Annex 18.1

# South Humber Channel Marine Studies: Archaeology and Cultural Heritage Desk Study

*(Humber Field Archaeology)*

**Humber Field Archaeology**
*Archaeological Consultants and Contractors*

# SOUTH HUMBER CHANNEL

# MARINE STUDIES:

# ARCHAEOLOGY

# AND

# CULTURAL HERITAGE

# DESK STUDY

*Work carried out on behalf of Yorkshire Forward*

**Humber Archaeology Report No. 341**

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*Work carried out on behalf of Yorkshire Forward*

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## Contents

# INTRODUCTION

1.1 This desk study assesses the impacts of the proposed marine development upon the archaeological and cultural heritage resource, using currently available records pertaining to the proposed development site and a larger Study Area surrounding it, including the impact of the proposal on any sites in the vicinity afforded statutory protection (e.g. Listed Buildings, Scheduled Monuments). It also provides an assessment of the potential for the presence of hitherto unknown archaeological sites. Site investigation works, in the form of geophysical survey and vibro-coring, have taken place within the proposal area and the results of this work are considered in the assessment where appropriate.

1.2 Features of cultural heritage interest discussed in this assessment are shown in Figure 1. A gazetteer lists the archaeological sites in the Study Area.

1.3 The assessment has been carried out by Humber Field Archaeology (HFA), an archaeological organisation based in Hull, East Yorkshire, at the request of Roger Tym & Partners, acting on behalf of Yorkshire Forward.

### *Definition of the Study Area*

1.4 The proposed development comprises a multi-user marine terminal occupying an area of *c.* 45ha, adjoining the current coastline at Killingholme Marshes, North Killingholme parish, North Lincolnshire. A single Study Area has been defined which encompasses the development area, plus a 1km wide area surrounding it – an area of around 7.6km$^2$ is involved, including land within the parishes of North and South Killingholme and an area of the Humber Estuary immediately offshore. Much of the land within the Study Area is currently farmland, though there are significant areas in industrial or commercial use.

### *Objectives of report*

1.5 The principal objectives of the assessment will be as follows:

- to identify known archaeological sites within or immediately adjacent to the proposal site;
- to identify areas with the potential to contain any unrecorded archaeological remains;
- to assess the effects of any proposed development upon archaeological sites;
- to propose archaeological measures which could be built into the development proposals to avoid, reduce or remedy any potential adverse effects identified.

1.6 The Department of Communities and Local Government Planning Policy Statement 5 (PPS5) Planning for the Historic Environment, issued in March 2010, sets out the national policy on archaeological remains, how they should be preserved or recorded (policy HE7); this applies to both designated (paras HE9.1 to HE9.4) and non-designated sites (paras HE9.5 and HE9.6). Where archaeological remains can be demonstrated through research and/or evaluation, a mitigation strategy should be prepared in consultation with the Local Planning Authority. The presumption is in favour of preservation *in situ* through the modification of a proposed development, and only where this is not possible, an appropriate level of recording ('preservation by record') is acceptable as a last resort.

### *Assessment of the significance of cultural heritage sites in the Study Area*

1.7 The effects of a development proposal will depend upon the adequate prior assessment of the significance of the archaeological sites and features which will potentially be affected and the degree of impact of the proposals. There are occasions when insufficient is known to make informed judgements and an assessment of risk is all that can be offered. In assessing the effects of the proposals upon cultural heritage resources, it is necessary to consider the importance of the resources, as well as the magnitude of impact. Professional judgement and a degree of flexibility need to be applied.

1.8 Importance is based on statutory designations (e.g. Scheduled Monuments, Listed Building grades) as well as on the following generally accepted criteria:

- Period
- Rarity
- Group Value
- Condition

1.9 The criteria of importance (as originally set out in Annexe 4 of PPG 16, the predecessor to PPS5), modified to take account of the whole range of site values, not just scheduled monuments, can be used as a guide for judgements of importance used in cultural heritage studies. The following categories are used in this report (with letter codes used in the gazetteer in brackets):

- **National (A)**: the highest status of cultural heritage site: e.g. scheduled monuments, listed buildings (Grade I & II*), well-preserved historic landscapes;
- **(County)/Regional (B)**: includes the bulk of cultural heritage sites with reasonable evidence of occupation, ritual, industry etc, listed buildings Grade II; reasonably preserved historic landscapes;
- **Local (C)**: cultural heritage sites with some evidence of human activity, but in a fragmentary or poor state, buildings of local importance, dispersed elements of historic landscapes.
- **Unknown/Unimportant (N)**: insufficient evidence or data to make an informed judgement of importance, where a building, site or finds spot is considered to have no significance, or represents a monument or find known only from documentary sources with no specific identifiable location.

1.10 Where a decision is borderline or where an entry potentially applies to a range of different sites of differing perceived importance (e.g. a cropmark complex, mixed finds assemblage), then “mixed” gradings such as B/C have been used.

1.11 There are three Grade II listed buildings in the Study Area, though they lie outside of the Proposal Area.

# METHODOLOGY AND SOURCES

1.12 The assessment comprises a desk-based review of evidence for the archaeological and cultural heritage potential of the development area and the surrounding Study Area, though it will also include an assessment of the results of marine geophysical survey and coring carried out on the site.

1.13 The information upon which the study will be based will be collated from existing written, published, graphic and unpublished information, directly or indirectly relating to archaeological remains or features of historical interest within the Study Area.

1.14 It is acknowledged here that some data sources which are normally part of a desk-based assessment have not been included here due to the budgetary constraints imposed by Yorkshire Forward; principal amongst these are a walkover survey and an aerial photographic assessment. These were not considered necessary within the limited scope of this assessment, though these will need to be included should the application proceed to a full Environmental Impact Assessment.

1.15 The data derived from the various sources of information which have been consulted are presented in a gazetteer of archaeological remains in tabulated format; gazetteer numbers are also given at appropriate points in the text. Additional published and unpublished sources are quoted in the report text and their details are noted in the bibliography. The locations of the various archaeological sites or find-spots are shown on Figure 1.

1.16 To aid in the definition of the archaeological context of the Study Area, some archaeological sites from the area immediately surrounding have also been discussed.

1.17 The report on the coring has been assessed to extrapolate relevant details such as levels, depths of material, evidence for potential former land surfaces, presence/absence of organic content etc.

1.18 The report on the geophysical survey has been assessed to extrapolate relevant details of geology and the location or character of underwater and/or buried features.

### *Sources*

1.19 Various cultural heritage research sources were used during this assessment:

- North Lincolnshire Sites and Monuments Record (NLSMR);
- National Monuments Record: Archaeology;
- Listed Buildings Online;
- published and unpublished historical and archaeological studies;
- cartographic sources (including historic Ordnance Survey maps).

### *Geophysical Survey*

1.20 The geophysical survey (Ferris 2010) was carried out in June 2010 by Emu Ltd for Vinci Construction and involved a boomer survey, bathymetry and magnetometry; see Appendix 1.

1.21 Water depth across the surveyed areas was found to vary from 4m at its shallowest to 18m at the north-eastern extremity of the site. The depth of rock head was calculated at 3m near the shore end of the survey area, 8m at the north-eastern boundary of the site and deepest, at 14m, in the centre.

1.22 The magnetometry survey involved data collection at 10m line spacing using a pair of caesium vapour marine magnetometers, with the unit being towed a minimum of 60m behind the survey vessel, being maintained at an altitude of 2-4m above the seabed.

1.23 Seven significant magnetic anomalies and two smaller targets were identified. One of the targets (no. 2) corresponds to the wreck (Gaz.44) of a barge which sunk in the 1950s, the position of which is recorded on the relevant Admiralty chart. The other eight anomalies are unidentified ferrous objects – they could potentially be discarded material from shipping or unexploded ordnance – the further identification of which could only be established either through the use of side scan sonar or through diving.

***Coring***

1.24 Vibrocore survey was carried out by Vinci Construction in July 2010 with 30 positions being sampled at depths varying from 2.15m OD to –10.79m OD (upper core heights estimated through bathymetry); see Appendix 2 for the draft geotechnical report (Jackson 2010) and Appendix 3 for the coring logs (Soil Engineering 2010).

1.25 Soils encountered were predominantly silts and clays, though chalk gravel was encountered at the base of 5 cores at around –9 to –13m OD.

1.26 Peat was identified in 8 cores (VC5, VC6, VC7, VC8, VC9, VC12, VC13 and VC15), all of which lie at least 800m offshore (see Figure 2 in Appendix 2). The peat is described as being amorphous or pseudofibrous and lying in lenses, laminations or thin beds within sand or gravel layers. The peat deposits were generally encountered between about –9m and –11m OD. Pockets of material described as "clayey peat" were also noted in sands and gravels at the top of core VC17, at around –6.5m OD.

1.27 Two cores at a much higher level (CV20 and CV21), close to the shore, recorded organic deposits with visible plant remains at around OD, derived from modern marine vegetation.

1.28 One core (CV14), close to the shore, recorded decomposed wood at around –0.4m OD. This core lay close to geophysical anomaly no. 3, which potentially represented multiple ferrous debris; there is a possibility, therefore, that the debris detected is a composite of wood and iron.

# ARCHAEOLOGICAL POTENTIAL OF THE STUDY AREA

1.29 Archaeological and historic sites recorded within the Study Area (or close by) are listed in the gazetteer. The sites are given a gazetteer reference (eg. Gaz.00), which is correlated where applicable with the numbers assigned by NLSMR, the National Monuments Record and the Listed Buildings register. The results of the recent geophysical survey and coring are also considered and where the results merit it, sites have been assigned gazetteer entries.

1.30 A central grid reference, suggested classification and date are provided for each site, which are graded in archaeological significance as either: A (national), B (regional), C (local) or N (unknown/unimportant); see 1.9, above. The locations of the sites are shown on Fig. 1.

### *Site topography and geology*

1.31 The landward part of the survey area lies entirely on the Lincolnshire Marsh, the strip of low-lying land extending from the foot of the Lincolnshire Wolds to the fringes of the Humber Estuary and the North Sea. The underlying geology consists of chalk from the Upper Cretaceous period, above which is Quaternary chalky till, which takes the form of a boulder clay. The gently undulating till surface, at levels rising from 10m OD to 25m OD towards the Wolds, is known as Middle Marsh, and this is flanked by the coastal plain known as Outmarsh, land generally flatter and much of it well below 10m OD in level. The Outmarsh comprises estuarine and marine alluvial deposits resulting from Holocene sea-level rise and inundations, which overlie the till surface nearer the coast.

1.32 The soils in the Middle Marsh are classified as the 711u Holderness Soil Association by the Soil Survey of England and Wales (1983), being seasonally waterlogged fine loamy soil (surface-water gleys), best suited to cereal crops and short-term pasture, while those on the Outmarsh are classified as the Newchurch 2 Soil Association, being deep stoneless soils (groundwater gleys), mainly calcareous and at risk of flooding, suitable for the growing of root crops only.

1.33 The seaward part of the survey area overlies undersea or intertidal areas with widely varying depths, gradients and channel bottom composition, the latter principally alluvial clays and silts overlying sands and gravels or glacial till. Details can be found in Appendix 2, which includes a useful series of cross-sections.

### *Post-glacial landscape development*

1.34 Study of the Outmarsh depositional sequence, principally of a Holocene date, can be summarised as follows (taken largely from Lillie & Gearey 2001, 21-22). A forest, comprising oak, alder and birch, became established on the surface of the glacial till, a sample from Immingham having been dated to 6681±BP, within the Mesolithic period; these tree remains are still sometimes exposed today as a result of coastal erosion. A change to wetter conditions led to the formation of a peat layer over the forest bed, itself sealed beneath thick marine clay, associated with saltmarsh, then freshwater clay, the latter formed when reduction in the rate of sea-level rise facilitated the development of freshwater marsh; deposition of these clays may date to the Bronze Age. Formation of upper peats followed, with these being finally overlain by tidal silts up to around current ground levels.

1.35 The formation of the upper estuarine alluvium has been variously dated to the early Iron Age (c.1000 BC) and to the post-Roman period, the latter because the alluvium overlay a Roman site at Ingoldmells, south of Grimsby. It is clear that the rate and commencement of accumulation was highly variable, depending on localised and perhaps relatively minor changes in land levels and offshore features.

1.36 The landward extent of the alluvium provides an indication of the coastline in the prehistoric period, when episodes of tidal transgression extended the coast inwards at the expense of littoral marshland. The larger inundations in this early coastline show the positions of stream channels and creeks, which continued to drain into the sea when the coast advanced seawards and which largely correspond to the position of modern drains and canalised streams.

1.37 The present extent of the alluvium, as shown on BGS mapping, is indicated on Fig. 1, and this boundary corresponds to the western limits of more recent areas of coastal marsh and seasonal grazing land which lay in North and South Killingholme prior to late 18th-century enclosure (see Figs 2 and 3), after which it was reclaimed as farmland. The line of the earlier, prehistoric coast (Gaz.12), identified by archaeological fieldwork in one part of the Study Area, has, however, been found to lie some distance east of the alluvial boundary. This was presumably the coastline when lower sea-levels prevailed and Iron Age settlement remains (Gaz.13), recorded close to this buried coastline, were found to be sealed beneath a thick layer of alluvium which extended further west.

***Prehistoric activity***

1.38 During the Mesolithic period the landscape of the Lincolnshire Marsh would have been mostly wooded (see above), but during the Late Mesolithic to the Late Neolithic period, the formation of peat deposits, dated to 3943 ± 100 BP (at Chapel Point, Lincolnshire), indicates that a wetter, more mixed woodland habitat, containing ferns and sedges, was developing (cited in Van de Noort & Davies 1993, 21). This was probably formed by water running off the Wolds. A Mesolithic flint core (Gaz.31) was recovered during fieldwalking on the western edge of the Study Area, in South Killingholme parish, while further north, a flint assemblage (Gaz.18) recovered during trial excavations for the Able UK vehicle storage facility contained some material of a Mesolithic date.

1.39 Pollen samples taken from higher peat deposits at Chapel Point, dated to the Neolithic period, seem to suggest that some farming may have been taking place in the area of the Outmarsh at that time (ibid.), presumably with some forest clearance. Settlement activity is represented by a Neolithic flint blade-like flake (Gaz.33) and a flint flake (Gaz.38) recovered during fieldwalking, and some Neolithic material in a flint assemblage (Gaz.18) recovered during trial excavations for the Able UK vehicle storage facility in North Killingholme. Outside the Study Area, a Neolithic polished stone axe was found north of Immingham (at TA 174 151), and two stone axes were found near Manor Farm, North Killingholme (at TA 1446 1749; Loughlin & Miller 1979, 207).

1.40 During the Early Bronze Age, the deposition of a 3m thick, saltmarsh clay on the Outmarsh indicates a significant marine inundation. The habitat would have consisted of saltmarsh plants such as sea-rush, sea-arrow grass, sea-pink and sea-lavender (Van de Noort and Davies 1993, 21). The area then reverted back to a fresh water marsh, suggesting a marine regression had taken place. The Middle Marsh at this time would

have consisted of mixed oak woodland with some arable and pastoral agriculture (op. cit., 22).

1.41 During the Mid to Late Bronze Age and possibly into the Iron Age, the habitat on the Outmarsh seems to have consisted of a mixed landscape of alder carr, with areas of reeds, radio-carbon dated to 3340 ± 110 BP (ibid.). Pollen analysis from a kettlehole at Butterbump, in the Lincolnshire Marsh, shows that woodland clearance was taking place, and was probably directly related to the growth of mixed arable farming. This was indicated by an increase in the amount of grass, herb and cereal pollen. It has been suggested that woodland clearance for farming was taking place some time after 2480 ± 90 BP and definitely prior to the Iron Age. Worked flints of Bronze Age date have been recovered during fieldwalking in the Study Area (Gaz.33 in North Killingholme and Gaz.31 in South Killingholme), while Bronze Age material was also present in an assemblage (Gaz.18) recovered during trial excavations for the Able UK vehicle facility in North Killingholme.

1.42 Bronze Age and Iron Age settlements associated with the making of salt have been documented on the Lincolnshire Marsh, especially around the area of Ingoldmells in Lincolnshire (Van de Noort & Davies 1993, 70), though early salt-production was recorded at Tetney Lock, just south of Grimsby (at TA 331 033). The salt industry was established in scrubland that was cut by deep, estuarine creeks and it was from these creeks at high tide that the salt water was taken to be used in the salt-making process. Pottery recovered from these sites indicate that salt production in the area commenced as early as the 4th century BC continuing through the Iron Age and into the Romano-British period (Baker 1975). Although no evidence of salt-making has so far been recovered from within the Study Area, two excavations just to the west have provided evidence in the form of salt-making vessels (briquetage): the site of the Immingham CHP plant (at TA 1670 1710), and the Clough Road re-alignment works (at TA 1587 1912).

1.43 Iron Age settlement remains have been recorded during some of the many recent episodes of archaeological fieldwork which have preceded development in the Killingholme area, much of it taking place inside the Study Area or close to it.

1.44 Parts of two Iron Age enclosures were excavated during archaeological evaluation and mitigation works preceding construction of the Able UK vehicle storage facility. The northernmost (Gaz.13) was at least 27m wide, with wide enclosure ditches being recorded on all sides and traces of roundhouses and other structural features being located in the interior. Pottery recovered suggested occupation in the Middle Iron Age. The settlement would have lain on the northern edge of a narrow coastal creek or inlet, the line of the coast (Gaz.12), a short distance to the east, having been established through geophysical survey and trial trenching; the site itself was sealed beneath a thick layer of alluvium, the result of later tidal transgression.

1.45 The southern settlement (Gaz.16) would have lain on the other side of the same inlet, also lying close to the coastal edge. This enclosure was oval in shape, measuring 65m by 45m, with an internal dividing ditch. The enclosure ditch was substantial, 5m wide, with evidence that it had been re-cut on several occasions, with pottery ranging in date from the Middle Iron Age in the lower fills through to the Late Iron Age and early Romano-British pottery in the upper fills. Part of at least one roundhouse was recorded in the interior of the enclosure. Evidence was also recorded of later ditches containing 2nd-century AD Roman pottery, which post-dated the enclosure. This settlement may have been contemporary with that to the north (Gaz.13) when first

established, though it continued in use for a longer period; there is no mention of alluvium overlying this enclosure and it may have been rising sea levels which led to the northernmost settlement being abandoned.

1.46 In the area west of the Study Area, further evidence of Iron Age settlement has been recorded. The site of the Immingham CHP plant (at TA 1670 1710) and the Clough Road re-alignment works (at TA 1587 1912) have already been mentioned, both of which recorded significant structural remains, including roundhouses, while a 400m-long Iron Age boundary ditch (at TA1660 1760) was recorded during trial excavations prior to construction of works associated with the Total oil refinery, running roughly parallel to Rosper Road, and this substantial feature, and other smaller ones, may have been contemporary with the settlement excavated further south at the CHP site.

1.47 It is clear that deposits representing earlier landscapes ranging in date from the Mesolithic to the Iron Age will survive in places beneath the estuarine alluvium. There is also a possibility that there will be buried boat remains, potentially from the Bronze Age or later; Bronze Age boats have, for example, been found on the north bank of the Humber at Kilnsea and elsewhere along the Humber.

***Romano-British activity***

1.48 Excavations in advance of the Clough Road re-alignment, and subsequent work connected with the Able UK vehicle storage facility, recorded several phases of activity, principally a series of field or boundary ditches on two alignments (Gaz.4) associated with Roman pottery dating from the 2nd century to the 4th century AD. No traces of buildings were recorded, though carbonised grain in one part of the site suggests at least some human activity. Further west, outside of the Study Area, work on the same scheme (at TA 1587 1912) recorded a sequence of overlapping rectilinear field boundaries and small paddocks/enclosures, six phases being represented of short duration. Further north, on the edge of the Study Area, Romano-British finds and some structural traces (Gaz.2) were recorded during construction of a gas plant in the 1960s, perhaps a continuation of the settlement at Gaz.4.

1.49 As mentioned above, the Iron Age settlement recorded at Gaz.16 continued in use into the Roman period, with at least one ditch containing Romano-British pottery being located in the area to the east of the Iron Age enclosure. It is perhaps no coincidence that two sherds of Roman pottery recovered from fieldwalking (Gaz. 27 and Gaz. 28) lie directly east of this site and may have been dispersed from it by ploughing.

1.50 Significant remains of settlement of this date have been recorded west of the Study Area. The Iron Age site beneath the Immingham CHP plant has already been mentioned and occupation of that settlement continued into the Roman period. The settlement lay adjacent to the northern edge of a stream channel and the excavations provided evidence for several phases of flooding. Activity in the Roman period near to the steam was broadly limited to the cutting and re-cutting of enclosure and drainage ditches, while further north there was an area of new enclosures, with the ditches being repeatedly re-cut and new enclosures created; a droveway connected the area to the creek. Settlement continued on a reduced scale into the 4th century. A number of finds, principally of Romano-British pottery, have also been made within the areas now occupied by oil refineries (eg. at TA 1510 1800, TA 1650 1780). These concentrations of finds suggest that Roman settlement was relatively intensive on this area of the Middle Marsh.

1.51 These discoveries and others mentioned above suggest a significant density of Romano-British settlement, particularly on the higher ground of the Middle Marsh and its fringes, with settlements in many cases lying alongside or close to the various creeks and inlets which crossed the Outmarsh.

1.52 It is considered that most of the Outmarsh here would have been marginal land, probably saltmarsh, during the Roman period. In the Study Area, there are only two find-spots of material of that date over the area of the alluvium, sherds of Roman pottery (Gaz. 27 and Gaz.28) found during fieldwalking.

1.53 Activity of this date on the Outmarsh cannot be wholly discounted, however, and in this regard it is worth highlighting the results of archaeological work further south in Stallingborough, North East Lincolnshire, on a site (at TA 2312 1302) which lies wholly on the alluvium, over 2km east of its western extent and less than 1km from the present shoreline. Geophysical anomalies were recorded which could indicate salt-making or, for instance, pottery production, and subsequent excavation recorded enclosures and deep ditches containing late 3rd- to late 4th-century Roman pottery, with environmental evidence pointing to crop-processing as one of the activities being carried out in the vicinity. There was no evidence of flood deposits sealing or masking any of the excavated features and this suggests that by the late Roman period, at least, parts of the Outmarsh were suitable for settlement, despite the land being low-lying, presumably due to falling sea-levels rendering the alluvial surface habitable.

***Anglo-Saxon and early medieval activity***

1.54 During the subsequent Anglo-Saxon occupation of the area, the distribution of settlements along the eastern edge of the Middlemarsh and the place-name evidence suggests that the Outmarsh was once again too inhospitable for permanent settlement, although it would have been suitable for seasonal grazing (Van de Noort and Davies 1993, 23).

