to coarse sub-angular gravel of steel slag with cobbles and boulders up to 300mm in diameter (imported fill). Becomes fine to coarse gravel with occasional cobbles from 3.5m BGS.	MADE GROUND
6.00	6.60	-0.77	-1.37	Dark grey/black silty fine to medium sand	ALLUVIUM

Table 7: Geotechnical description of BH07, Tees Renewable Energy Plant Site

Depth (m BGS)		Depth (m OD)		Geotechnical description	Stratigraphic interpretation
Top	Base	Top	Base		
0	5.20	6.90	1.70	Grey/brown fine to coarse sub-angular gravel of steel slag with cobbles and boulders up to 300mm in diameter (imported fill). Patch of red/brown clay at 0.5m BGS Becomes fine to coarse gravel with occasional cobbles from 2m BGS.	MADE GROUND
5.20	5.45	1.70	1.45	Dark grey/black silty fine to medium sand	ALLUVIUM

Table 8: Geotechnical description of BH201, Tees Renewable Energy Plant Site

Depth (m BGS)		Depth (m OD)		Geotechnical description	Stratigraphic interpretation
Top	Base	Top	Base		
0	5.95	5.00	-0.95	Cobbles and boulders with some dark grey and grey brown steel slag; cobbles and boulders are sub-angular to sub-rounded; boulders to 450mm; gravels are sub-angular to sub-rounded, fine to coarse.	MADE GROUND
5.95	7.70	-0.95	-2.70	Very dark grey to black uncompact silt with strong hydrocarbon odour; bedding	ALLUVIUM

				disturbed by sampling. Hydrocarbon odour present but reduces in strength with depth.	
7.70	8.10	-2.70	-3.10	Very dark grey slightly silty sand; sand is fine to coarse with occasional fine gravel of orange brown quartzite; no visual or olfactory evidence of contamination.	ALLUVIUM

Table 9: Geotechnical description of BH202, Tees Renewable Energy Plant Site

Depth (m BGS)		Depth (m OD)		Geotechnical description	Stratigraphic interpretation
Top	Base	Top	Base		
0	5.90	5.27	-0.63	Light to dark grey and grey brown cobbles and boulders with some gravels of steel slag; cobbles and boulders are sub-angular to sub-rounded; boulders >300mm; gravels are angular to sub-rounded, fine to coarse.	MADE GROUND
5.90	8.80	-0.63	-2.90	Very dark grey to black uncompact silt with strong hydrocarbon odour; bedding disturbed by sampling. No evidence of contamination from 7.50m BGS.	ALLUVIUM
8.80	12.00	-2.90	-6.73	Black fine sand with no visual or olfactory evidence of contamination	ALLUVIUM

DISCUSSION, CONCLUSION AND RECOMMENDATIONS

The borehole records indicate that in the northern and central areas of the site, the Made Ground tends to range between 5 and 8m in thickness and extends down to between ca. -0.50m and -1.00m OD (Figures 2 & 3). This level may be representative of the natural topography of the site prior to reclamation. However, it is also possible that in some places this former surface has been truncated during or prior to the reclamation process. In Borehole BH04, for example, towards the south of the site, the base of the Made Ground is at the lower level of -2.10m OD.

Whilst the borehole records provide limited information on the nature and thickness of the Alluvium, there is no evidence for the presence of organic-rich units beneath the site which might contain archaeobotanical (e.g. pollen, plant macrofossils) or zooarchaeological (e.g. insect) remains. In addition, the potential for gaining a chronology for the Alluvial sequence is limited by the lack of organic remains, and probably also by contamination (noted in at least three of the borehole records). Fine-grained sediments such as the silts in boreholes BH201 and BH202 may contain diatom, Ostracoda, Foraminifera or Mollusca remains which might provide the basis for a reconstruction of the hydrological history of the site, but this would be of limited significance without a chronological framework for the site, or if contaminated. Therefore, no further geoarchaeological work is recommended on the Tees Renewable Energy Plant Site.

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