1.55 The place-name of Killingholme is Old English in origin, though there is some debate as to its meaning. Ekwall suggests that it is derived from an Anglo-Saxon personal name *'Cylfingas'*, a possible contraction of *'Cynwulfingas'*, to which was added the Old Scandinavian word *holmr*. Thus, Killingholme would mean 'a raised area of ground in a marshy area belonging to the *Cynwulfingas*' (Ekwall 1960, 276). However, Cameron suggests that Killingholme is more likely to be derived from *'Ceolwulfingas'* and '-ham', meaning 'the homestead of the followers of *Ceolwulf*'. This implies that the name may have developed as Killingham, but the '-ham' was replaced by the Old Scandinavian *holmr*, meaning 'higher ground in a marshy area' due to changes in dialect (Cameron 1991, 193-198). This would fit quite nicely with the positioning of both North and South Killingholme on the higher ground to the west of the Outmarsh.

1.56 Killingholme is one of four 'group name', or *-ingas*, settlements north of Grimsby and these names are confidently believed to belong to an early period of Anglo-Saxon settlement in the areas in which they occur (Cameron 1991, 164). Place-name evidence seems to suggest that early Anglo-Saxon settlement occurred on the higher and drier ground of the Middle Marsh to the west of the wetter Outmarsh.

1.57 There are no discoveries of Anglo-Saxon or early medieval date in the Study Area, though an 8th-century coin was recovered from the upper fills of one of the former droveway ditches on the Iron Age and Romano-British settlement excavated beneath the Immingham CHP Plant. Much further north, a small quantity of Frankish pottery imported from the Low Countries or northern Germany, dating to the Middle-Saxon

period, has been discovered at East Halton Skitter (George 1999, 13). The Humber would have been a main trading artery for bringing imported goods from the Continent into northern England, with a number of havens along its edges acting as landing areas; there is a possibility that the creeks along the costs in the Survey Area may have been used for this purpose.

***Medieval activity***

1.58 The early origin of the local village place-names (see above) confirms that the area under study had been settled by the late 11th century. The medieval village settlements such as Killingholme (North and South) lay on the slightly higher and better-drained Middle Marsh with their accompanying common cultivated field strips (e.g. East Field and West Field). A number of areas of ridge-and-furrow ploughing representing the cultivated fields have been recorded within or adjacent to the Study Area (Gaz.25 and Gaz.39); very few areas now survive as earthworks, most having been ploughed out in the 19th and 20th centuries and only now noted on aerial photographs.

1.59 South of the Study Area, the possible site of an isolated medieval farmstead (at TA 1750 1640) has been postulated close to the boundary between South Killingholme and Immingham parishes, east of Houlton's Covert wood; a farm or toft recorded in the 12th century as *Enchetun* or *Enketoft* from place-name evidence (Cameron 1991, 199) has been identified with a small pre-enclosure close there. It is therefore possible that other outlying farmsteads could have existed away from the village centres.

***Post-medieval–early modern activity***

1.60 Enclosure by Act of Parliament in the 17th to the 19th century saw the open fields and common lands of English medieval villages being enclosed and allocated to a number of private landholders, removing the rights that people once held to graze animals on these areas. North and South Killingholme were enclosed in 1776.

1.61 The enclosing of land was often accompanied by large-scale drainage works, either public or private, which allowed the land to be improved and in many cases converted to arable cultivation for the first time. Existing streams or creeks – many marking parish boundaries – were deepened, dredged or straightened to take the water from the multitude of new field drains. Areas of former marshland were, through improved drainage, converted to cultivation (see Fig. 00).

1.62 The establishment of field hedges was also an integral part of enclosure. In North and South Killingholme a number of hedgerows survive which appear to have been established at the time of enclosure in the late 18th century (Gaz.6 and Gaz.34), while the hedgerow which follows the parish boundary (Gaz.26) could conceivably be older.

1.63 A small number of buildings of post-medieval or early modern date are included in the Gazetteer, including farm buildings (such as Gaz.10). The most significant buildings of this date in the Study Area, however, are the three lighthouses (Gaz.40, Gaz.41 and Gaz.42) in South Killingholme, constructed in the early-mid 19th century and which played a crucial role in the navigation of shipping into the Humber; all three are Grade II listed buildings.

1.64 In the Humber, there are records of three wrecked ships of this period (Gaz.43, Gaz.46 and Gaz.47), the exact positions of which are unknown, but which have been

variously accorded locations off Killingholme (e.g. Whitebooth Roads, Holme Spit). These wooden vessels were lost in heavy storms in deep seas or on sand spits and are unlikely to have survived in any intact form given the circumstances in which they sank.

***Modern activity***

1.65 The passing of the Humber Commercial Railway and Dock Act in 1901 and the subsequent construction of the Immingham Docks in the early part of the 20th century marked the advent of a massive phase of industrialization in the Immingham area, transforming a large area of former marshland and low-grade farmland. A number of railways were opened in the early years of the 20th century to service the docks and provide transport for goods and passengers (mostly workers) between and beyond the various dock facilities at Immingham and Grimsby. The Barton and Immingham Light Railway (Gaz. 1) passes through the Study Area; it was opened in 1910/11 and closed in the 1960s. The former Killingholme Station is now Station House (Gaz.35).

1.66 The docks and industrial facilities at Grimsby and Immingham were obvious targets for enemy attack during both World Wars, so there are a number of sites in the Study Area with a military origin, associated with the defence of these commercially-important areas.

1.67 In WWI, a naval fuel depot (Gaz.11) was established north of Killingholme Haven, consisting of 35 steel tanks with brick and concrete casings. Adjacent to them was Killingholme Battery (Gaz.23), built to defend the port facilities, which was equipped with two 12-pounder guns on octagonal concrete towers. These installations have all been demolished. The former site of a heavy anti-aircraft battery is also known at Killingholme Marshes (Gaz.37), operational in 1916 and 1917. A short distance north of the Study Area, at Halton Marshes, a seaplane base (at TA 1606 2076) built as a defence against Zeppelin raids, consisted of slipways, a jetty and sheds (one of which is now in use at Grimsby bus station).

1.68 Sites connected with WWII in the Study Area consist of two barrage balloon anchorage sites (Gaz.20 and Gaz.21), operated by 942 Squadron Balloon Command.

1.69 A former brickworks (Gaz.32) of late 19th-/early 20th-century date is recorded south of Killingholme Haven; it would have exploited the alluvial clays beneath.

1.70 Five wrecks (Gaz.44, Gaz.45, Gaz.48, Gaz.49, and Gaz.50) are recorded of vessels which foundered in the late 19th or 20th century on the stretch of the Humber opposite the Study Area. These range from fishing boats (Gaz.49 and Gaz.50), to cargo ships (Gaz.45 and Gaz.46) and barges (Gaz.44). In most cases, the exact position of these wrecks is unknown, being accorded a general location only. In one case, however, the wreck of a barge (Gaz.44) is marked on the relevant Admiralty chart and was detected during the recent geophysical survey undertaken as part of the current development proposal. The possibility cannot be discounted that some of the other geophysical anomalies detected represent debris associated with wreck fragments.

1.71 Many British and German aircraft were lost in the Humber area either through hostile action or accident; although none are currently known to lie within Study Area, the discovery of aircraft wreckage in the intertidal zone or in deeper water is a possibility. Military air crash sites are automatically protected under the *Protection of Military*

*Remains Act 1986*. The possibility cannot be discounted that some of the geophysical anomalies detected represent aircraft wreckage.

### *Potential of archaeologically "blank" areas*

1.72 It is apparent from consideration of the distribution of archaeological sites in the Study Area that, other than a few isolated find-spots of material recovered from fieldwalking, evidence of significant prehistoric and Romano-British settlement is restricted to areas away from the estuarine alluvium which occupies a 1-2km wide strip along the coast.

1.73 In the north-eastern part of the Study Area, Iron Age settlement remains were shown to be present beneath a thick layer of alluvial clay, while a possible contemporary coastline, fringed by creeks and channels, was detected beneath the alluvium, 50-100m east of its western edge. Trial excavations further south (Gaz. 16; Area E, Able UK vehicle storage facility) also recorded alluvial layers which were deeper further to the east, suggesting a buried coastline contemporary with later prehistoric activity. If this trend continues across the Study Area – and there is no reason to suppose otherwise – it would suggest that there is very little likelihood that later prehistoric settlement remains will extend as far eastwards as the present coastline.

1.74 Evidence from sites elsewhere on the Lincolnshire Marsh, however, has shown that the alluvium seals horizons associated with earlier phases of human activity, potentially ranging in date from the Mesolithic through to the Bronze Age. In some cases these will potentially extend beyond the modern shoreline, though they will have been eroded increasingly severely the further out from the shore they extend; within the deposits may, however, survive the remains of timber structures or other features, artefacts and animal remains. Where present, these remains will generally be of Local/Regional Importance (B/C); prehistoric boat remains or intact Mesolithic occupation sites would be rated higher (potentially National or Regional Importance; A or B).

1.75 The coring recorded some intermittent peat lenses, laminations or thin beds within sand and gravel layers, generally at between –9 and –11m OD, in several cores which lay over 800m offshore in relatively deep water. It is possible that these could represent a mix of disturbed and intact remnants of organic layers formed on early sand and gravel land surfaces, prior to the inundation around 6000 BC, during the Mesolithic, which formed the North Sea; only the examination and dating of samples of the peat would determine if terrestrial flora are present, or whether in fact decayed marine vegetation is represented.

1.76 The geophysical survey detected a number of anomalies representing ferrous debris, one of which corresponds to a known 20th-century wreck site. There is potential that the other detected anomalies represent remains of archaeological significance, such as wreck-sites, aircraft wreckage, or even unexploded ordnance.

### *Information gaps*

1.77 Readily-available documentary sources were consulted. There may be other sources held in repositories which have not been consulted as part of this assessment; however it is considered unlikely that further consultation of such sources would alter the conclusions reached by this assessment.

# EFFECTS AND MITIGATION

### *Introduction*

1.78 The magnitude of effects on archaeological sites is categorised using the criteria given below:

**High** Direct physical effect on monuments or archaeological sites, fundamentally changing their baseline condition, leading to their total destruction or major alterations to their character or setting; includes the subsequent major degradation of their preservational regime as a result of the development.

**Medium** Direct physical effect on monuments or archaeological sites, materially, but not fundamentally, changing their baseline condition, leading to their partial destruction or a partial alteration of their character or setting; includes some subsequent degradation of their preservational regime as a result of the development.

**Low** Minor physical effects which do not materially alter the baseline condition of the archaeological site or its setting.

**Neutral** No identified beneficial or adverse changes to the condition of the archaeological site or its setting.

1.79 The significance of an effect is then determined as a function of the importance of the archaeological site and the magnitude of the effect; the method of ranking of archaeological sites is described above (see 1.9) and the ranking of individual sites is listed in the Gazetteer. A matrix showing how these factors are combined to attribute significance is provided below.

| | **Level of Archaeological Importance** | | | |
|---|---|---|---|---|
| **Magnitude of Effects** | **National (A)** | **Regional (B)** | **Local (C)** | **Unknown (N)** |
| **High** | **Major** | **Major-Moderate** | **Moderate** | **Minor** |
| **Medium** | **Major-Moderate** | **Moderate** | **Minor** | **Minor** |
| **Low** | **Moderate-Minor** | **Minor** | **Minor** | **None** |
| **Neutral** | **None** | **None** | **None** | **None** |

1.80 Where the boxes in the matrix contain a range of values, professional judgement is used to assign a value within the range given. An effect of moderate significance or greater (shaded grey in the matrix) is considered to be significant in terms of the EIA Regulations. Further explanation of the levels of mitigation attendant to these effects follows below:

**Major** These effects are likely to be associated with sites and features of national or county/regional importance. Mitigation measures and/or detailed design work (including re-siting of elements and/or foundation design) may remove all of the effects upon the affected archaeological sites.

| | |
|---|---|
| **Moderate** | These effects are likely to be associated with sites and features of local or county/regional importance. Mitigation measures and detailed design work would ameliorate/enhance some of the consequences upon affected sites. |
| **Minor** | Effects associated with sites and features of local or unknown importance. Mitigation measures, where deemed necessary, will remove these effects. |
| **None** | No effects or those which are beneath levels of perception, within normal bounds of variation or within the margin of forecasting error. |

### *Potential effects of the development on archaeology and cultural heritage*

1.81 The key elements of the proposed development are not listed here in detail, though the following points discuss what are perceived to be the likely effects of particular aspects of the development on archaeological sites, known or unknown.

1.82 The marine terminal and its supporting structures could potentially affect below-ground archaeological remains where any are present. Archaeological remains identified or potentially surviving within the proposal area are expected to lie beneath estuarine alluvium, with erosion having damaged them increasingly severely the further out from the shore they extend.

1.83 Construction of the dock and associated structures will involve excavation for pile foundations – as such they have the potential to affect relatively small areas of below-ground (sub-bottom) archaeological deposits where such survive; considered to be of **Low or Medium Impact**.

1.84 The formation of associated onshore temporary works compounds, lay-down areas or crane hardstandings on adjacent land could potentially involve some below-ground disturbance to archaeological remains, where land which has not already been developed is used, though given the depth of alluvium known to overlie archaeologically-significant deposits, this is considered to be of **Low Impact**.

1.85 Trenches excavated for mains services, particularly drainage or sewerage, have the potential to be amongst the deepest groundworks; there is some potential, therefore, for this activity to disturb surviving archaeological deposits, though it is acknowledged that large parts of the adjacent onshore area have already been subject to archaeological survey preceding development. Service trenches are generally of limited extent and are here considered to potentially have a **Low Impact.**

1.86 The assessment of known and potential archaeological sites discussed above suggests that the proposal might contain archaeological sites of **Local/Regional** importance. Therefore any of the below-ground construction works associated with the proposed development, likely to be effects of **Low** or **Medium** magnitude, would potentially affect such sites to **Minor** or **Moderate** adverse significance.

### *Mitigation strategy*

1.87 The preferred mitigation to protect significant archaeological remains is to allow their preservation *in situ*, and it is this principle which guides national archaeological planning policies such as PPS5. This is usually achieved through design solutions such as changes to foundations or the re-siting of elements of a development, though where this is not possible, the next best solution is preservation by record; here the remains are subject to archaeological investigation and recording, the scope of such work being dependant on the extent and significance of the archaeological remains and the scale of the development works which potentially affect them.

1.88 Formulation of mitigation solutions of whatever form, however, relies on there having been a prior evaluation of the extent, date and degree of survival of archaeological remains, with an assessment of their significance. Aside from this desk-based assessment, evaluation of the potential survival of archaeological deposits within the current Proposal Area at Killingholme has relied on ground investigation works: geophysical survey and coring.

1.89 The geophysical survey identified a number of ferrous anomalies, one of which has been correlated with a known 20th-century wreck site. Further identification of the remaining targets would require use of sonar or diving; until such further identification has taken place, it is not yet possible to suggest specific mitigation measures pertaining to, say, the discovery of a wreck-site or aircraft wreckage, though only three anomalies lie close enough to the planned marine terminal to be directly affected by its construction.

1.90 The coring recorded the presence of intermittent peat lenses or laminations in sand and gravel layers cored in relatively deep water, over 800m out from the shore. These lie at some distance from the planned marine terminal itself and are not liable to be directly affected by construction. It is, however, desirable that the origin and date of these peat deposits is established; mitigation would involve specialist analysis of suitable sub-samples of the cores already taken and, if the results justify it, from suitable samples from any subsequent targeted coring.

1.91 The nature of the development precludes modifications to foundation design and location; with this being the case, the results of the assessment and the ground investigation works suggest that some archaeological investigation and recording may be required in advance of or during construction. This could take the form of archaeological recording and/or monitoring of adjacent on-shore works as well as palaeoenvironmental investigation of samples, combined with radiocarbon dating, to establish the character and date of buried peat or other significant deposits.

1.92 The written, drawn, photographic, artefactual and ecofactual data generated by any fieldwork will be collated into a site archive, from which reports will be generated presenting the results; though these will in the first instance take the form of unpublished client reports, where the results are of sufficient merit it may be appropriate that published accounts are produced, following any necessary post-fieldwork research or analysis. Upon completion of any such works, the site archive will ultimately be deposited in an appropriate local museum.

### *Residual effects*

1.93 The potential effects which the construction of the development would have on any surviving archaeological remains have been already been described above, effects considered as having **Minor** or **Moderate** adverse significance. The proposed mitigation measures will ensure that any such remains, if encountered before or during construction, would be adequately recorded. The proposed programme of mitigation takes the form of recording prior to (or during) construction, proceeding (as necessary) through to off-site assessment, research and analysis, resulting in the production of appropriate reports (including publications) and the eventual deposition of a site archive in a local museum. This will not only ensure the "preservation by record" of any archaeological remains which cannot be preserved in situ, but the knowledge gained will increase archaeological knowledge and understanding of the area.

1.94 It is considered, therefore, that the effective implementation of such mitigation measures will potentially result in a residual effect from development of **Minor beneficial significance** in the medium and long term.

## CONCLUSIONS AND RECOMMENDATIONS

1.95 The desk-based assessment resulted in the identification of 50 archaeological sites of varying grades of importance within the Study Area, a 7.6km2 area surrounding the Proposal Area. The totals of sites accorded grades were as follows:

A – 0
B – 3
B/C – 4
C – 35
N – 8

1.96 As can be seen, no sites of the highest grade of importance (A – national importance, equivalent to Scheduled Monuments and Grade I or II* Listed Buildings) were identified within the Study Area, though a significant number of sites of regional (B) or regional/local (B/C) importance were, varying from Grade II listed buildings through to Iron Age and Romano-British settlement sites and/or features identified by geophysical survey and trial excavation.

1.97 Should the project proceed to a full Environmental Impact Assessment, some additional works to enhance the current assessment would be required, principally including the carrying out of a walkover survey and an aerial photographic assessment.

1.98 Within the Proposal Area itself, no archaeological sites were identified, though the expectation is that other sites of **Local** or **Regional** importance, hitherto undetected, will potentially be present, perhaps including prehistoric settlement remains. The below-ground elements of the development, whether clearance of existing buildings and structures on the site, or construction, landscaping and infrastructure, could potentially affect archaeological remains and would have an effect of **Minor** or **Moderate** adverse significance.

1.99 Mitigation has been proposed (paras 1.88-1.91, above) and is re-iterated below; the highlighted elements could sensibly be recommended to take place if the project was to proceed to a full Environmental Impact Assessment:

- **The geophysical survey identified a number of unidentified ferrous anomalies, the further identification of which would require use of sonar or diving.**

- **The coring recorded the presence of intermittent peat lenses or laminations in sand and gravel layers cored in relatively deep water, over 800m out from the shore. It is desirable that the origin and date of these peat deposits is established through specialist analysis of suitable sub-samples of the cores already taken or from any subsequent targeted coring.**

- The results of the assessment and the ground investigation works suggest that some archaeological investigation and recording may be required in advance of or during construction, which could take the form of archaeological recording and/or monitoring of adjacent on-shore works as well as palaeoenvironmental investigation of soil samples.

- The written, drawn, photographic, artefactual and ecofactual data generated by any fieldwork will be collated into a site archive, from which reports will be generated presenting the results; where these are of sufficient merit it may be appropriate that published accounts are produced, following any necessary post-fieldwork research or analysis. Upon completion of any such works, the site archive should be deposited in an appropriate local museum.

1.100 The proposed mitigation will enable the proper recording of any affected remains immediately prior to or during construction, with the added benefit this will potentially bring of the recovery of new archaeological information about the area. It is considered that the implementation of such mitigation measures will result in a residual effect from development of **Minor** beneficial significance.

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# GAZETTEER

***Abbreviations***

PRE – prehistoric
PAL – palaeolithic
MESO – mesolithic
NEO – neolithic
BA – Bronze Age
IA – Iron Age
RB – Romano-British
AS – Anglo-Saxon/early medieval
MED – medieval
PMED – post-medieval
MOD – modern
UNK – Uncertain
NAT – natural

N – north; E – east; S – south; W – west

BGS – British Geological Survey
EH – English Heritage
HFA – Humber Field Archaeology
NLSMR – North Lincolnshire Sites and Monuments Record
HWP – Humber Wetlands Project
LB – Listed Building
LAS – Lindsey Archaeological Services
LBR – Listed Buildings Register
NMR – National Monuments Record
OS – Ordnance Survey
ASWYAS – Archaeological Services (West Yorkshire Archaeology Service)

| Gaz Ref | Name | PARISH | Record Type | Summary | Period | Easting | Northing | SMRUID | NMR UID | Other Refs | Importance | Sources |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | BARTON AND IMMINGHAM LIGHT RAILWAY | NORTH AND SOUTH KILLINGHOLME | Monument | The Barton and Immingham Light Railway was authorised in 1907 to give direct access from Hull to Immingham via New Holland. It ran from a junction with the New Holland line at Goxhill to join the Humber Commercial Railway at Immingham, and comprised a single line. It opened in 1910/1911 and closed in 1963. | MOD | 510000 | 421000 | MLS8827 | 1365564 | | C | NMR |
| 2 | RB OCCUPATION SITE, KILLINGHOLME HAVEN | NORTH KILLINGHOLME | Monument | RB site discovered in late 1960s on construction site of Gas Plant. Four hearths, two with burnt bone, were noted, together with "evidence of closely set vertical stakes." Finds include greywares, shell-gritted, mortaria, Samian wares dating from the 1st century AD. | RB | 515750 | 419650 | MLS1623 | | | B/C | |
| 3 | FLINT FLAKES, E. OF HAVEN ROAD | NORTH KILLINGHOLME | Findspot | Four flakes, three of till A flint and one of till B flint, recovered during HWP fieldwalking. Two are recorticated. Only one is complete and three have some post-depositional damage. One has a cortical striking platform and a pronounced bulb of percussion. Two are secondary flakes and two are tertiary removals. One has been utilised along the edges. | PRE | 515880 | 419700 | MLS19798 | | ELS1688 | C | NLSMR |
| 4 | ROMANO-BRITISH ENCLOSURE AND DITCHES | NORTH KILLINGHOLME | Monument | A geophysical survey was carried out in 2004 by WYAS, in advance of a proposed storage and distribution facility for Able UK. At the western end of Block 1 of the survey, a cluster of weak anomalies, some curvilinear, were detected. They were thought to be archaeological in origin, being caused by infilled ditches and gullies. Some of these ditches appeared to form part of a small enclosure.<br><br>An archaeological evaluation carried out in 2005 by WYAS recorded a small number of features, though it was during a subsequent episode of archaeological recording in advance of the Clough Road realignment in 2005 where the most significant discoveries were made. Area 'B', measuring 70m by 25m, was stripped of topsoil, mapped and recorded and six phases of archaeological activity were identified. Phase 1 consisted of two truncated gullies, undated. Phase 2 was represented by a ditch and two pits, the fills of which contained 2nd century AD pottery. The Phase 3 ditches and gullies were mainly on a N-S orientation, the main ditch being exposed for 23m. Its the two fills contained animal bone and 2nd - 3rd century AD pottery, and a high proportion of charcoal in the recut. A 5.5m section of ditch to the south may have been the same ditch with an entrance gap in between. Phase 4 was dominated by a significant E-W boundary ditch, which may relate to the enclosure detected on the geophysical survey. It was exposed for 35m, and measured up to 1.5m wide and 0.6m deep. There were up to three fills, containing pottery dating to no later than the 3rd century AD. At the eastern end, this ditch cut through an earlier one in the same phase. There was a second, parallel ditch to the south, and in the south-eastern corner was another ditch on the same alignment, containing pottery of a similar date. In plan the features suggested a possible enclosure, although there were no internal features.<br><br>Phase 5 features were generally on the same alignments as Phase 4. A curvilinear ditch followed the N-S section of the possible enclosure for about 6m, then turning E-W and ending with a square terminus. A wide variety of pottery types from the fills indicated that the ditch was open in the 3rd and 4th century AD. This, and the presence of carbonised grain, suggested the highest levels of human activity in Area B. Located to the south of the main E-W Phase 4 alignments, | RB | 515990 | 419420 | MLS20144 | 1496344 | ELS2197, ELS2244, ELS2943, ELS2362 | B/C | |

| Gaz Ref | Name | PARISH | Record Type | Summary | Period | Easting | Northing | SMRUID | NMR UID | Other Refs | Importance | Sources |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | were two parallel ditches, also E-W. The larger southern ditch was up to 1.5m wide and 0.2m deep, recut at the eastern end. The other was up to 1.0m wide and 0.3m deep. They both crossed an 8m long N-S ditch that may have been cut earlier in the same phase. Phase 6 consisted of only four features - three gullies and a pit – which may have been medieval or post-medieval in date. | | | | | | | | |
| 5 | FLINT CORE, E. OF HAVEN ROAD | NORTH KILLINGHOLME | Findspot | Part of a core of till A flint with at least eight blade-like flakes removed from a single plain striking platform, recovered during HWP fieldwalking. The worked edge also appears to have been used as a scraper. | PRE | 515990 | 419280 | MLS19797 | | ELS1688 | C | NLSMR |
| 6 | HISTORICALLY IMPORTANT HEDGEROWS | NORTH KILLINGHOLME | Landscape | Historically important hedgerows (pre 1840), North Killingholme parish | PMED | 516000 | 418000 | MLS20569 | | ELS1777; ELS2739; ELS2742 | C | NLSMR |
| 7 | ROMAN POTTERY SHERD | NORTH KILLINGHOLME | Findspot | A single body sherd in Roman greyware, recovered during HWP fieldwalking. | RB | 516020 | 419300 | MLS19796 | | ELS1688 | C | NLSMR |
| 8 | POSSIBLE LINEAR DITCHES | NORTH KILLINGHOLME | Monument | Three linear ditches, south of Haven Road, detected by geophysical survey in 2003 and 2004. No trace found during WYAS evaluation in 2005. | UNK | 516060 | 419400 | MLS20139 | | | N | NLSMR |
| 9 | GEOPHYSICAL ANOMALIES | NORTH KILLINGHOLME | Monument | A geophysical survey was carried out in 2004 by Stratascan, in advance of a proposed storage and distribution facility for Able UK. Two curvilinear anomalies were located in the southern section of survey area 2. Their origins are uncertain, but they may have an archaeological origin. Also within this section were several small 'area' anomalies, which may relate to cut features such as pits. Further anomalies of this types were also present in the southern part of the central survey area. At least one anomaly is in the same position as a post-medieval field boundary. | UNK, PMED | 516080 | 419050 | MLS20148 | | ELS2243 | C | NLSMR |
| 10 | FARM BUILDINGS (SITE OF) | NORTH KILLINGHOLME | Monument | Unnamed range of buildings shown on OS 1st and 2nd edn. maps. The buildings are gone but a well is shown in the same position on OS 1945 edition 6" map. A geophysical survey was carried out in 2003 by ArchaeoPhysica Ltd, in advance of a proposed storage and distribution facility for Able UK detected anomalies which were detected as disturbance due to tipping, but are likely to be associated with demolition of the buildings. | PMED | 516110 | 419300 | MLS20138 | | ELS2244 | C | NLSMR |
| 11 | NAVAL OIL DEPOT (SITE OF), NORTH KILLINGHOLME HAVEN | NORTH KILLINGHOLME | Monument | The North Killingholme Royal Naval oil storage depot may have been established just before the outbreak of the first World War. It consisted of 35 steel tanks, each about 24m in diameter. The tanks were clad in a protective outer skin of brick, with steel mesh and concrete within the cavity. All tanks now demolished. | MOD | 516200 | 420200 | MLS15395 | | | C | NLSMR |
| 12 | FORMER SHORELINE | NORTH KILLINGHOLME | Monument | Geophysical surveys in 2003 and 2004 detected a system of buried channels and creeks which appeared to mark a former high water position. Deposits interpreted as the buried shoreline were also recorded during archaeological evaluations in 2004 and 2005. Interestingly, the possible shoreline runs roughly parallel to the western limit of alluvium shown on the BGS map, lying 50-100m to the east. | UNK | 516217 | 419354 | MLS20141 | | | C | NLSMR, BGS |
| 13 | IRON AGE ENCLOSURE | | Monument | In advance of a proposed vehicle storage and distribution facility for Able UK, Areas D2 and D3, a geophysical survey in 2003 detected a cluster of ditch type anomalies representing one side of a rectangular enclosure, with a width of 27 metres. Fragmentary anomalies were also detected inside the enclosure, which may have been sited on a low rise above wetter ground. An archaeological evaluation was subsequently carried out by Archaeological Services WYAS in June 2004. Crossing were targeted to investigate the enclosure which was detected by geophysical survey. They revealed that the archaeological deposits were sealed beneath a thick layer of estuarine alluvium, to a maximum depth of 2.56m OD.<br><br>The northern enclosure ditch was 2.42m wide, aligned east-west. 10.2 metres to the south was a larger, parallel ditch, measuring 3.55m wide., and a further parallel ditch was observed 26.5m to the south of the second, and was about the same width (4m); it was 1m deep. Within the area bounded by the enclosure ditches, a curvilinear feature was exposed which was interpreted as the drip gully of a roundhouse. It was between 0.65m and 2.25m wide, and may have been re-cut. The fill contained occasional bone and frequent pottery. Two post holes were located at the east of the circumference of the gully, suggesting an entrance. Other post or stake holes in the vicinity appeared to define two sides of a possible porch. The eastern edge of the gully was truncated by a north-south ditch, 1.25m wide and up to 0.75m deep. It may represent an internal division within the enclosure, created after the roundhouse had fallen out of use. The western arm of the main enclosure ditch, 4.22m wide, was also located, and further east, inside the enclosure, were recorded pits and postholes. The eastern enclosure ditch, 2.3m wide, had not been detected by the geophysical survey due to the thick deposit of alluvium overlying it.<br><br>Of the 277 sherds of hand-made Iron Age pottery, the majority were stone-tempered pottery, hard fired and reduced, with some exterior oxidation, the dominant form being the jar, some examples paralleling those from Phase 2 at Weelsby Avenue, which have been dated to Middle Iron Age. | IA | 516240 | 419160 | MLS20140 | | ELS2193, ELS2521 | B/C | NLSMR |
| 14 | FLINT IMPLEMENT | NORTH KILLINGHOLME | Findspot | Trial trench evaluation by LAS at Area G of the Vehicle Redistribution and Storage Facility recorded no archaeological features, though a residual ?Palaeolithic flint implement was recovered. | ?PAL | 516300 | 418700 | ELS2407 | 1496352 | | C | NMR |
| 15 | FLINT FLAKES, E OF ROSPER ROAD | NORTH KILLINGHOLME | Findspot | Five secondary flakes of recorticated till A flint. Three are patinated and three have some post-depositional damage. Most have been utilised and are worn along the edges. Found during HWP fieldwalking. | PRE | 516350 | 418700 | MLS19802 | | ELS1701 | C | NLSMR |

| Gaz Ref | Name | PARISH | Record Type | Summary | Period | Easting | Northing | SMRUID | NMR UID | Other Refs | Importance | Sources |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 16 | IRON AGE ENCLOSURE, DITCHES AND PITS | NORTH KILLINGHOLME | Monument | A geophysical survey was carried out in 2005 in advance of a proposed vehicle storage facility for Able UK, 2005. A probable Iron Age/Romano-British enclosure complex was detected (in Area 'E'). It was ovoid in shape, measuring 65m by 45m, with an internal ditch dividing the enclosure into two discrete areas. Other short linear ditches were detected both inside and outside the enclosure, and pits and/or areas of burnt material were also detected within the enclosure.<br><br>Subsequently, forty-six evaluation trenches were excavated by LAS, with Trenches 3-10 targeting the enclosure and associated features. In the north-western quarter of the enclosure, the main ditch was found to be 5m wide and in excess of 1.5m deep, having been re-cut on at least five occasions, moving progressively east to west. To the east of the main ditch was a sub-rectangular pit, containing much charcoal, a linear north/south ditch, another pit and a northwest-southeast aligned ditch, cut by a wider and shallower ditch on a different alignment. A curvilinear ditch was also recorded, which may have been the drip gully of a circular building (roundhouse).<br><br>The main ditch in the south-eastern part of the enclosure had been re-cut four times. The earliest ditch cut contained middle Iron Age pottery, while the first and third re-cuts both contained late Iron Age and Roman pottery, while the single fill of the final recut again containing middle Iron Age pottery. East of the main ditch, within the enclosure, was recorded a length of curvilinear gully with a terminal, while a north-south ditch visible on the geophysics, was confirmed and may have been part of a rectangular enclosure within the main enclosure.<br><br>A trench located within the south eastern quarter of the enclosure, recorded a series of intercutting ditches, while another positioned to investigate the terminal of a ditch on the east side of the enclosure also recorded curving ditch containing RB pottery of 2nd century AD. Further 2nd-century pottery was recovered from a ditch lying outside the enclosure and to the east of it.<br><br>Subsequently open area excavation established that the archaeological remains consisted of two enclosures and three roundhouses but the full extent of the settlement was not established within the excavation area with activity extending both to the east and west beyond the limit of excavation. All activity here has been dated to some time within the Late Iron Age (3rd to 1st century BC) representing settlement development of unknown duration within this period. Three sub-phases were identified of small scale changes within an essentially static farmstead.<br><br>The Iron Age pottery ranges from the middle to Late Iron Age, with erratic-tempered ware and slag-tempered ware the predominent types, as at Weelsby Avenue (Grimsby). Shell gritted wares, normally more abundant on Lincolnshire sites, take second place, and are mostly later in date. At least one type is known to occur in the 1st and 2nd centuries AD. The Roman pottery included a rusticated jar fragment of the late 1st-early/mid 2nd century, a curved rim jar of the early-mid 2nd century, and a lid-seated jar of the same date. A single sherd of Samian ware was from a mid 2nd century cup. There were no Roman sherds later than this date. | IA, RB | 516355 | 418823 | MLS20441 | 1496353 | ELS2408 | B/C | NMR, NLSMR |
| 17 | FLINT FLAKES, E OF ROSPER ROAD | NORTH KILLINGHOLME | Findspot | Four flakes and a chunk of till A flint, found during HWP fieldwalking. Two are recorticated and patinated, one is complete and two have some post-depositional damage. One flake has a plain striking platform and a diffuse bulb of percussion. Three are secondary flakes and one is a tertiary removal. | PRE | 516360 | 418940 | MLS19800 | | ELS1697, ELS1703 | C | NLSMR |
| 18 | MESOLITHIC TO EARLY BRONZE AGE FLINT | NORTH KILLINGHOLME | Findspot | A small assemblage of 27 pieces of worked flint, found in 8 trial trenches during an evaluation carried out by LAS for Able UK. The majority of the flint was found in Trenches 3 and 7, located on the slightly higher ground in the north-western corner of the application area. The assemblage comprised 2 scrapers, 1 scraper/knife, 11 flakes, 1 notched piece, 1 retouched piece, 2 retouched flakes, 1 blade, 2 blade-like flakes, 1 core and 5 pieces of debitage. | MESO, NEO, BA | 516370 | 418810 | MLS20440 | | ELS2408 | C | NLSMR |
| 19 | FLINT FLAKE, E. OF ROSPER ROAD | NORTH KILLINGHOLME | Findspot | A complete secondary flake of till B flint, with a plain striking platform, a pronounced bulb of percussion and some post-depositional damage. Found during HWP fieldwalking. | PRE | 516380 | 418470 | MLS19803 | | ELS1702 | C | NLSMR |
| 20 | BARRAGE BALLOON ANCHORAGE (SITE OF) | NORTH KILLINGHOLME | Monument | A barrage balloon site, operated by 942 Squadron Balloon Command, was located on marshland south of Haven Road. Access was by a specially constructed track, 900 yards long. This was required to carry a winch lorry over a dyke to a turning circle. A shelter was also constructed at the end of the track, later used to store farm equipment. Exact site unknown. | MOD | 516400 | 419000 | MLS21228 | | | C | NLSMR |
| 21 | BARRAGE BALLOON ANCHORAGE (SITE OF) | NORTH KILLINGHOLME | Monument | The general location of a barrage balloon anchorage, operated by 942 Squadron Balloon Command during WW II. Exact site unknown. | MOD | 516400 | 418600 | MLS21227 | | | C | NLSMR |
| 22 | POSSIBLE LINEAR DITCHES | NORTH KILLINGHOLME | Monument | A geophysical survey was carried out in 2004 by Stratascan, in advance of a proposed storage and distribution facility for Able UK. In the southern section of survey area 1, several positive and negative linear anomalies were detected. Three parallel anomalies, the central one negative, run in a N-S orientation. To the west of these, two parallel positive anomalies run on a NE-SW alignment. Their linear form might indicate a man-made origin. ?Not tested by subsequent evaluation. | UNK | 516470 | 419340 | MLS20147 | | | C | NLSMR |
| 23 | KILLINGHOLME BATTERY | NORTH KILLINGHOLME | Monument | Killingholme Battery was built to defend the port of Killingholme on the Humber estuary. It opened between 1915-1916 and by February 1916 was equipped with two quick-firing 12 pounder guns emplaced on two octagonal concrete towers. The guns were removed in 1919 and the site was | MOD | 516480 | 420050 | MLS8195 | 1321225 | 1216169, 1356984, 1419808 | C | NMR |

| Gaz Ref | Name | PARISH | Record Type | Summary | Period | Easting | Northing | SMRUID | NMR UID | Other Refs | Importance | Sources |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | disused in 1926. The battery was demolished in 1998; drawn and photographic surveys undertaken before and during demolition. | | | | | | | | |
| 24 | FLINT FLAKES, E OF ROSPER ROAD | NORTH KILLINGHOLME | Findspot | Three secondary flakes of till A flint, two having some post-depositional damage. Found during HWP fieldwalking. | PRE | 516490 | 418780 | MLS19801 | | ELS1701 | C | NLSMR |
| 25 | OPEN FIELD SYSTEM | NORTH KILLINGHOLME | Monument | Ridge and furrow | MED | 516500 | 418150 | MLS20098 | | ELS1780; ELS2228; ELS2243; ELS2742 | C | NLSMR |
| 26 | HISTORIC HEDGEROW | NORTH AND SOUTH KILLINGHOLME | Hedgerow | A hedgerow which forms the parish boundary between North and South Killingholme, east of the refinery, is shown on enclosure maps, and may be medieval in origin. | MED/PMED | 516505 | 417943 | MLS20121 | | ELS2225; ELS1777; ELS2240 | C | NLSMR |
| 27 | FLINT FLAKE, E. OF ROSPER ROAD | NORTH KILLINGHOLME | Findspot | A tertiary flake of till A flint with a hinge termination, found during HWP fieldwalking. | PRE | 516590 | 418970 | MLS19805 | | ELS1710 | C | NLSMR |
| 28 | ROMAN SHERD, E OF ROSPER ROAD | NORTH KILLINGHOLME | Findspot | A single body sherd in Roman greyware, found during HWP fieldwalking. | RB | 516600 | 418880 | MLS19804 | | ELS1709 | C | NLSMR |
| 29 | ROMAN SHERD, N OF STATION ROAD | NORTH KILLINGHOLME | Findspot | Single greyware sherd, north of Station Road, 1999 | RB | 516660 | 418230 | MLS19806 | | ELS1711 | C | NLSMR |
| 30 | ROMAN SHERD, S OF STATION ROAD | SOUTH KILLINGHOLME | Findspot | Single greyware sherd, south of Station Road, 1999 | RB | 516720 | 417960 | MLS19807 | | ELS1713 | C | NLSMR |
| 31 | FLINT CORE, 3 FLAKES, S OF STATION ROAD | SOUTH KILLINGHOLME | Findspot | A core and three flakes were found near Killingholme Marshes during HWP fieldwalking. Two pieces are of till A flint and two of till B flint. One is recorticated and two are complete. The core is a late Mesolithic blade core with two plain striking platforms; one large platform has at least 18 blade-like removals and the second has at least seven flakes removed (Figure 7.7). The core retains a small patch of cortex at the distal end. One flake is blade-like and may be of a similar date to that of the core. One flake has a plain striking platfonn and one has a shattered platfonn. One has a pronounced bulb of percussion and one has a flat bulb. One flake is utilised. All three are secondary flakes. Two of the flakes are likely to be of a later date than the core and the blade-like flake, possibly dating to the Bronze Age period. | MESO/BA | 516840 | 417910 | MLS19726 | | ELS17137 | C | NLSMR |
| 32 | BRICK AND TILE YARD (SITE OF) | NORTH KILLINGHOLME | Monument | Site of a brickworks. Brick and Tile Yard' with 'Jetty' and 'footbridge' printed and shown on OS 25" first edition map. 'Brick & Tile Works' with 'Jetty' and 'Windpump' printed and shown on OS 25" second edition map. | MOD | 516880 | 419660 | MLS20136 | | | C | NLSMR |
| 33 | FLINT SCATTER, N OF STATION ROAD | NORTH KILLINGHOLME | Findspot | A scraper, two cores, nine flakes and a chunk were found to the west of Killingholme Marshes during HWP fieldwalking. Eight pieces are of till A flint and five of till B flint. Two are recorticated. Three pieces are complete and two have some post-depositional damage. The scraper is on an incomplete secondary flake that retains about 30% cortex. It has abrupt retouch along the distal section of the left edge. Both cores are incomplete, but still show evidence for rejuvenation. They both have one striking platform from which flakes have been removed. One has at least 13 flakes removed and the other at least 16. One of the flakes is a core rejuvenation piece, which has removed a large plain striking platform from a core. It has a cortical striking platform and a pronounced bulb of percussion. Two flakes have plain striking platforms and diffuse bulbs of percussion, and two have hinge terminations. Seven flakes are secondary removals and one is a tertiary flake. The only piece within this assemblage that is likely to be datable is a blade-like flake that could date from the Neolithic period. However, this piece is out of character amongst the rest of the assemblage, which is more likely to be of a later date. | NEO/BA | 516900 | 418200 | MLS19727 | | ELS1711 | C | NLSMR |
| 34 | HISTORICALLY IMPORTANT HEDGEROWS | SOUTH KILLINGHOLME | Landscape | Historically important hedgerows (pre 1840), South Killingholme parish | PMED | 517000 | 417000 | MLS20570 | | ELS1777, ELS2739; ELS2742 | C | NLSMR |
| 35 | KILLINGHOLME STATION | SOUTH KILLINGHOLME | Building | Site of railway station on the Barton and Immingham Light Railway opened in 1910 and closed in 1965. Now Station House. | MOD | 517300 | 418300 | | 498356 | NBR 3008 | C | NMR |
| 36 | CROPMARK ENCLOSURE | SOUTH KILLINGHOLME | Monument | Cropmark, visible on an aerial photograph, may represent an enclosure with a double ditched trackway to the east. Of unknown date. | UNK | 517370 | 417810 | MLS20789 | | | C | NLSMR |
| 37 | KILLINGHOLME MARSHES HEAVY ANTI AIRCRAFT BATTERY | NORTH KILLINGHOLME | Monument | General location for the site of a First World War heavy anti aircraft battery at Killingholme Marshes which was armed with two 6-pounder Hotchkiss guns, one 1-pounder gun on a Naval carriage, and one 1-pounder gun on a travelling carriage in 1916. A 12-pounder 12-hundredweight gun was listed here in 1917. | MOD | 517400 | 418600 | | 1473796 | | C | NMR |
| 38 | FLINT FLAKE, N OF STATION ROAD | NORTH KILLINGHOLME | Findspot | Single flint flake, north of Station Road, 1999 | NEO | 517500 | 418590 | MLS19808 | | ELS1733 | C | NLSMR |
| 39 | OPEN FIELD SYSTEM | SOUTH KILLINGHOLME | Monument | Ridge and furrow plotted from air photographs. Includes an area of narrow ridge and furrow, east of Rosper Road, which is assumed to be of post-medieval date. | MED/PMED | 517500 | 417300 | MLS20104 | | ELS1785; ELS2742 | C | NLSMR |
| 40 | KILLINGHOLME NORTH LOW LIGHTHOUSE | SOUTH KILLINGHOLME | Building | Killingholme North Low Lighthouse GV II Lighthouse and adjoining lighthouse keeper's house, now house. Built 1851 by William Foale for Trinity House, with later alterations and additions to rear. The lighthouse was used as a signal station for trawlers until 1920. Date of erection and names of wardens recorded on plaque on nearby Killingholme High Lighthouse. Grade II listed. | PMED | 517778 | 418443 | MLS8618 | | LB 165872; DSL888; ELS2739 | B | NLSMR |
| 41 | KILLINGHOLME HIGH LIGHTHOUSE | SOUTH KILLINGHOLME | Building | Killingholme High Lighthouse GV II Lighthouse. Established 1831, rebuilt 1876-7 for Trinity House. Lighthouse, no longer manned, is used in conjunction with the nearby Killingholme South Low Lighthouse to guide shipping in the Humber, and in the C19 was a link in the Hull Telegraph. Grade II listed. | PMED | 517834 | 418214 | MLS8617 | | LB 165871; DLS887; ELS2739 | B | NLSMR |
| 42 | KILLINGHOLME SOUTH LOW | SOUTH KILLINGHOLME | Building | Lighthouse. 1836 by Francis Dales for Trinity House. Brick, rendered and colourwashed. 4-storey | PMED | 518011 | 418148 | MLS8619 | | LB 165873; DLS1362; | B | NLSMR |

| Gaz Ref | Name | PARISH | Record Type | Summary | Period | Easting | Northing | SMRUID | NMR UID | Other Refs | Importance | Sources |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | LIGHTHOUSE | | | tapered round tower approximately 15 metres high, with small rectangular projections on south face. Plain recessed board door to south. Recessed louvred openings to ground and first floors. 6-pane casements to 2nd floor. Projecting timber joists support balcony to top floor with plain iron railings. Top floor has plinth and wide 18-pane east-facing window (partly painted over). Ribbed dome with scalloped eaves, capped with squat cylindrical ventilator. Projecting stack with cornice and 3 cylindrical pots. Lighthouse, no longer manned, is used in conjunction with the nearby Killingholme High Light (q.v.) to guide shipping in the Humber. Date of erection and names of wardens recorded on plaque of Killingholme High Lighthouse. Grade II listed. | | | | | | ELS2739 | | |
| 43 | CATHARINE 1827 | | Wreck | On 3rd April 1827, ship Catharine (possibly Norfolk registered) collided with CATHARINA MAGDALENA (from Germany) on an area of the Humber opposite Killingholme known as Whitebooth Roads. The Catharine sank in deep water, though the crew was saved. N 53 39.80 W 000 12.50 (named location). | MOD | | | | 1304735 | | N | NMR |
| 44 | BARGE, COOK S26, 1955 | | Wreck | Remains of a salvaged barge, reported sunk in 1955, salvaged 1959; reportedly 8.8m depth 1977. N 53 39.008 W 000 12.259 (centre point). Marked on Admiralty chart. Detected by geophysical survey June 2010. | MOD | | | | 907862 | | C | NMR |
| 45 | NEWLAND 1928 | | Wreck | 5th September 1928, cargo vessel Newland caught on Holm Sand, taking in water, some cargo saved, but eventually wrecked. N 53 39.80 W 000 12.50 (named location) | MOD | | | | 1357695 | | N | NMR |
| 46 | ATALANTA 1831 | | Wreck | On 19th March 1831, the cargo vessel Atalanta was totally wrecked on sands near Hull, all crew lost. Named location “Offshore Kilingholme”. N 53 39.80 W 000 12.50 (named location) | MOD | | | | 1358152 | | N | NMR |
| 47 | FAIRY 1833 | | Wreck | A wooden sailing vessel, Fairy, wrecked in 1833 when stranded on Holme Spit during a gale, while en route from Newcastle-upon-Tyne to Gainsborough. N 53 39.80 W 000 12.50 (named location). | MOD | | | | 1431654 | | N | NMR |
| 48 | SERGEI 1899 | | Wreck | Dispersed remains of 1923 wreck of English cargo vessel which foundered in the River Humber following collision. This steel steam vessel, built 1899, was en route from Malmo to Kingston upon Hull with pit props. The sunken vessel was raised and broken up in 1924 and it was reported to be no less than 42ft of water over the wreck. N 53 39.000 W 000 13.000 (centre point) | MOD | | | | 907861 | | N | MNR |
| 49 | IVY, ENGLISH KETCH, 1897 | | Wreck | Vessel was on a fishing trip when she foundered and was lost following collision in wind conditions W force 2, with the Goole registered SS COREA. N 53 39.00 W 000 13.00 (named location). | MOD | | | MLS20122 | 943015 | | N | NMR |
| 50 | WILLIAM, ENGLISH SLOOP 1883 | | Wreck | Vessel foundered and lost following collision with the Hull registered steam trawler ORINOCO. | MOD | | | MLS20123 | 943096 | | N | NMR |

East Halton

North Killingholme

Killingholme Marshes

SOUTH KILLINGHOLME CP

River Humber

Key

Study area

Edge of alluvium

23 Gazetteer reference

Parish boundary

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43, 45-47 44 48-50

*scale 1: 16 000*

*Figure 1 Gazetteer*

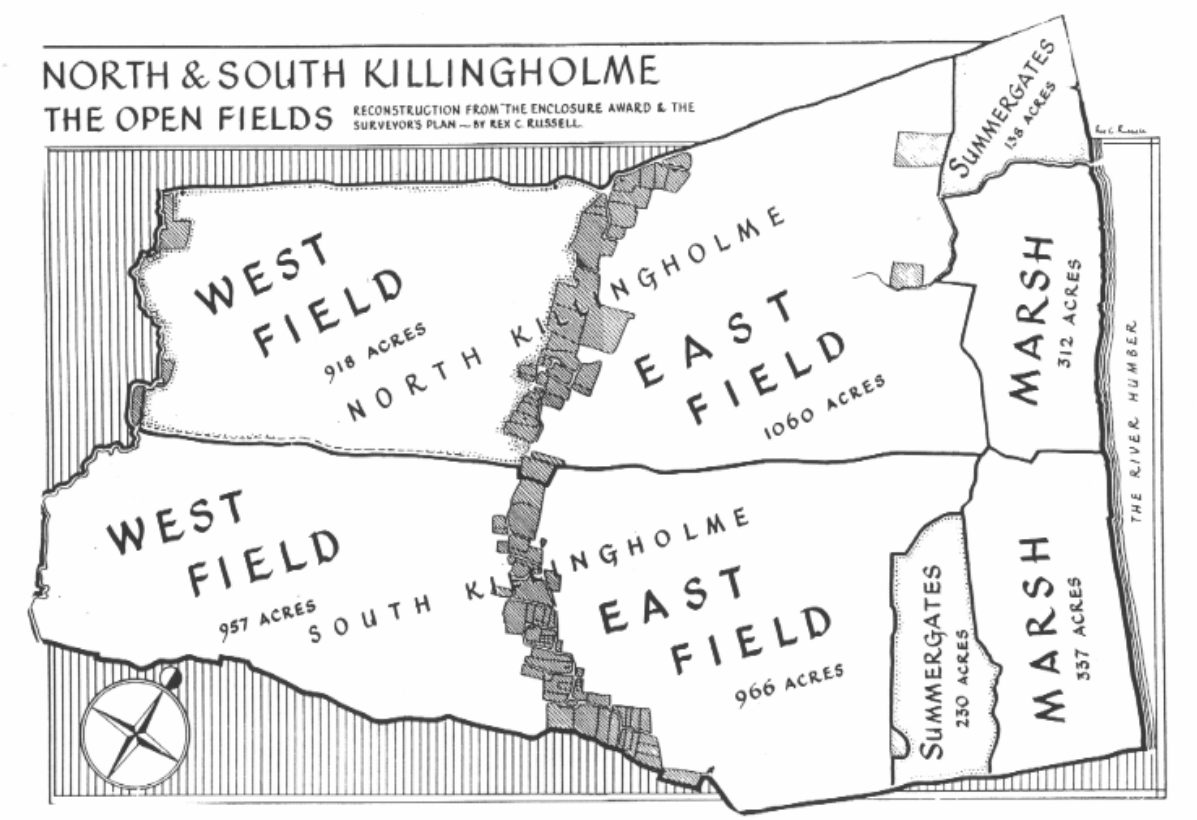


**Figure 2:** The Open Fields of North and South Killingholme before the Enclosure Act of 1776, after Russell (1982).

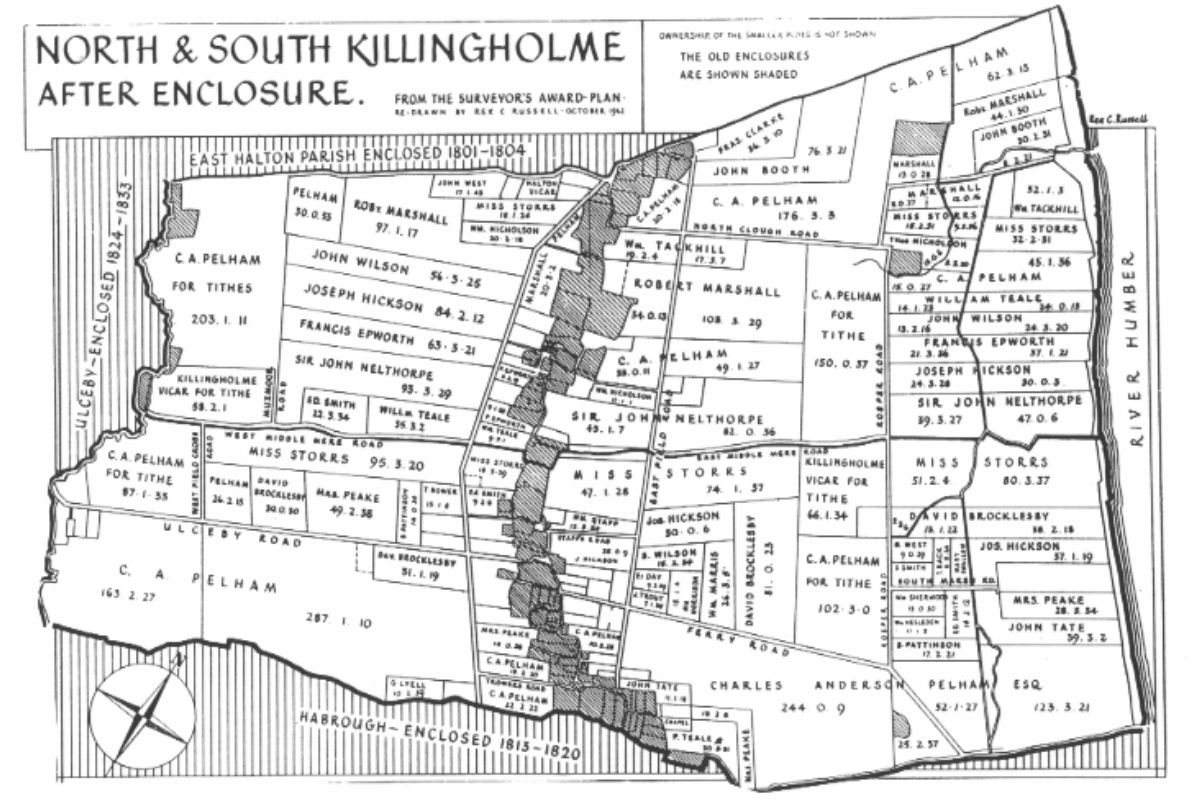


**Figure 3:** North and South Killingholme post Enclosure, after Russell (1982).

# APPENDIX 1: Geophysical survey

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# North Killingholme Geophysical Report

# for

# Vinci Construction

| | |
|---|---|
| Report No.: | 10/J/1/25/1695 |
| Issue Date: | 26th July 2010 |
| Emu Contact: | Rob Ferris |
| Emu Job No.: | J/1/25/1695 |

| Title: North Killingholme Geophysical Survey | | | |
|---|---|---|---|
| Report No. | : 10/J/1/25/1695 | | |
| Emu Job No. | : J/1/25/1695 | | |
| Client Name | : Vinci Construction | | |
| Client Contact | : Rob Rogers | | |
| Project Manager | : Robert Ferris | | |
| | | Signature | Date |
| Report written by | Rob Ferris | | |
| Report checked by | Ben Rainbow | | |
| Report authorised by | | | |
| Report Status | FINAL REPORT | | |
| Issue Date | 26/07/2010 | | |

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|---|---|---|
| | | |
| | | |

## EXECUTIVE SUMMARY

Emu Limited completed the geophysical data acquisition component of the North Killingholme survey. This consists of a single beam echo sounder survey recording the water depth across the site. A magnetometer survey to identify any potential ferrous objects including unexploded ordnance (UXO), a boomer survey to depict the shallow geology of the site in particular the distance from the seabed to the first detected acoustic interface thought to be the rock head.

The data was acquired using the Humber estuary harbour master's survey vessels. The acquisition period occurred from the 16th to 20th June 2010. The timing of the survey and lines run maximised the use of the high tide in order to survey as close to the shore as was practical and safe to do so.

The magnetometer survey highlighted a number of potential ferrous targets which are illustrated in the magnetometer chart. The shallow geology dataset shows a thickening of the over lying sediments away from the shore and into the south eastern extremity of the site.

# 1 INTRODUCTION

## 1.1 Scope of Work

For further information refer to document "P102-10-1036 Geophysical and Geotechnical Vibrocore Survey Humber".

## 1.2 Location

The surveyed site lies on the southern shore line of the Humber estuary offshore from the village of Killingholme.

Restrictions in the survey area were due to a number of factors. In the north western end of the site a power station water outlet/inlet restricted the survey area due to the practicality of surveying over such structures. The inner bound was limited by the water depth, the skipper of the survey vessel manoeuvred as close to the shore as safe and practical to do so, following the approximate four meter contour.

# 2 SUMMARY OF EVENTS

Table 1 outlines the key events for the geophysical survey operations. Daily Progress Reports (DPRs) were completed throughout the duration of the survey.

| Date | No. of days | Event |
|---|---|---|
| 15th June 2010 | 1 | Boomer survey |
| 16th, 19th, 20th June 2010 | 3 | Bathymetry and magnetometer survey |

**Table 1** **Summary of Survey Events**

# 3 METHODOLOGY

## Sub Bottom Survey Methodology

| SUB BOTTOM SURVEY | |
|---|---|
| **Requirement** | **Implementation** |
| Determine distance to rock head from seabed | Sub bottom boomer survey along lines at 50 m line spacing to provide profiles |
| **Data Collection** | |
| **Equipment:** | Applied Acoustics Boomer<br><br>20-element single-channel hydrophone<br><br>Coda Octopus DA2000 digital acquisition and processing system |
| **Methodology:**<br><br>Before the survey commenced, the boomer system was tested near the survey area to establish optimum, site-specific settings. The boomer catamaran and hydrophone were maintained at 25m astern throughout the survey. This layback was applied during post-processing. The recorded digital seismic data sweep time was 120 ms but a display range of 80ms was maintained for online data QA. Fixes were generated at 50m intervals and recorded within digital records. All settings and offsets were recorded in online logs. All data were logged digitally (.cod format) in the Coda Octopus DA2000 acquisition and processing system.<br><br>Post-processing and interpretation were carried out using Coda Octopus GeoSurvey. A combination of band-pass filters were used to remove noise and aid the interpretation. Rock head was interpreted and exported to a database. These were imported into ESRI ArcGIS where the data were contoured and quality checked. All interpreted points were converted from two-way travel time (TWT) to metres below seabed using a velocity of 1600 $ms^{-1}$. | |
| **Data Outputs** | |
| J.1.25.1697.02 Isopachyte map depicting distance from seabed to interpreted rockhead | |

**Table 2 Sub Bottom Survey Methodology**

## 3.1 Magnetometer Survey Methodology

| MAGNETOMETER SURVEY | |
|---|---|
| **Requirement** | **Implementation** |
| Magnetometer survey to identify ferrous objects, possibly unexploded ordnance (UXO). | Marine magnetometer survey with survey lines spaced at 10m |
| **Data Collection** | |
| **Equipment:** | Geometrics G-882/G-881 caesium-vapour magnetometer<br>MagLog acquisition software<br>Geosoft Oasis Montaj GIS and processing software |
| **Methodology:**<br><br>A pair of Geometrics caesium vapour marine magnetometers were utilised for this aspect of the survey. The towfish unit housed a total magnetic field sensor and provided absolute readings of total magnetic field in nanoteslas (nT).<br><br>The magnetometer towfish was towed a minimum of 60m behind the vessel. The altitude was maintained between 2 and 4 m above the seabed.<br><br>Following the survey, post-processing was carried out using Geosoft Oasis Montaj software. The magnetic field intensity was calculated by applying a polynomial filter to the raw data to calculate a trend. This curve was subtracted from the raw data to give the residual magnetic field intensity. An analytical signal grid was calculated for this residual which represented the square root of the sum of the derivatives in x, y and z directions (magnetic gradient). This was used to identify the edges of magnetic source bodies. Magnetic targets, or anomalies, were calculated from this grid. | |
| **Data Outputs** | |
| J.1.25.1697.02 | Magnetometer analytical signal grid |

**Table 3 Magnetometer Survey Methodology**

## 3.2 Single Beam Echo Sounder Survey

| Single Beam Echosounder SURVEY | |
|---|---|
| **Requirement** | **Implementation** |
| Measure the water depth over the site | A Knudson echo sounder was implemented to record the water depth |
| **Data Collection** | |
| **Equipment:** Knudsen 320M single beam echosounder | |
| **Methodology:**<br><br>A Knudsen 320M single beam echo sounder was used to collect water depths over the site, run simultaneously with the magnetometer.<br><br>The raw data collected was then corrected for tidal variations using tidal data supplied from Associated British Ports (ABP) tide gauge from Immingham. | |
| **Data Outputs** | |
| J.1.25.1697.04 | Bathymetric chart |

**Table 4 Echo sounder methodology**

# 4 RESULTS

Draft drawings have been provided with this preliminary report presenting the magnetometer analytical signal grid and sediment isopachyte chart.

## 4.1 Bathymetry

All depths are referenced to Chart Datum (CD) unless otherwise stated. Bathymetry data has been reduced using tidal data supplied from Associated British Ports (ABP) tide gauge from Immingham.

The water depth across the site varies from 4m (the minimum depth that was safe to survey to around 18m on the north eastern extremity of the site.

## 4.2 Magnetometer

All magnetometer data was collected at 10m line spacing using the G882/G881 magnetometers.

Seven significant magnetic anomalies and two smaller targets have been identified.

Target two on image one overleaf corresponds to a wreck which is recorded on the admiralty chart for the area.

The other 8 anomalies are identified as unknown ferrous objects, this means they could potentially be UXO or discarded ferrous objects from passing shipping.

The relative target sizes shown below are a unitless peak value to give a relative relationship between the various targets and can't be quantified to a physical dimension.

| Anomaly No | Easting | Northing | Rel Target Size | Comments |
|---|---|---|---|---|
| 1 | 684405 | 5948527 | 8.83 | Apparent large single object |
| 2 | 684658 | 5948245 | 12.62 | Wreck as shown on admiralty chart |
| 3 | 684219 | 5948205 | 9.47 | Apparently multiple objects |
| 4 | 685292 | 5947834 | 8.63 | Appears to be two objects close together or joined |
| 5 | 683566 | 5948791 | 12.58 | Strong singular signature |
| 6 | 683604 | 5949240 | 11.55 | Strong singular signature |
| 7 | 683539 | 5949089 | 11.41 | Apparently multiple objects |
| 8 | 685152 | 5947769 | 6.65 | Weak singular signature |
| 9 | 685547 | 5947530 | 10.4 | Strong singular signature |

There are two methods to further identify the targets. The first is by far the quickest and simplest, this would be to use side scan sonar to record a high resolution acoustic image of the site. This would then give the ability to visually recognise any surface lying or partially buried objects.

If further analysis was required and remote methods had been exhausted, divers could be sent down to visually identify the objects. This is not an easy process however within the Humber river due to the poor visibility and hazardous tidal streams

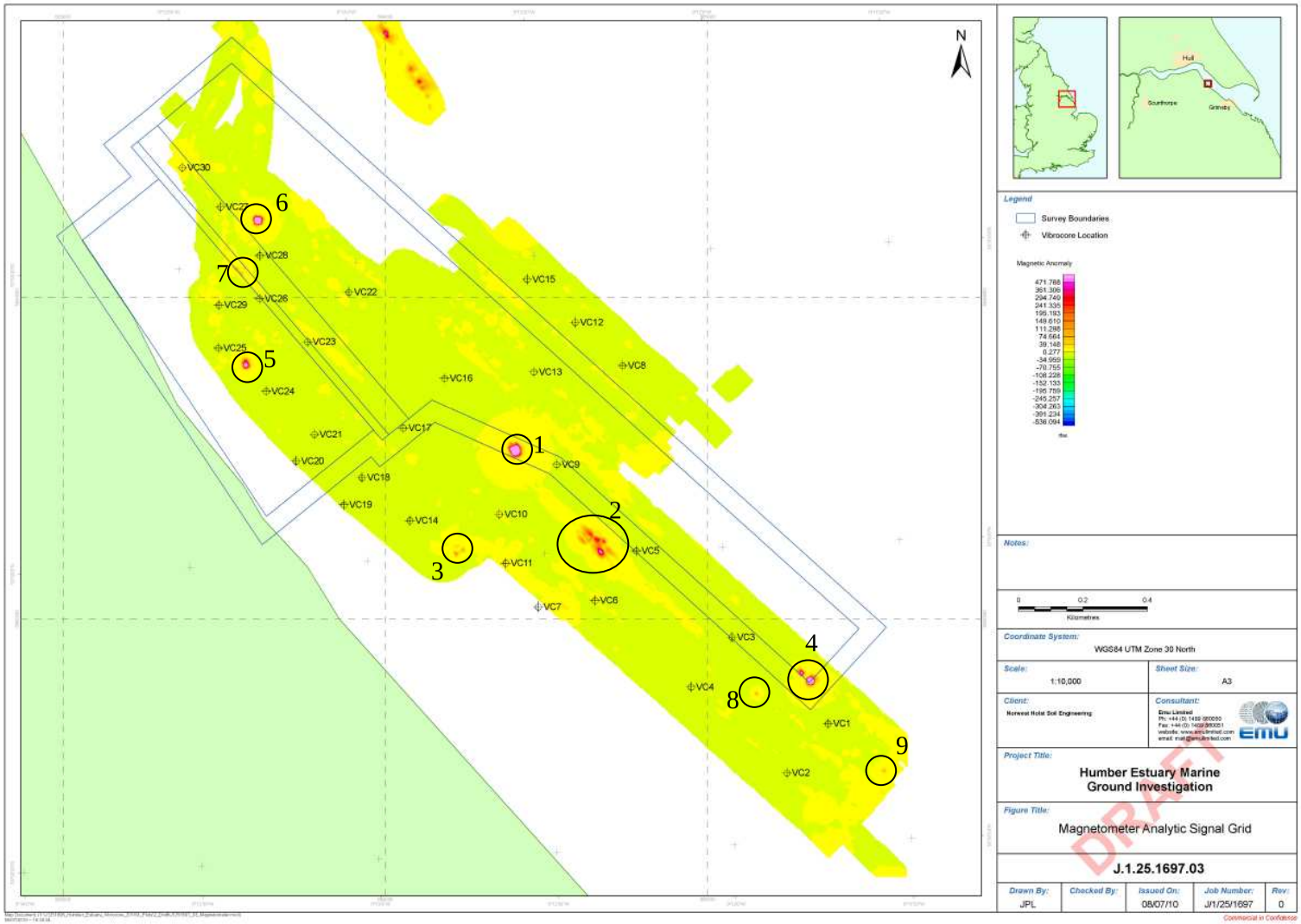


Image 1 Detected Magnetometer anomalies

## 4.3 Boomer

All depth results reported within this section have been converted from two-way travel time (TWT) to depth below seabed using an estimated seismic velocity of 1600 $ms^{-1}$.

The interpreted primary sub bottom interface probably depicting rock head (to be confirmed by the vibrocores) was calculated from the data set collected and varies from 3m at the shore end to 8m at the north eastern boundary of the site deepening in the centre of the site to around 14m from seabed.

## 4.4 Vibrocore locations

The table below shows the original vibrocore locations and the positions that were actually used due to seabed obstructions identified in the magnetometer survey.

| | Original | | Revised | | |
|---|---|---|---|---|---|
| **Vibrocore ID** | **Easting** | **Northing** | **Easting** | **Northing** | **Comments** |
| VC1 | 685374 | 5947675 | 685374 | 5947675 | Location unchanged |
| VC2 | 685246 | 5947522 | 685246 | 5947522 | Location unchanged |
| VC3 | 685076 | 5947944 | 685076 | 5947944 | Location unchanged |
| VC4 | 684949 | 5947789 | 684949 | 5947789 | Location unchanged |
| VC5 | 684779 | 5948212 | 684779 | 5948212 | Location unchanged |
| VC6 | 684651 | 5948058 | 684651 | 5948058 | Location unchanged |
| VC7 | 684375 | 5948038 | 684475 | 5948038 | **Moved 100m East** |
| VC8 | 684737 | 5948788 | 684737 | 5948788 | Location unchanged |
| VC9 | 684482 | 5948480 | 684532 | 5948480 | **Moved 50m East** |
| VC10 | 684354 | 5948326 | 684354 | 5948326 | Location unchanged |
| VC11 | 684224 | 5948174 | 684374 | 5948174 | **Moved 150m East** |
| VC12 | 684589 | 5948922 | 684589 | 5948922 | Location unchanged |
| VC13 | 684461 | 5948768 | 684461 | 5948768 | Location unchanged |
| VC14 | 684077 | 5948306 | 684077 | 5948306 | Location unchanged |
| VC15 | 684440 | 5949056 | 684440 | 5949056 | Location unchanged |
| VC16 | 684184 | 5948748 | 684184 | 5948748 | Location unchanged |
| VC17 | 684056 | 5948594 | 684056 | 5948594 | Location unchanged |
| VC18 | 683928 | 5948440 | 683928 | 5948440 | Location unchanged |
| VC19 | 683801 | 5948284 | 683872 | 5948355 | **Moved 100m North East** |
| VC20 | 683652 | 5948420 | 683723 | 5948491 | **Moved 100m North East** |
| VC21 | 683780 | 5948574 | 683780 | 5948574 | Location unchanged |
| VC22 | 683887 | 5949016 | 683887 | 5949016 | Location unchanged |
| VC23 | 683759 | 5948862 | 683759 | 5948862 | Location unchanged |
| VC24 | 683631 | 5948708 | 683631 | 5948708 | Location unchanged |
| VC25 | 683482 | 5948842 | 683482 | 5948842 | Location unchanged |
| VC26 | 683610 | 5948996 | 683610 | 5948996 | Location unchanged |
| VC27 | 683589 | 5949281 | 683489 | 5949281 | **Moved 100m West** |
| VC28 | 683461 | 5949130 | 683611 | 5949130 | **Moved 150m East** |
| VC29 | 683334 | 5948976 | 683484 | 5948976 | **Moved 150m East** |
| VC30 | 683313 | 5949264 | 683370 | 5949403 | **Moved 150m North North East** |

## 4.5 Vibrocore depths relative to chart datum.

| Vibrocore_ | Easting | Northing | Top of core rel to chart datum (m) |
|---|---|---|---|
| VC1 | 685374 | 5947675 | -9.93 |
| VC2 | 685246 | 5947522 | -10.28 |
| VC3 | 685076 | 5947944 | -10.07 |
| VC4 | 684949 | 5947789 | -10.79 |
| VC5 | 684779 | 5948212 | -10.01 |
| VC6 | 684651 | 5948058 | -10.25 |
| VC7 | 684366 | 5948185 | -9.81 |
| VC8 | 684737 | 5948788 | -8.91 |
| VC9 | 684532 | 5948480 | -9.51 |
| VC10 | 684354 | 5948326 | -8.86 |
| VC11 | 684213 | 5948317 | -4.64 |
| VC12 | 684589 | 5948922 | -8.58 |
| VC13 | 684461 | 5948768 | -8.67 |
| VC14 | 684077 | 5948306 | 0.26 |
| VC15 | 684440 | 5949056 | -8.63 |
| VC16 | 684184 | 5948748 | -7.87 |
| VC17 | 684056 | 5948594 | -6.44 |
| VC18 | 683928 | 5948440 | 0.6 |
| VC19 | 683872 | 5948355 | 1.95 |
| VC20 | 683723 | 5948491 | 2.15 |
| VC21 | 683780 | 5948574 | 1.3 |
| VC22 | 683887 | 5949016 | -6.87 |
| VC23 | 683759 | 5948862 | -3.87 |
| VC24 | 683631 | 5948708 | 1.14 |
| VC25 | 683482 | 5948842 | 1.53 |
| VC26 | 683610 | 5948996 | -3.54 |
| VC27 | 683489 | 5949281 | -5.57 |
| VC28 | 683611 | 5949130 | -5.74 |
| VC29 | 683484 | 5948976 | -0.56 |
| VC30 | 683370 | 5949403 | -6.3 |

# 5 HEALTH AND SAFETY

On the commencement of the geophysical survey a vessel safety briefing was attended by all survey personnel and crew. Emergency procedures were explained and the use of emergency equipment was demonstrated. Fire and man overboard drills were carried out. Following changes in vessel, additional safety briefings were carried out for the new vessel.

A safety plan and risk assessment was completed prior to commencement of the survey. All survey and crew members were required to read the safety plan. This is available on request.

No reportable incidents occurred over the duration of the geophysical survey.

# APPENDIX 2: Geotechnical report

Buro Happold

# 027559 South Humber Channel Marine Studies

## Geotechnical Interpretative Report

October 2010

Draft

| Revision | Description | Issued by | Date | Checked |
|---|---|---|---|---|
| 00 | Draft | bsj | 29/10/2010 | ASP |

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| | |
|---|---|
| **author** | **Brian Jackson** |
| signature | |
| date | **29/10/2010** |
| approved | **Syd Pycroft** |
| signature | |
| date | **29/10/2010** |

# Contents

# 1 Introduction

## 1.1 Study Aims and Objectives

The aim of this study was to develop strategies for the design of building foundations, the construction of earth retaining structures and earthworks.

This was achieved though the following objectives:

- To determine the ground conditions (ground profile, ground water levels)
- To determine the geochemical composition for foundation purposes of the soils and groundwater
- To provide recommendations on the concrete class for buried structures
- To determine parameters for the detailed design of foundations
- To assess the design parameters for construction any earth retaining structures

# 2 The Site

### 2.1 Location and Description

The site is located on the south bank of the Humber estuary on Killingholme Marshes approximately 3.5km to the north west of Grimsby town centre at Ordnance Survey grid reference 517359, 419018. The landward side of the site is flat, with a general ground level lying at approximately 3m OD. The land use is mixed, with both industrial and arable farm land as well as small areas of unused space comprising predominantly of standing water. The industrial land is concentrated mainly to the north of the site and consists mainly of hardstanding used for vehicle storage. The landward edge of the site is marked by a flood defence bund, comprising a concrete pavement and wall. The pavement level lies at approximately 5.8m OD, some 1.8m above the general site levels.

The seaward section of the site, comprises a gently shelving foreshore, with a narrow, near shore margin hosting grasses and small trees/shrubs which passes in to mud flats. The bathymetric data for this area shows the sea bed slopes away from the shoreline in a south west north east direction with the lowest bed level lying at approximately -10m OD. The gradient of the submarine slope varies, but at it steepest lies at 1 in 22.

### 2.2 Previous Ground Investigation

A number of previous ground investigations have been undertaken across the site. The earliest was by George Wimpey & Co Ltd in 1965. This investigation was followed by a further two investigations carried out in 1970 by Soil Mechanics Ltd and Dredging Investigations Ltd. The factual data from these reports is not presently available but the field data was précised and summarised by Allot Atkins Mouchel (Ref. 1). Details of the findings are summarised in Table 2-1 below.

### 2.3 Geology & Hydrogeology

#### 2.3.1 Published Geology

The British Geological Survey sheet 81, 1:50,000 series, shows that the superficial deposits on the site comprise two distinct groups of soils. The spatial distribution of the various soils across the site are shown on a extract from the geological plan presented in Figure 1.The near shore materials comprise estuarine deposits composed of silts, clays, thin peat layers and undifferentiated beds. In land from the shore line, the soils grade in to glacial deposits which are predominantly Tills, however there are outcrops of sands and gravels which lie just to the south of the site. The Tills are reported to be between 10m to 21m thick in the area and contain a coarser gravel size fraction comprising sandstone, mudstone and chalk. Shell fragments are also reported to be present within the Till.

In addition to the natural superficial soils the geological plan also identifies areas of filled ground which are concentrated to the north area of site. No detail is given regarding the nature or vertical extent of this material.

The solid geology underlying the superficial deposits comprises the Upper Cretaceous Chalk which is reported to be in excess of 250m thick in this region. The Chalk strata dip at a very shallow angle, of the order of 2° to the north east and east, and have an undulating top surface. The undulations are described as shallow depressions which run in a north west to south east direction. The upper surface is also characterised by a highly fractured zone extending apparently to a depth of 10m to 20m, and is reported to be a function of glacial and periglacial processes.

The Upper Cretaceous Chalk beneath site has been divided in to two formations, the Flamborough Chalk and Burnham Chalk.

The younger Flamborough Chalk has identifiable bedding surfaces, distinct marl bands and is reported to be "without" flints. The underlying Burnham Chalk, which subcrops along the eastern side of the site, is described as thinly bedded and laminated and contains continuous flint bands, which vary in thickness from 10mm to 300m.

The subsoil profile on the site derived from the available information is summarised in Table 2-1 and incorporates the data from the previous desk study (Ref. 1)

**Table 2—1**:-Existing Information on Ground Profile

| Strata | Top level of Strata (m AOD) | Thickness (min-max) m | Material |
|---|---|---|---|
| Made Ground | 2.3 – 5.5 | 0.8 – 5.8 | Fill comprising ash, clay, concrete, slag, sand, gravel. Occasional wood, domestic refuse, glass & pottery |
| Alluvium | 2.5 to -0.9 | 2.10 – 8.9 | Very soft – soft very silty clay, fibrous peat. Firm laminated clay. Stiff grey – blue clay traces of roots |
| Glacial Till | 1.2 to -7.2 | 10.0 – 13.7 | Firm and stiff clay – laminated – thin sand bands – laters of sandy silt, with some gravel of siltstone, sandstone & chalk |
| Chalk | -10 to -20.6 | Thickness proved 1.7 - 45 | Gravel sized chalk fragments in a stiff silty clayey matrix with occasional flints |

### 2.3.2 Hydrology/ Hydrogeology

The available data from the Environment Agency shows that the Chalk bedrock is designated as a Principal Aquifer. The superficial deposits in the foreshore area beyond the flood defence bund are designated as Secondary (undifferentiated) aquifer whilst the remainder of the superficial deposits on the site are unclassified. In terms of source protection zones the site lies outside any zones however an inner zone lies just to the south of the site boundary.

# 3 Ground Investigation

### 3.1 General

A ground investigation was undertaken by Soil Engineering Ltd (part of the Technology Division of VINCI Construction UK Limited) between 15 June and 15 July 2010. The scope of works was defined by Buro Happold within the budgetary constraints imposed by Yorkshire Forward. The work was concentrated on the offshore section of the site and comprised the following work:

- 30 No vibrocores
- Bathymetric Survey
- Magnetometer Survey
- Unexploded Ordnance Desk Study

The results of the investigation are reported in the factual ground investigation report by Soil Engineering (Ref. 2)

### 3.2 Soil Sampling and Laboratory Testing

Soil samples for geotechnical testing were selected from the soils recovered at all vibrocore locations. The site investigation was followed by laboratory testing of the soil samples retrieved from the vibrocores including:

- soil classification tests (moisture content, tests for plasticity, particle size distribution tests);
- unconsolidated-undrained (UU) triaxial tests;
- one-dimensional consolidation tests including measurement of swelling and swelling pressure; and
- Sulphate and pH tests (BRE SD1 2005 Suite).

### 3.3 Exploratory Holes

A total of 30 vibrocores where sunk as part of the investigation. The depth penetrated by the vibrocores in to the sea bed varied form 1.8m at VC 14 to 6m at VC 02. The vibrocore locations are shown on the exploratory hole location plan presented in Figure 2.

### 3.4 Geophysics and Bathymetric Survey

*Magnetometer*

As part of the investigation a magnetometer survey was undertaken to determine the presence of any magnetic anomalies. The survey was undertaken using a 10m line spacing using G882/G881 magnetometers. The investigation located 7 No. significant anomalies and 2 No. smaller anomalies. One of the significant anomalies

was a known wreck which is plotted on the admiralty charts. The remainder are unknown ferrous objects which may be debris or possible UXO. The detailed findings of the survey are presented in the Soil Engineering report (Ref. 2) and sketch plan showing the anomalies is presented in Figure 3.

*Single Beam Echo Sounding*

The bathymetric survey was undertaken using Knudsen 320M single beam echo sounder. The results of the survey show that the deepest bed level occurs at the northern edge of the site with a variation in bed level ranging from -1m OD to -17m OD. The detailed results from the survey are presented in Soil Engineering's report (Ref. 2) and a sketch plan showing the bathymetric levels in m below Ordnance Datum is presented on Figure 4.

*Boomer Survey*

A boomer survey was undertaken using an Applied Acoustic Boomer and 20 element single-channel hydrophone array. The purpose of the survey was to determine the depth from seabed to "rockhead". An isopachyte plan contouring the distance from seabed to rockhead, and a plan showing the contour levels of the interpreted rockhead are presented in the Soil Engineering report (Ref. 2).

An extract from the contour plot is presented in Figure 5. The plot shows the contoured surface in relation to Chart Datum. Chart Datum is 3.9m below Ordnance Datum. The inferred rockhead levels based on the Boomer survey suggest that rockhead level dip away from the foreshore area from a level around -6m OD to approximately -22m OD furthest from the shore.

As with all geophysical methods the boomer survey, which is a seismic reflection technique, relies on there being sufficient contrast in the physical properties between geological layers to generate a reflection of the seismic wave. A seismic reflection is generated when there is a contrast in the acoustic impedance which is a product of the density of the rock (ρ) and the wave travel velocity (v). If there is not sufficient contrast in these properties then no reflection is detectable. The published geological data indicates that the chalk rockhead is highly fractured and a weathered zone also exists which may be vertically fairly extensive. There is a possibility that the difference in acoustic impedance between the glacial till and chalk at rockhead is not sufficient to generate a reflection. It is therefore important that any future investigations include deep boreholes to correlate with the seismic information.

# 4 Ground Conditions

## 4.1 General

The vibrocore investigation shows that the general subsoil sequence in the area of the investigation comprises the following:

- Very soft – soft alluvial clays/clayey silts – occasional thin peat layers
- Silty and gravelly sands
- Soft to firm becoming stiff glacial till with beds of glacial sands and gravels

A series of sketch sections have been produced across the site, these show the variation of the subsoil sequence. The location of the sections is presented on Figure 2 and the sections, A to F, are presented on Figures 6 to 11. On the cross sections no attempt has been made to differentiate between the alluvial sands and the glacial sands and gravels. In some locations the distinction is clear, as there are bands of peat present which is a clear indication that the material is alluvial in origin. Where peat is not present however it is not possible to clearly differentiate the materials. There is a compositional difference in places, refer to Figure 16, here there is a set of data which shows the material to be predominantly a silty fine sand, there is a chance that that this material could be alluvial sands, simply due to the lack of gravel. However glacial sands can also exhibit a similarly narrow compositional variation. At this stage it is not too critical to be able to differentiate between the two. Differentiating between sand with peat and sand without is probably sufficient. In Figure 2 the location of the peat layers has been delimited. Knowing the relative density of the sand/gravel material would be useful and this can be done in later phases of the investigations using techniques such a static cone testing.

## 4.2 Alluvial Clays/Silts

### 4.2.1 General Characteristics of the Alluvial Clays/Silts

With the exception of vibrocores 11, 14, 18, 23 and 28 alluvial clays and silts where encountered to depth varying between 0.3m (VC 8) and 3.90m (VC12). The Atterberg limits tests undertaken on this material (Figure 12) show the material to range between a low to high plasticity clay with bands of low and high plasticity silt. The grading curves show the particle size distribution to vary and compositionally the material ranges from a gravelly clay to a silty clay with the clay fraction ranging from 11% to 35%. The undrained shear strength of the alluvium is very low (Figure 14). The maximum shear strength recorded was 20kN/$m^2$ however there is a significant proportion of the data which is less than 5kN/$m^2$. Consolidation test data on a single sample of alluvium (Figure 15) shows it to be highly compressible with a coefficient of volume change ($m_v$) value of 1.3$m^2$/MN.

Peat layer were encountered in within the alluvial clays at 6 vibrocore locations which are given in Table 4.2.1. (VC 05, 07, 09,12 13 &15). The peat is generally described as occurring in thin lenses, which range in thickness from <10mm to <30mm. At one location however, VC13, two thicker, persistent bands of peat are recorded, each less than 100mm thick.

### 4.2.2 Engineering Properties of the Alluvial Clays and Silts

The undrained strength of the alluvial clays is very low. As a consequence the material will be highly compressible and this is born out by the oedometer test data which indicates the material has a constrained modulus, $E_{oed}$ of 550kN/m$^2$. The shear strength shows similarly low values, however there is a larger data set so the variability of the layer stiffness can be estimated in more detail. The Young's modulus for normally consolidated clays can be derived from the relationship E=250 x Cu. Using this relationship, the variation in stiffness of the alluvium, ranges from 500kN/m$^2$ to 5000kN/m$^2$. The long term strength parameters (effective stress) can be determined from the plasticity index data (Ref. 3). The general range of the plasticity index varies from 35% to 70% (Figure 12). Based on this data the drained angle of shearing resistance $\phi$' is expected to vary between 22$^o$ and 26$^o$. No drained cohesion should be considered. The permeability of the alluvial clays is estimated form the oedometer test data. This shows the permeability of clay material lies in the range 1x10$^{-9}$ to 9x10$^{-11}$m/s. The test results will not however reflect the influence of mass fabric such as silt or sand laminations which could result in significantly higher mass permeability characteristics.

## 4.3 Silty and Gravelly Sands

### 4.3.1 General Characteristics of the Silty and Gravelly Sands

As discussed above it is difficult to clearly differentiate whether the sands/gravels are of alluvial or glacial origin. In some cases, the presence of peat for instance in VC 05, 06, 08 and 09, defines the material as alluvium (Refer to Figure 2) for the plan positions where peat was encountered). In other cases, sand/gravel underlies the glacial clays, and must be glacial in origin. Elsewhere the distinction is not clear; therefore, no distinction is made in this report.

In general terms the grading test results (Figure 16) show the granular soils to vary between a silty sand and gravel, a gravelly sand to a silty fine sand. The layer thickness of these granular soils varied generally between 0.3m and 4.25m.

### 4.3.2 Engineering Properties of the Silty and Gravelly Sands

The grading curves, Figure 16, show that this material can be divided in to two groups based on the particle size distribution. The finer group, which is a silty fine sand, has a uniformity coefficient of 2, whilst the coarser material, comprising a silty very gravelly sand, has a uniformity coefficient of around 20. In the absence of field strength test data it is not possible to determine the stiffness of this material, however in terms of the effective

angle of shearing resistance $\phi$' the guidelines given in BS8002 (Ref. 3) can be used in conjunction with the grading curves and the soil descriptions on the logs. This method is not rigorous, but provides a guide to the likely values. On this basis it is estimated that the finer material will have a $\phi$' value of approximately $32^{\circ}$ whilst the coarser material will have a $\phi$' value in the range $34^{\circ}$ to $36^{\circ}$.

The permeability of granular soils can also be estimated from the methods detailed CIRIA Report 113 (Ref. 4). This uses the $D_{10}$ value from the grading curves. On this basis the permeability of the material is estimated to vary between $4.0 \times 10^{-5}$ and $1.7 \times 10^{-4}$m/s. The values are presented merely as guidance as the more accurate values would require a wider data set and an indication of the in situ density of the material.

### 4.4 Glacial Till

#### 4.4.1 General Characteristics of the Glacial Till

The glacial till was encountered in the majority of the vibrocore locations but was not encountered in VC 07, 08, 09 12 & 15, the general spatial distribution of the material is shown on the sections presented in Figures 6 to 11. The till comprises generally of soft to firm, firm, and stiff low to intermediate plasticity clay. The undrained strength data is presented in Figure 14, and shows the strength range to lie generally between 30kN/m$^2$ and 110kN/m$^2$. The plasticity data presented on Figure 17 show the Atterberg Limits of the material lie in a tight range with the plasticity index (PI) varying between 7% and 25%.

The grading curves, Figure 18, show the material to be well graded, with a size fraction ranging from fine to medium gravel to clay. The clay content ranges between 22% and 62%. The gravel fraction generally comprises sandstone mudstone and chalk, however at certain locations, VC 05, 10, 13, 16 and 22 there is a very high proportion of chalk present. In VC 22, the material was very similar to structureless chalk and therefore could be interpreted as chalk rockhead. The data from previous investigations and the BGS information suggests that the glacial tills in this area are of the order of 10m to 21m thick, therefore it is unlikely that the material in VC 22 represents chalk rockhead (see 2.3.1) However it must also be born in mind that the chalk "surface" is described as "undulating" (see 2.3.1) and any future investigations should set out to establish the relationship between the till and the underlying chalk as any variation in chalk surface level, may have a significant influence and the settlement behaviour of any earthworks and the length of any piles associated with the construction of the marine facility.

#### 4.4.2 Engineering Characteristics of the Glacial Till

The till varies in strength and the data shows that the strength increases with depth below bed level (Figure 14). The oedometer test data (Figure 15) indicates that the till is of low to medium compressibility with $m_v$ values varying between 0.12 and 0.34m$^2$/MN. This equates to a constrained modulus ranging from 3MN/m$^2$

to 8MN/$m^2$. Based on the undrained strength, the Young's Modulus suggests higher values, with undrained modulus (Eu) in the range 12MN/$m^2$ to 44MN/$m^2$ and drained modulus E' varying from 6MN/$m^2$ to 22MN/$m^2$.

In respect of permeability, this can be estimated from the oedometer test data and this suggests that the permeability of the till lies in the range $10^{-10}$ to $10^{-11}$m/s. It should be born in mind that this does not take account of any influence of coarser layers within the clay, which could significantly increase the mass permeability.

| Engineering properties | Alluvial clays/silts | Silty gravelly sands | Glacial till |
|---|---|---|---|
| Bulk unit weight, $\gamma$ (kN/$m^3$) | 1.37 – 2.09 | - | 2.13 – 2.23 |
| Plasticity Index, PI (%) | 35 to 70 | N/A | 7 to 25 |
| Undrained shear strength, $c_u$ (kN/$m^2$) | 5 to 20 | N/A | 30 to 110 |
| Angle of shearing resistance, $\phi$' (deg) | 22 to 26 | 32 fine grading<br>34 to 36 coarse grading | |
| Estimated in situ permeability, k (m/s) | $1.0x10^{-9}$ to $9.0x10^{-11}$ | $1.7x10^{-4}$ to $4.0x10^{-5}$ | $1.0x10^{-10}$ to $1.0x10^{-11}$ |
| Coefficient of volume change, $m_v$ ($m^2$/MN) | 1.3 | N/A | 0.12 to 0.34 |

**Table 4—1 Summary of engineering parameters**

# 5 Engineering Assessment

## 5.1 Design Considerations

The key design consideration with a development such as this is the consolidation of the founding soils under the loads imposed by the dock walls, structures and back fill materials. Rate of settlement is also an important consideration

The ground investigation has shown that the alluvial soils are highly compressible containing impersitent peat layers. Values of Young's moduli for the alluvial soils lie in the range 0.5 to 5 MN/$m^2$. Based on these figures a preliminary settlement estimate assuming a general surcharge loading imposed from the development of the order 50 kN/$m^2$ as a UDL would result in consolidation settlement order of 250 to 350mm.

With respect to differential settlement the ground investigation shows that the highly compressible alluvial clay layer varies in thickness across the area, ranging from 0.3m to 3.9m thick. With such a variation it is likely that differential settlements of the order of 50% or more of the total settlement, could occur over specific areas of the development.

In order to mitigate the effects of overall settlement and the effects of differential settlement a number of construction options could be considered. The choice of options will be largely dependant on the construction programme. A critical element in a design of this nature, is the rate of settlement of the subsoils under the imposed loads. The results of the ground investigation has shown, that both the alluvial and glacial clay soils have relatively low permeability, between $10^{-9}$ to $10^{-11}$ m/s. It should be born in mind that the data comes from tests on relatively small samples, and the results will not reflect the mass permeability of the soil. Mass permeability of soils can be significantly higher than lab data suggests as it is very often governed by the macro structure of the soils, which is difficult to reproduce in the laboratory. The macro structure often comprises silt and sand laminations and layers, which have the effect of significantly reducing the drainage path which governs the rate of settlement. In order to accurately assess the effects of this macro structure, future investigations should employ methods such as piezocone testing which can readily identify the presence of thin layers of higher permeability material.

The construction options which could be considered are as follows:

Option A – dredge alluvial soils leaving a subgrade of more uniform stiffness

Option B – install vertical drains to increase the rate of settlement

Option C – Surcharge the backfill to accelerate the settlement

Option D – Any combination of the above

### 5.1.1 Option A – Dredge out alluvial soils

A significant proportion of the overall settlement results from the settlement of the alluvial clays. By removing this material through dredging the overall magnitude of the total settlement and the differential settlement could be significantly reduced.

### 5.1.2 Option B - Install vertical drains

The effects of settlement and differential settlement can be mitigated to a greater oo lesser extent by speeding up the settlement process and ensuring that a certain percentage of the overall settlement has occurred prior to construction of the settlement sensitive structures on the quay. The rate of settlement is a function of the permeability of the soils, the mass permeability determined by the presence of a soil fabric, and the drainage path. The permeability and the mass fabric are in effect a constraint but the drainage path can be altered by the provision of vertical drains. The vertical drains are proprietary products which can be installed rapidly. The technique require on site monitoring to ensure that the anticipated settlement occurs at the expected rate.

### 5.1.3 Option C – Surcharge

Surcharging of fills and subgrades is a commonly used technique and  works by applying load ahead of the main construction phase, thereby reducing the level of settlement from the construction stage onwards. It requires that sufficient surplus material is available to form the surcharge and that sufficient time is available in the constructionm programme to allow the required settlement to accure.

### 5.1.4 Option D –Combined Treatment

It is often the case that more than one technique is adopted to accelerate the settlement phase and all the above could be used to a lesser or greater degree in combination. The key drivers are often cost and programme and it is necessary to optimise the design to achieve the most satisfactory result.

Stability

The bathymetric data indicates that the seashore slopes at a gradient of approximately 1 in 20 at its steepest point. Whilst this is a relatively slack slope instability can be generated by the surcharging effect of placing the fill. The alluvial soils are very weak, and time will be required for these to consolidate and gain strength during the filling process. Instability can also be generated through the build up of excess pore water pressures, particularly in finer grained soils such as silt. If the rate of filling is not controlled, and monitored against the development of pore pressures, then the strength of the soils can be reduced due to a decrease in effective stress. If overall stability is an issue then these effects can be mitigated by the introduction of vertical drains or controlling the rate of filling.

### 5.1.5 Retaining Structures

The ground conditions on the site lend themselves well to the construction of embedded cantilever or propped/anchors retaining walls. The driving conditions appear to be favourable and sheet piles, combi walls or driven bearing piles should be acceptable. The depth to which piles can be driven may be governed by rockhead level, and more data is required to identify accurately the depth and nature of this layer. Flint bands in the chalk may present an obstacle to piling, and further investigation is required to identify the presence or otherwise of significant flint bands.

### 5.1.6 Additional Investigations

The current ground investigation has given a good overall indication of the nature and variability of the shallower ground conditions. In order to complete the detailed design it is recommended that further investigations are undertaken to obtain more data. As discussed above overall settlement, rate of settlement and stability are important aspects of the design. In order to obtain sufficient and adequate data the additional work should include cone penetration testing with pore water measurement, cable percussion and rotary boreholes to obtain quality samples to the superficial deposits and accurate determine the depth and nature of the chalk.

# 6 Geoenvironmental Assessment

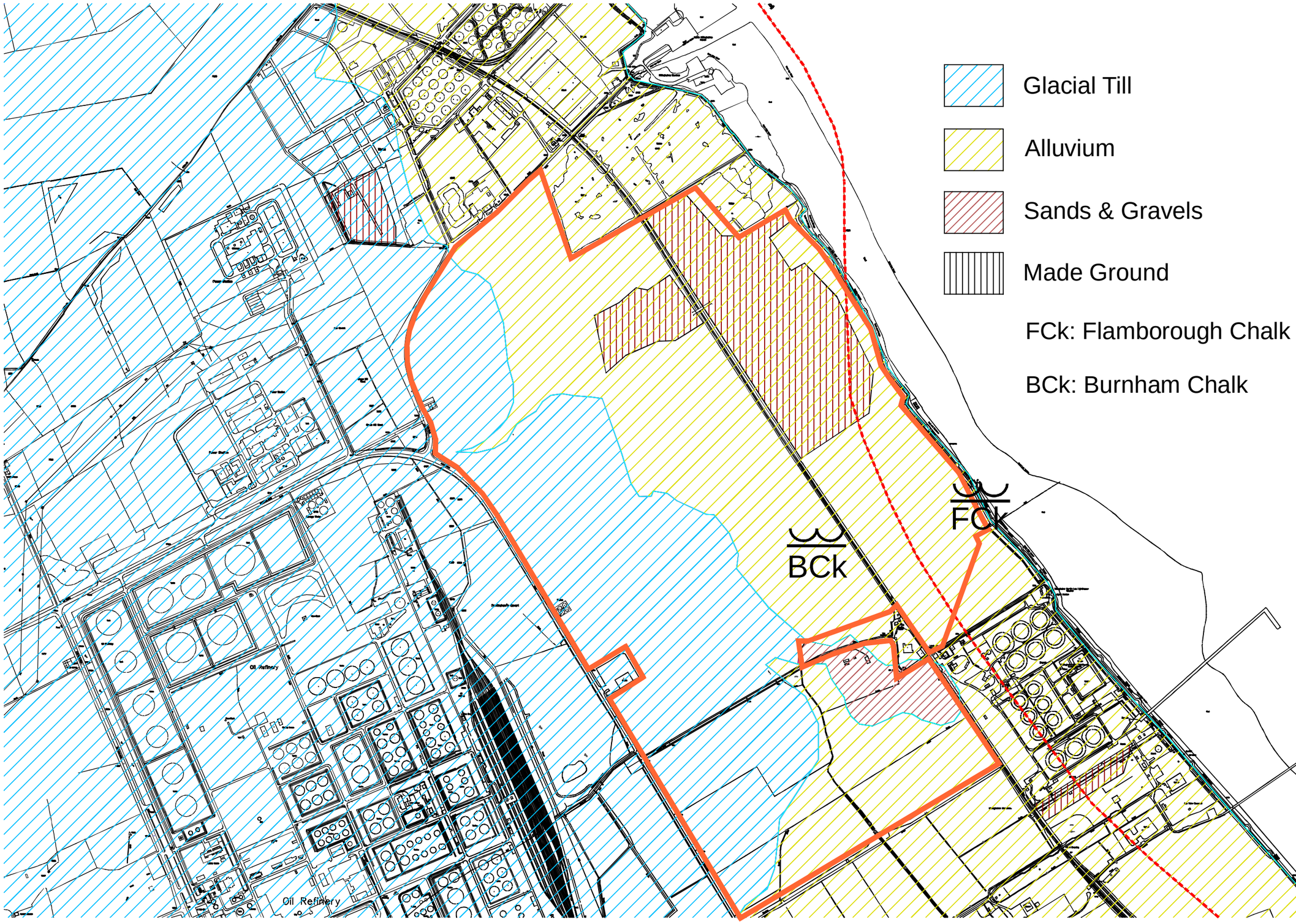
# References


Ref. 1. Desk Study by Allott Atkins Mouchel, in connection with a proposed power station development (1987)

Ref. 2. Report on a Ground Investigation for South Humber Channel Marine Studies, Soil Engineering Ltd (part of the Technology Division of VINCI Construction UK Limited), Report No SI FR 1.05 2010

Ref. 3. BS 8002 : (1994) Code of Practice for Earth Retaining Structures

Ref. 4. CIRIA Report 113 (1986) Control of Groundwater for Temporary Works




**Project: Humber Multi-User Terminal**

| Scale: NTS | Drawn: JMB | Chk: BJ | Date: OCTOBER 2010 | Job No: 027559 | Figure No: 1 | Rev: 00 |
|---|---|---|---|---|---|---|

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# SKETCH SHOWING THE VIBROCORE LOCATIONS WHERE PEAT & PLANT MATERIAL WAS ENCOUNTERED

VIBROCORE

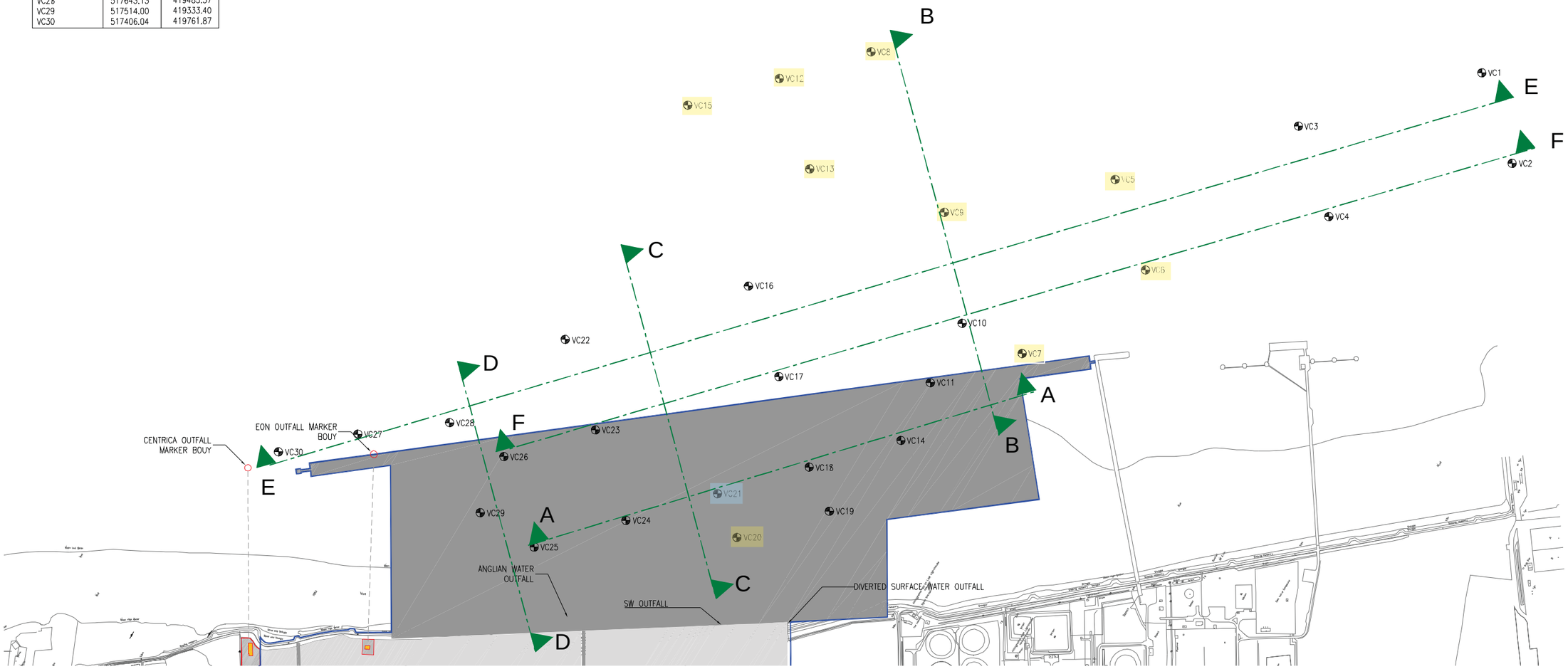
| VIBROCORE REF. | EASTING | NORTHING |
|---|---|---|
| VC1 | 519385.11 | 418006.23 |
| VC2 | 519254.99 | 417855.08 |
| VC3 | 519090.98 | 418279.34 |
| VC4 | 518961.84 | 418126.17 |
| VC5 | 518797.85 | 418551.43 |
| VC6 | 518667.72 | 418399.28 |
| VC7 | 518384.45 | 418530.56 |
| VC8 | 518763.96 | 419127.84 |
| VC9 | 518554.69 | 418822.82 |
| VC10 | 518374.58 | 418671.37 |
| VC11 | 518233.13 | 418664.33 |
| VC12 | 518617.89 | 419263.88 |
| VC13 | 518487.77 | 419111.73 |
| VC14 | 518097.39 | 418655.27 |
| VC15 | 518470.83 | 419399.93 |
| VC16 | 518210.57 | 419095.63 |
| VC17 | 518080.45 | 418943.48 |
| VC18 | 517950.32 | 418791.33 |
| VC19 | 517893.14 | 418707.14 |
| VC20 | 517746.10 | 418845.20 |
| VC21 | 517804.25 | 418927.37 |
| VC22 | 517917.44 | 419367.72 |
| VC23 | 517787.31 | 419215.57 |
| VC24 | 517657.18 | 419063.42 |
| VC25 | 517510.12 | 419199.47 |
| VC26 | 517640.24 | 419351.63 |
| VC27 | 517523.29 | 419638.24 |
| VC28 | 517643.13 | 419485.57 |
| VC29 | 517514.00 | 419333.40 |
| VC30 | 517406.04 | 419761.87 |

Vibrocores where peat was encountered

NB peat is generally described as pseudo-fibrous. It occurs either as distinct layers generally no more than 200mm thick but also as "frequent or occasional" lenses.

It generally lies at relatively shallow depths, ie less than 1.5m below bed level. There are some instances where peat occurs to greater depths eg VC05 & VC06 where it is present to 3.45 and 4.5m depth below bed level respectively

Vibrocores where plant remains where identified 1.50m to 3.10m below bed level (including seaweed) Also material had a strong organic odour NB peat was not present




**Project: Humber Multi-User Terminal**

| Scale: NTS | Drawn: JMB | Chk: BJ | Date: OCTOBER 2010 | Job No: 027559 | Figure No: 2 | Rev: 00 |
|---|---|---|---|---|---|---|

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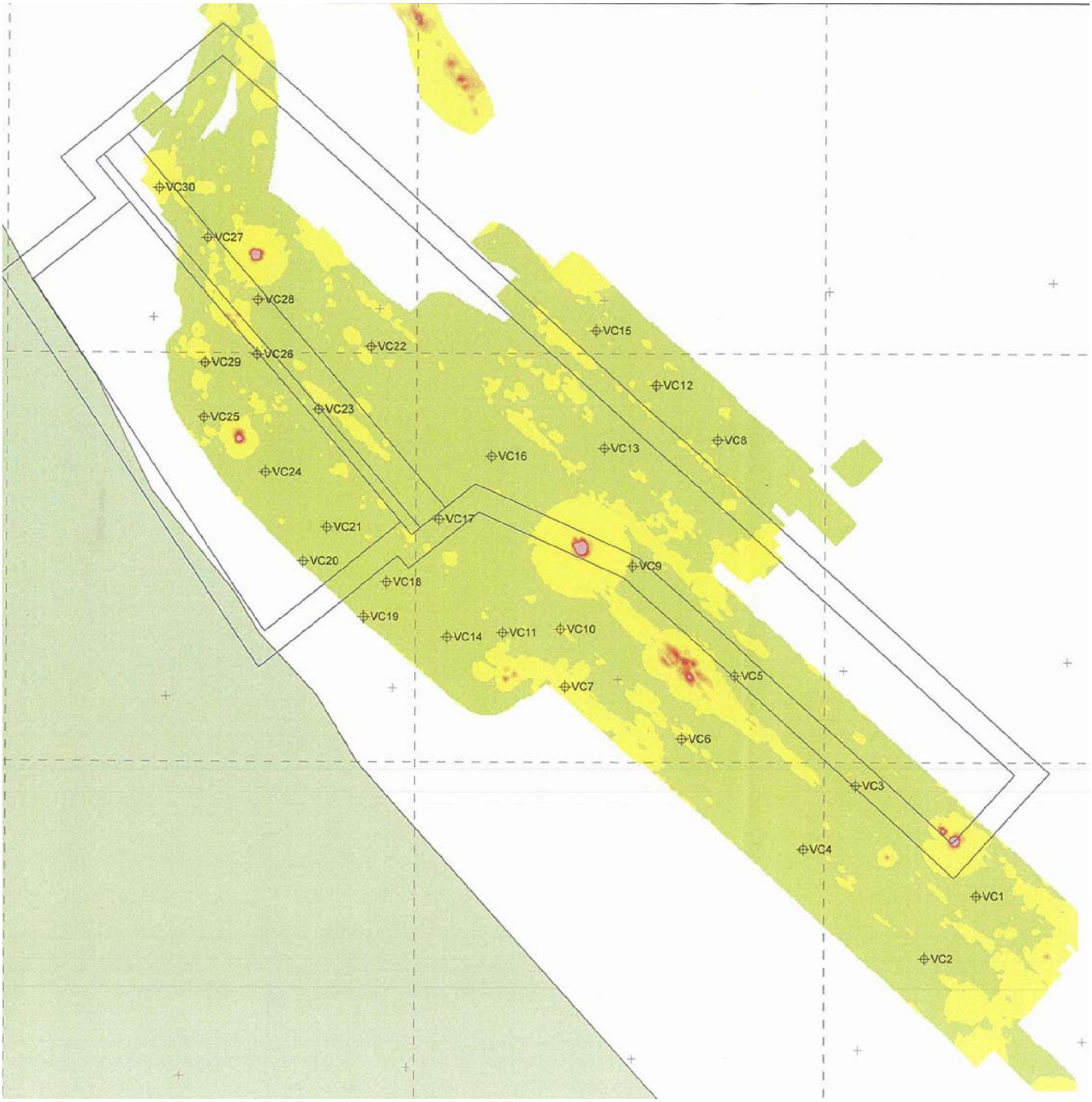


**Project: Humber Multi-User Marine Terminal**

| Scale: NTS | Drawn: JMB | Chk: BJ | Date: October 2010 | Job No: 027559 | Figure No: 3 | Rev:00 |
|---|---|---|---|---|---|---|

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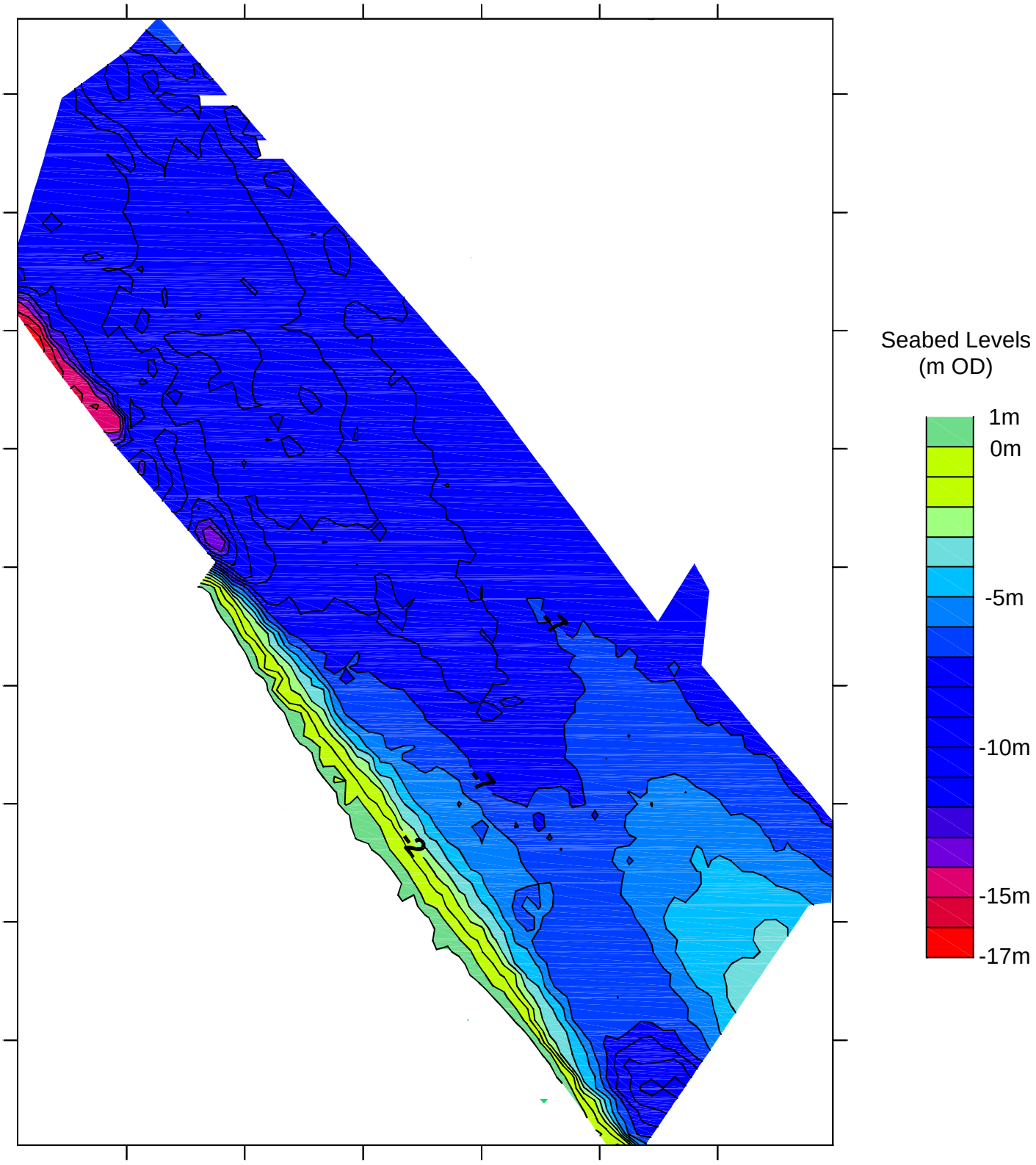


**Project: Humber Multi-User Marine Terminal**

| Scale: NTS | Drawn: JMB | Chk: BJ | Date: October 2010 | Job No: 027559 | Figure No: 4 | Rev:00 |
|---|---|---|---|---|---|---|

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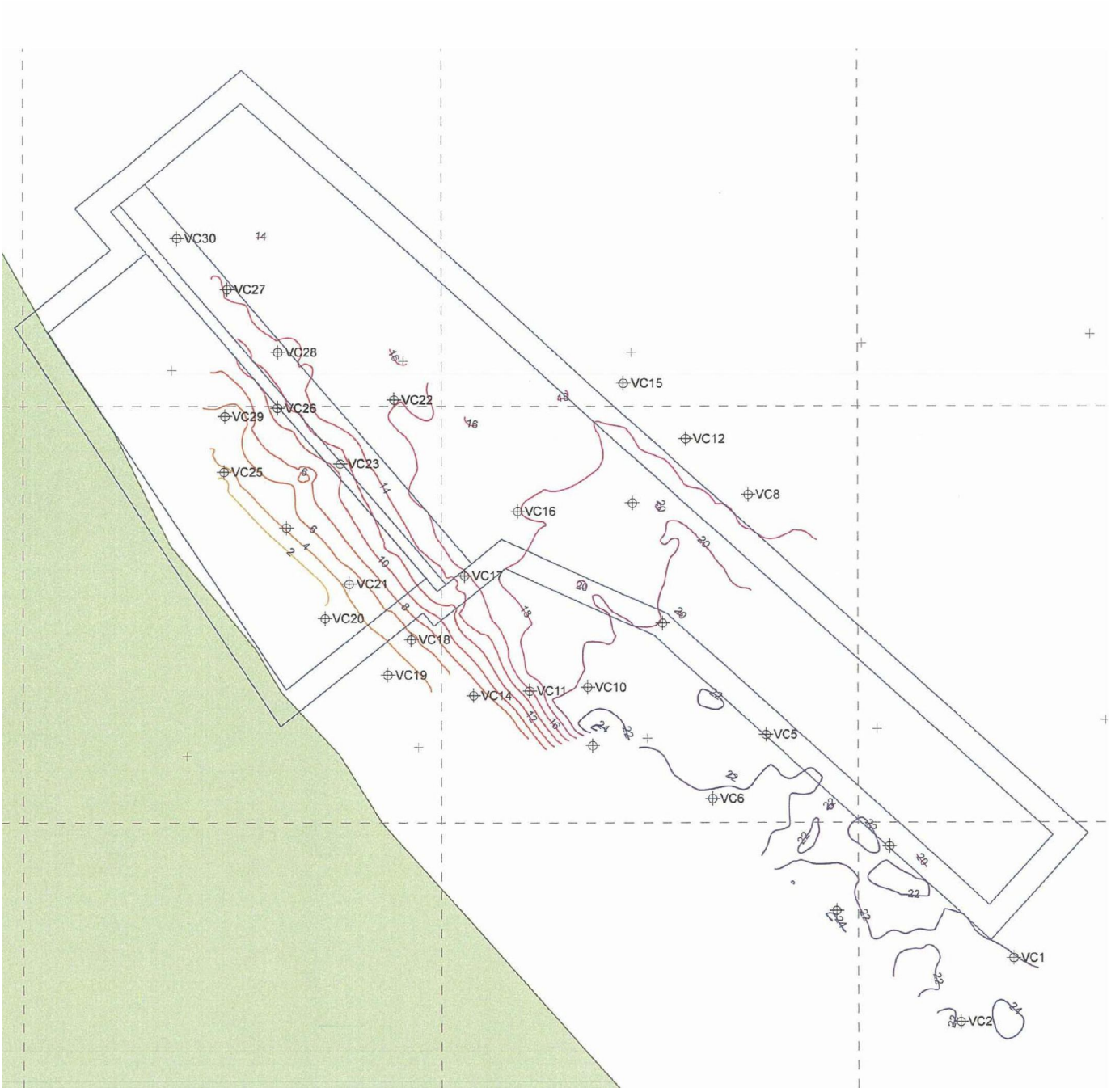


**Project: Humber Multi-User Marine Terminal**

| Scale: NTS | Drawn: JMB | Chk: BJ | Date: October 2010 | Job No: 027559 | Figure No: 5 | Rev:00 |
|---|---|---|---|---|---|---|

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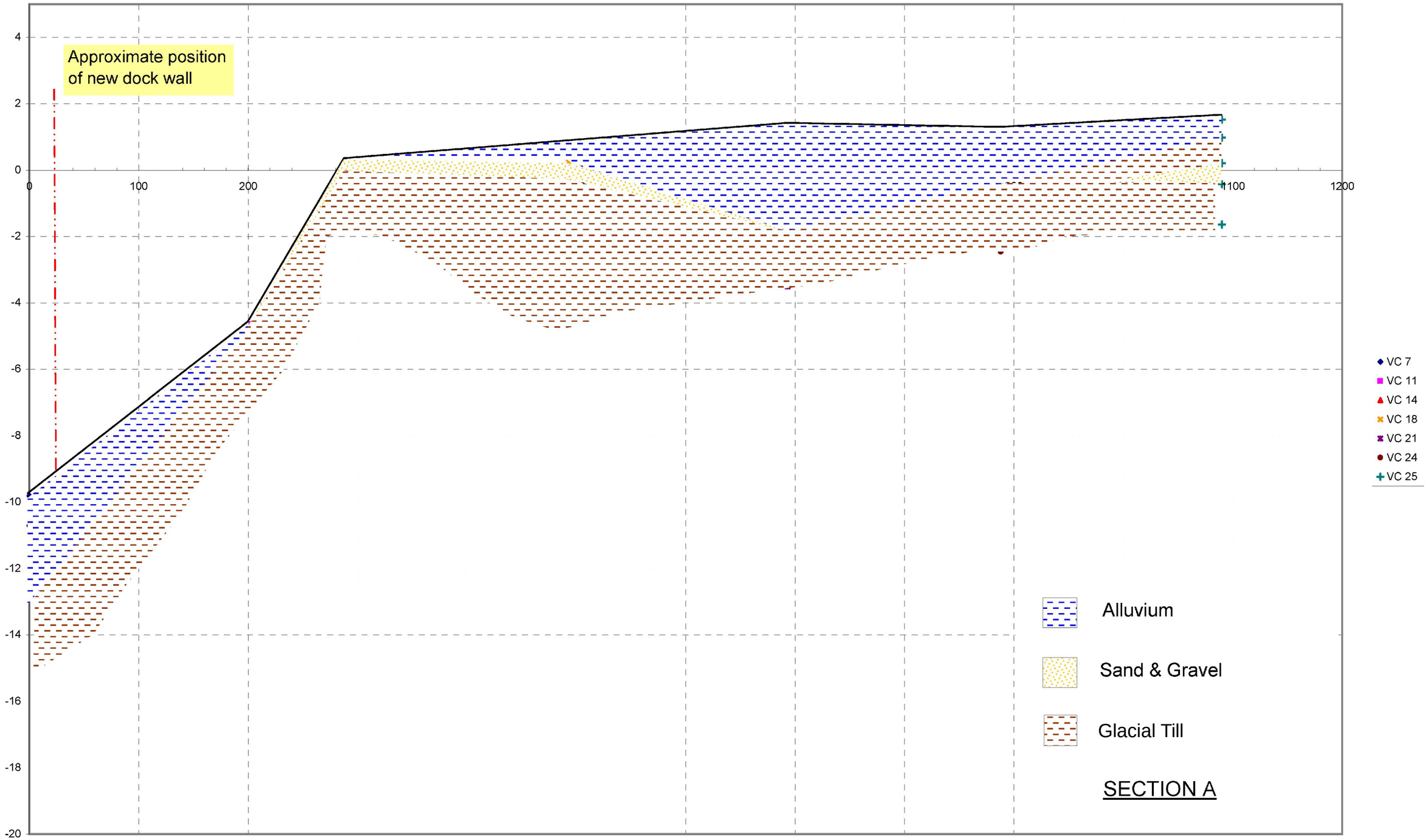


**Project: Humber Multi-User Terminal**

| Scale: NTS | Drawn: JMB | Chk: BJ | Date: OCTOBER 2010 | Job No: 027559 | Figure No: 6 | Rev: 00 |
|---|---|---|---|---|---|---|

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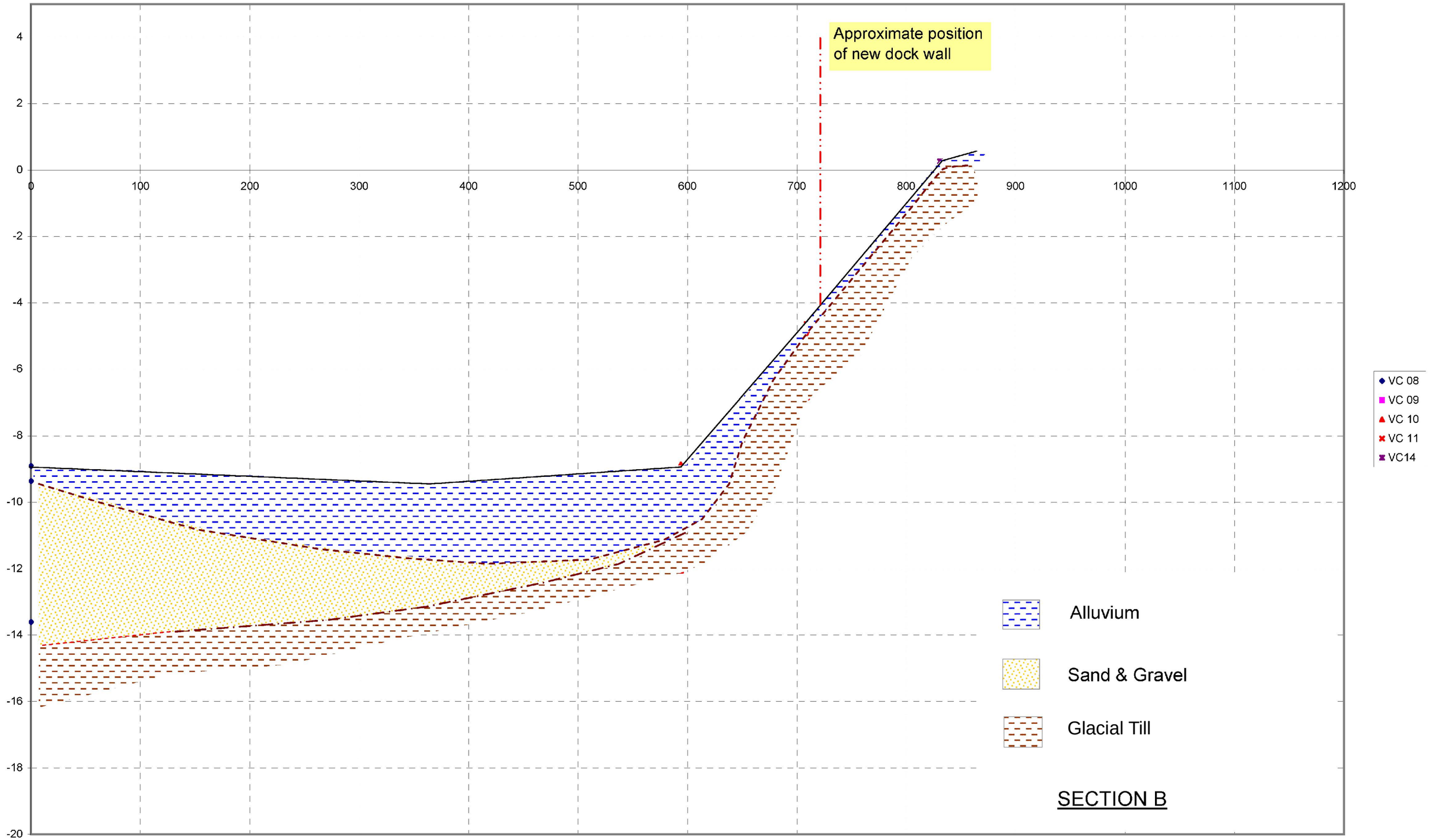


**Project: Humber Multi-User Terminal**

| Scale: NTS | Drawn: JMB | Chk: BJ | Date: OCTOBER 2010 | Job No: 027559 | Figure No: 7 | Rev: 00 |
|---|---|---|---|---|---|---|

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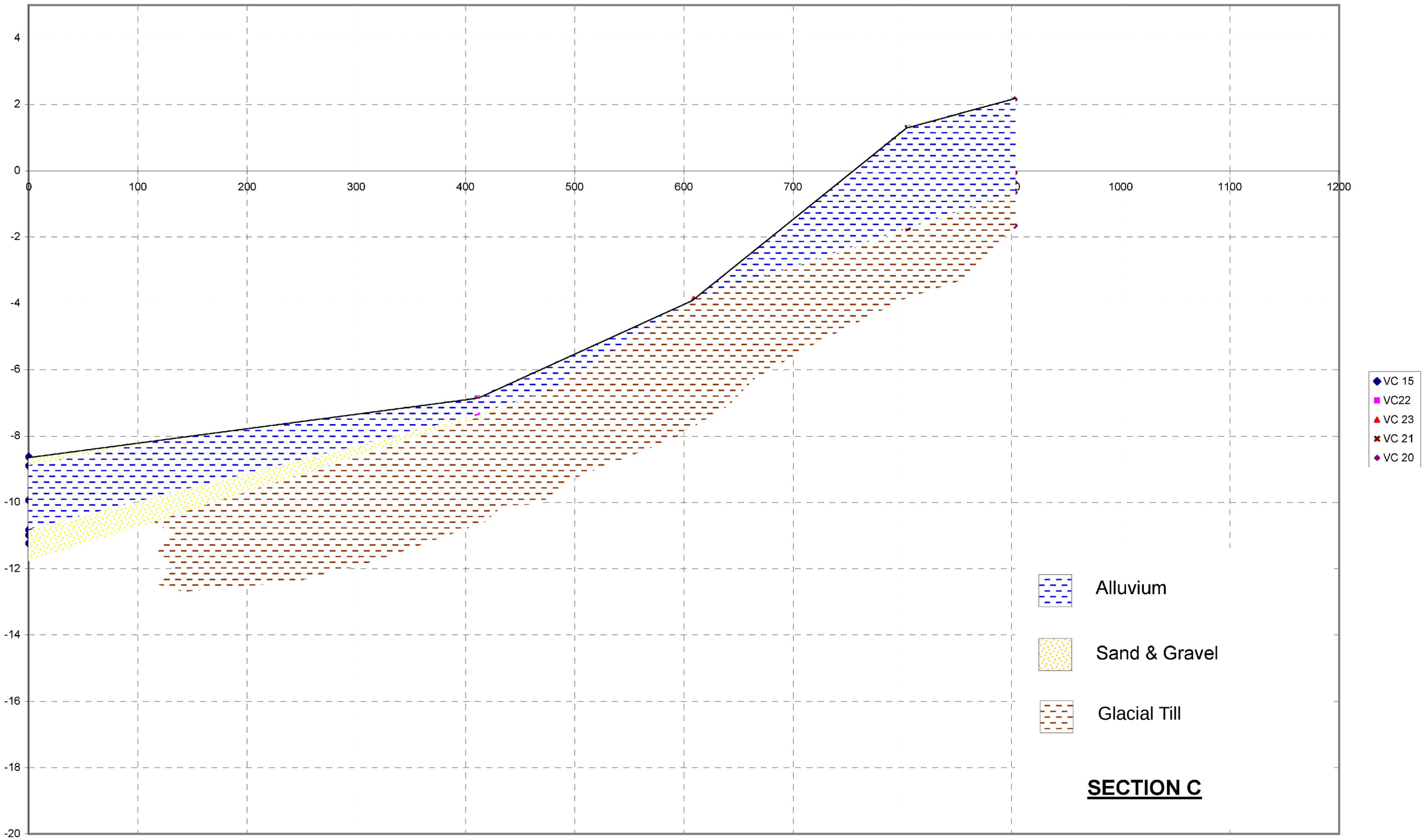


**Project: Humber Multi-User Terminal**

| Scale: NTS | Drawn: JMB | Chk: BJ | Date: OCTOBER 2010 | Job No: 027559 | Figure No: 8 | Rev: 00 |
|---|---|---|---|---|---|---|

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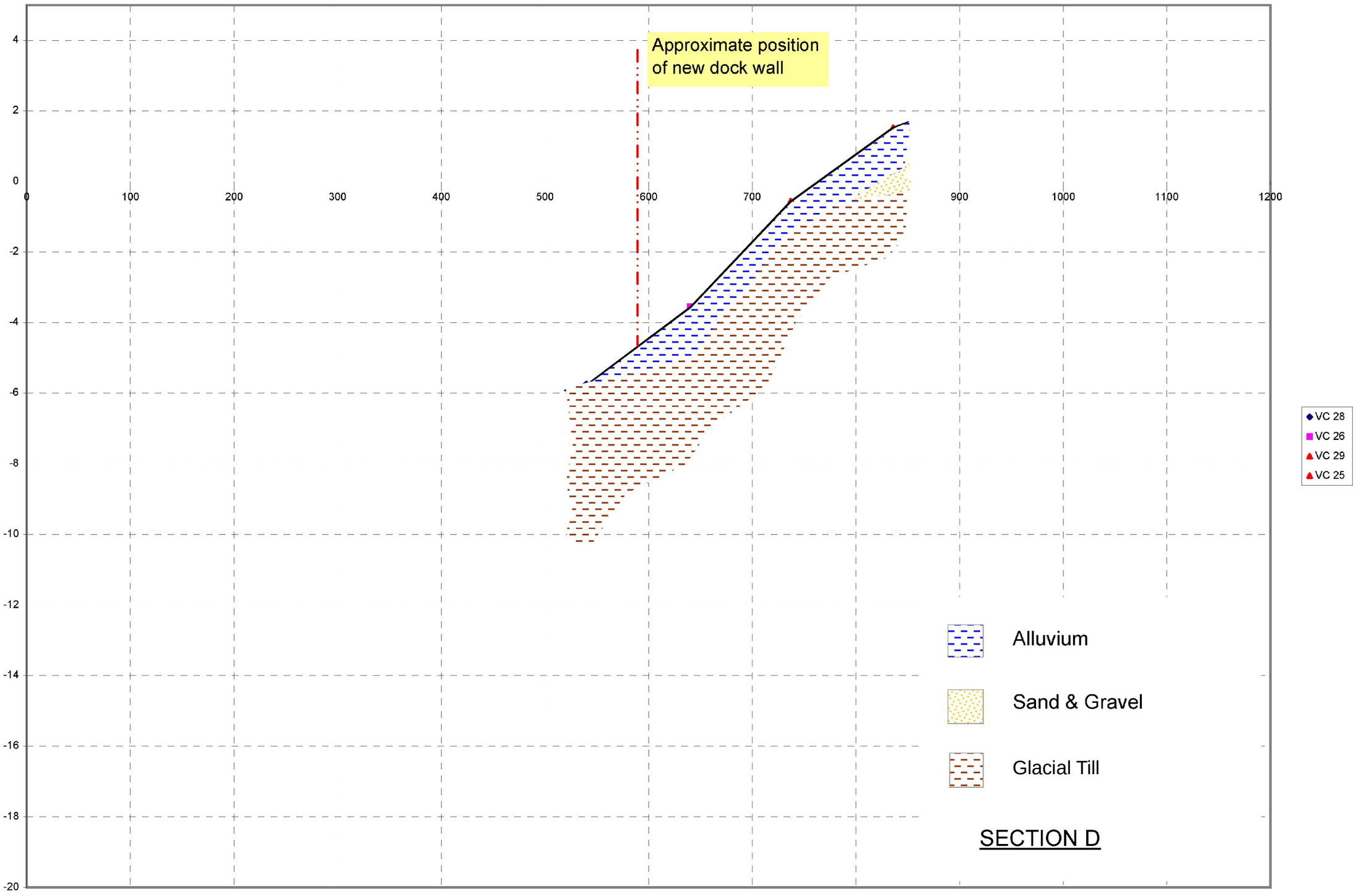


**Project: Humber Multi-User Terminal**

| Scale: NTS | Drawn: JMB | Chk: BJ | Date: OCTOBER 2010 | Job No: 027559 | Figure No: 9 | Rev: 00 |
|---|---|---|---|---|---|---|

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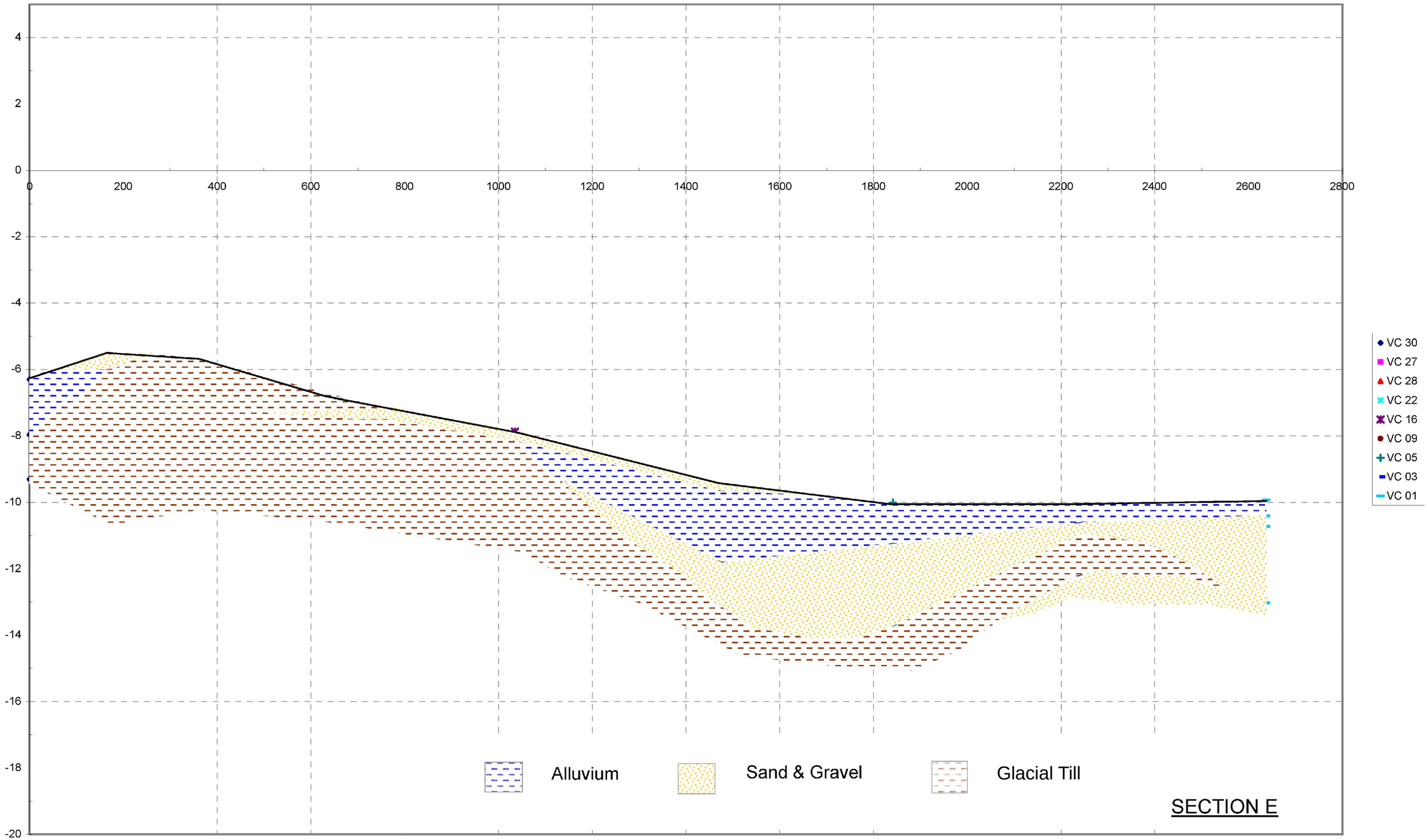


**Project: Humber Multi-User Terminal**

| Scale: NTS | Drawn: JMB | Chk: BJ | Date: OCTOBER 2010 | Job No: 027559 | Figure No: 10 | Rev: 00 |
|---|---|---|---|---|---|---|

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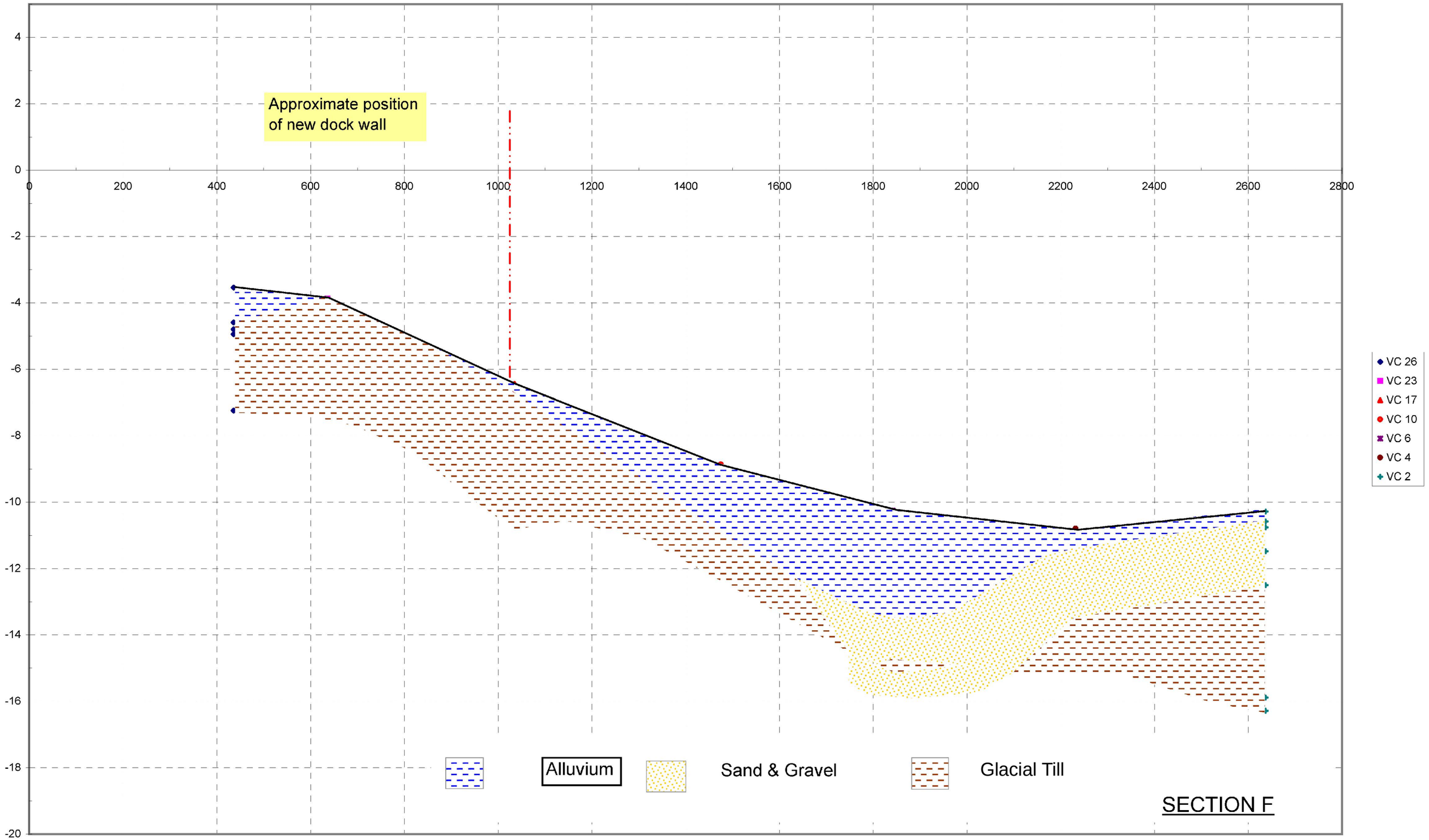


| Project: Humber Multi-User Terminal | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | | |
| Scale: NTS | Drawn: JMB | Chk: BJ | Date: OCTOBER 2010 | Job No: 027559 | Figure No: 11 | Rev: 00 |

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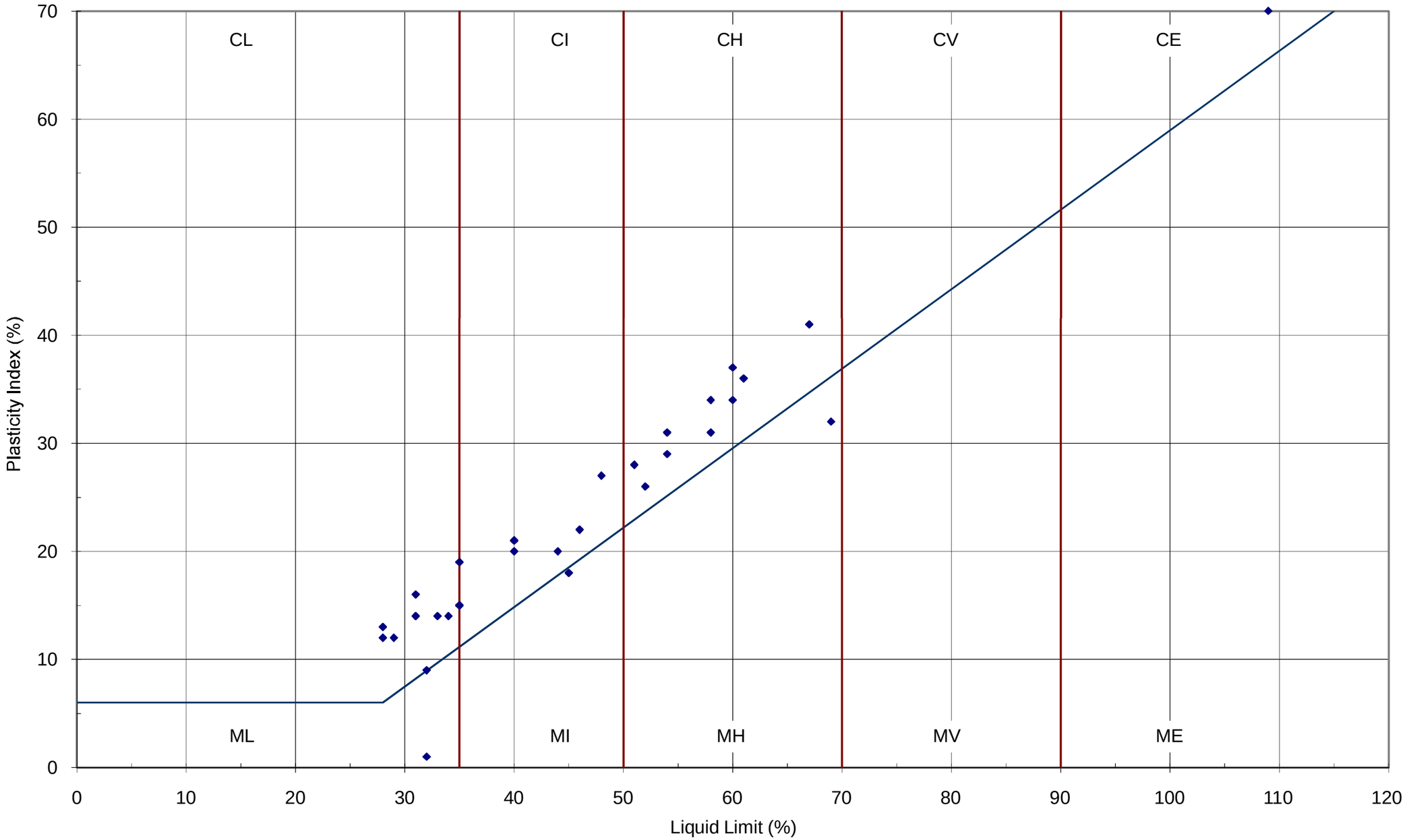
# Atterberg Limits - Alluvium




| | | | | | | |
|---|---|---|---|---|---|---|
| **Project: Humber Multi-User Terminal** | | | | | | |
| Scale: NTS | Drawn: JMB | Chk: BJ | Date: OCTOBER 2010 | Job No: 027559 | Figure No: 12 | Rev: 00 |

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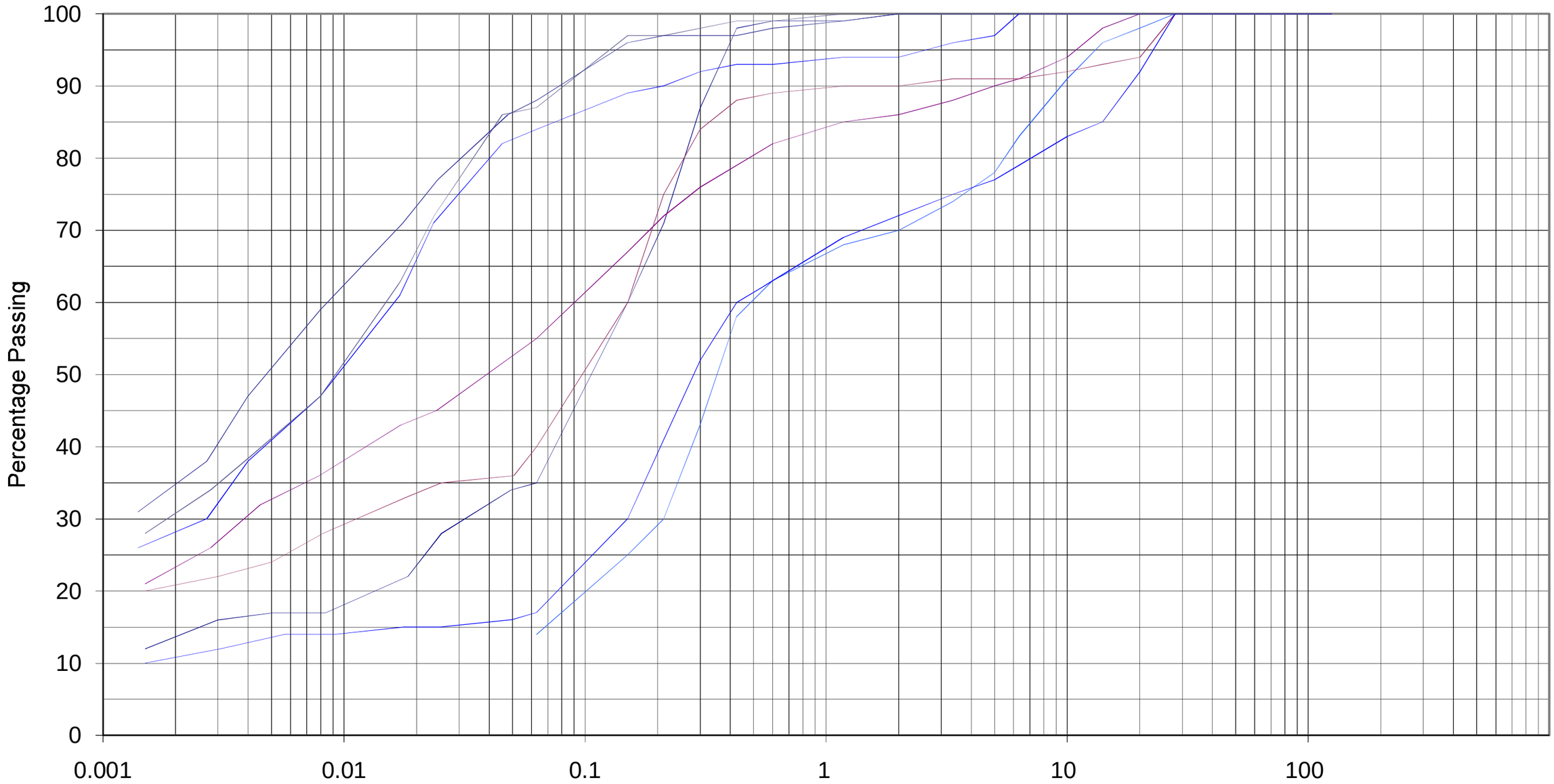
# Particle Size Distribution Curves - Alluvium




| Project: Humber Multi-User Terminal | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | | |
| Scale: NTS | Drawn: JMB | Chk: BJ | Date: OCTOBER 2010 | Job No: 027559 | Figure No: 13 | Rev: 00 |

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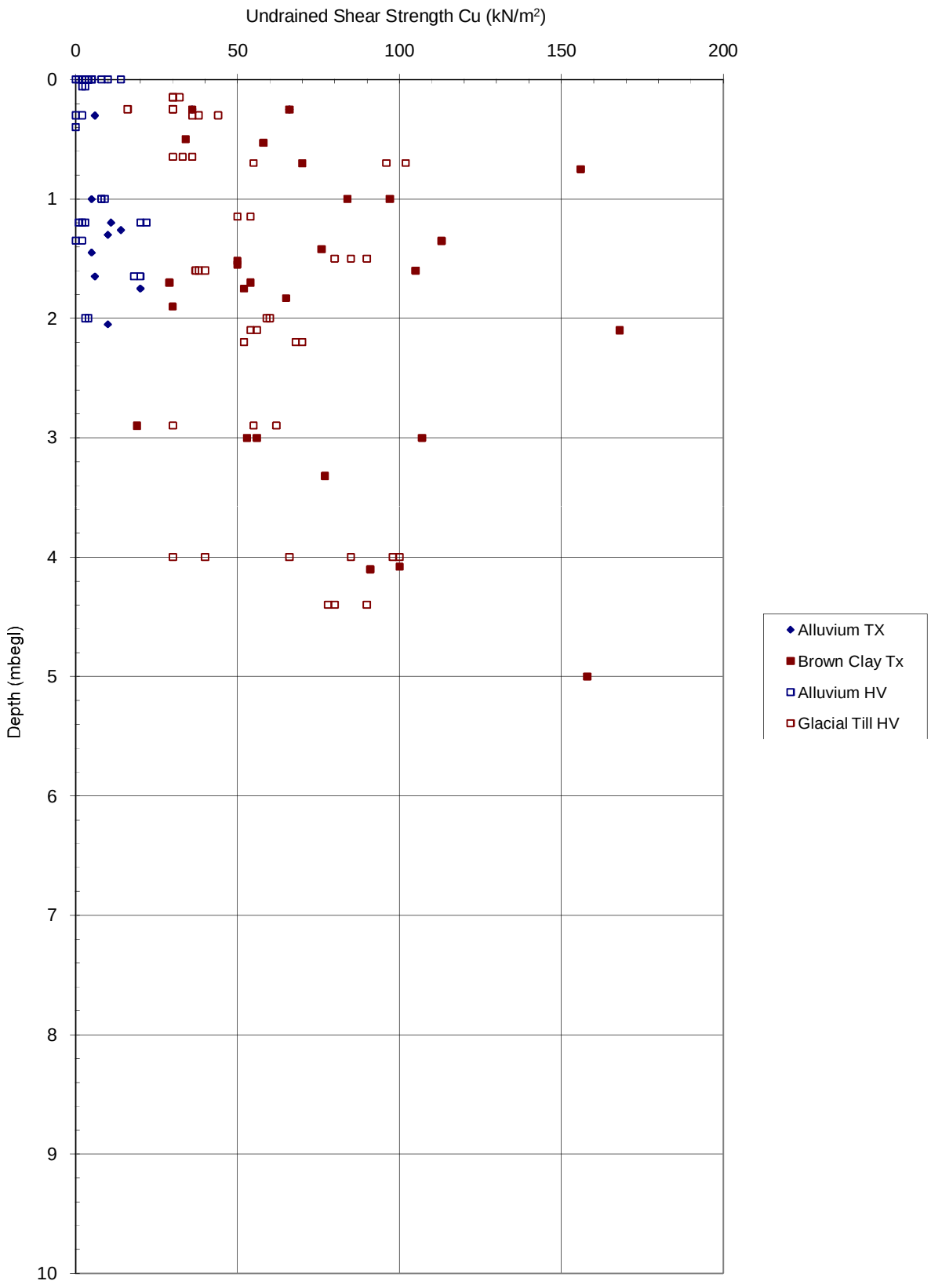
# Triaxial and Hand Vane Undrained Shear Strength




**Project: Humber Multi-User Marine Terminal**

| Scale: NTS | Drawn: JMB | Chk: BJ | Date: October 2010 | Job No: 027559 | Figure No: 14 | Rev:00 |
|---|---|---|---|---|---|---|

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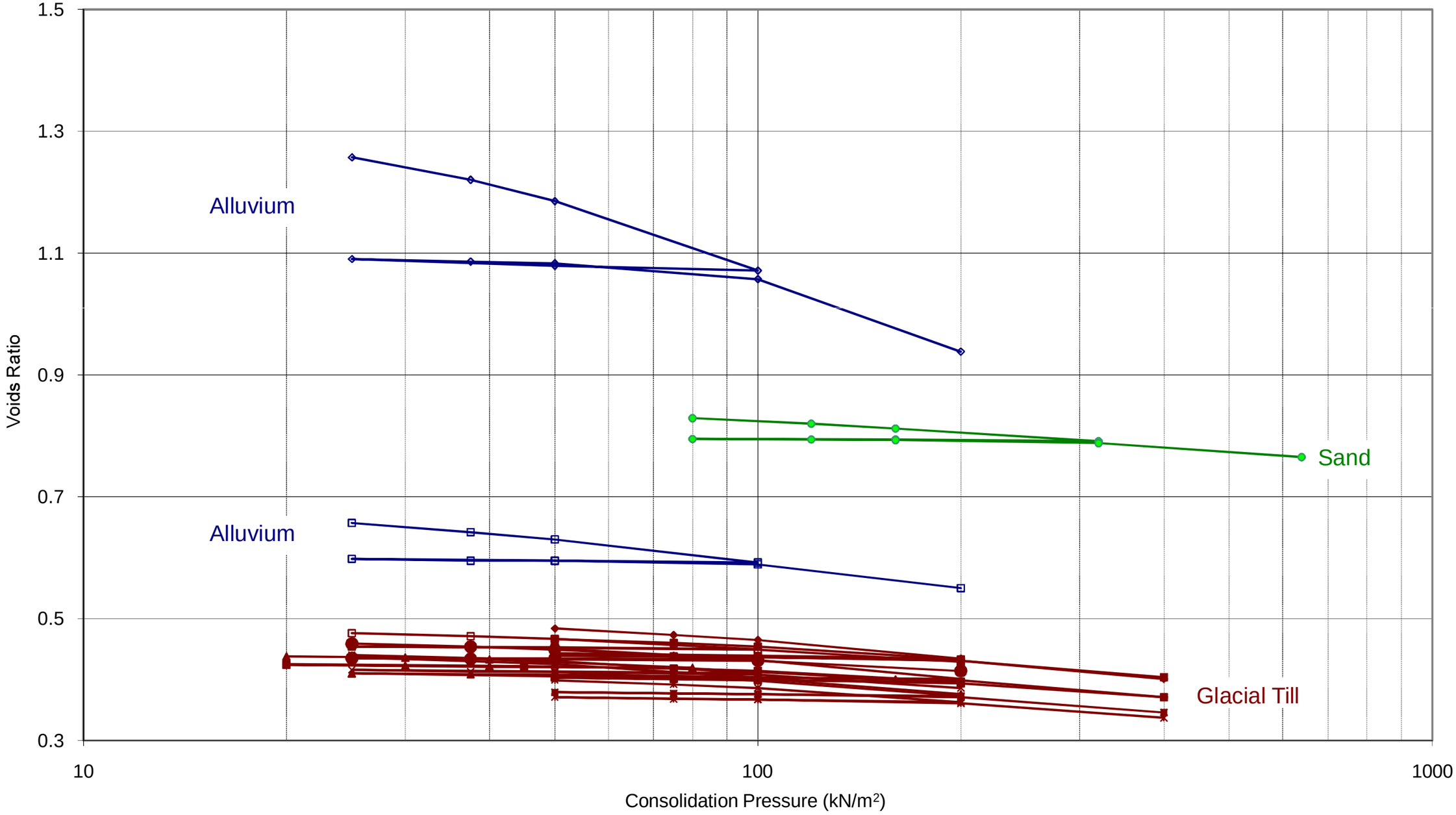
# ConsolidationTest Results




| | | | | | | |
|---|---|---|---|---|---|---|
| **Project: Humber Multi-User Terminal** | | | | | | |
| Scale: NTS | Drawn: JMB | Chk: BJ | Date: OCTOBER 2010 | Job No: 027559 | Figure No: 15 | Rev: 00 |

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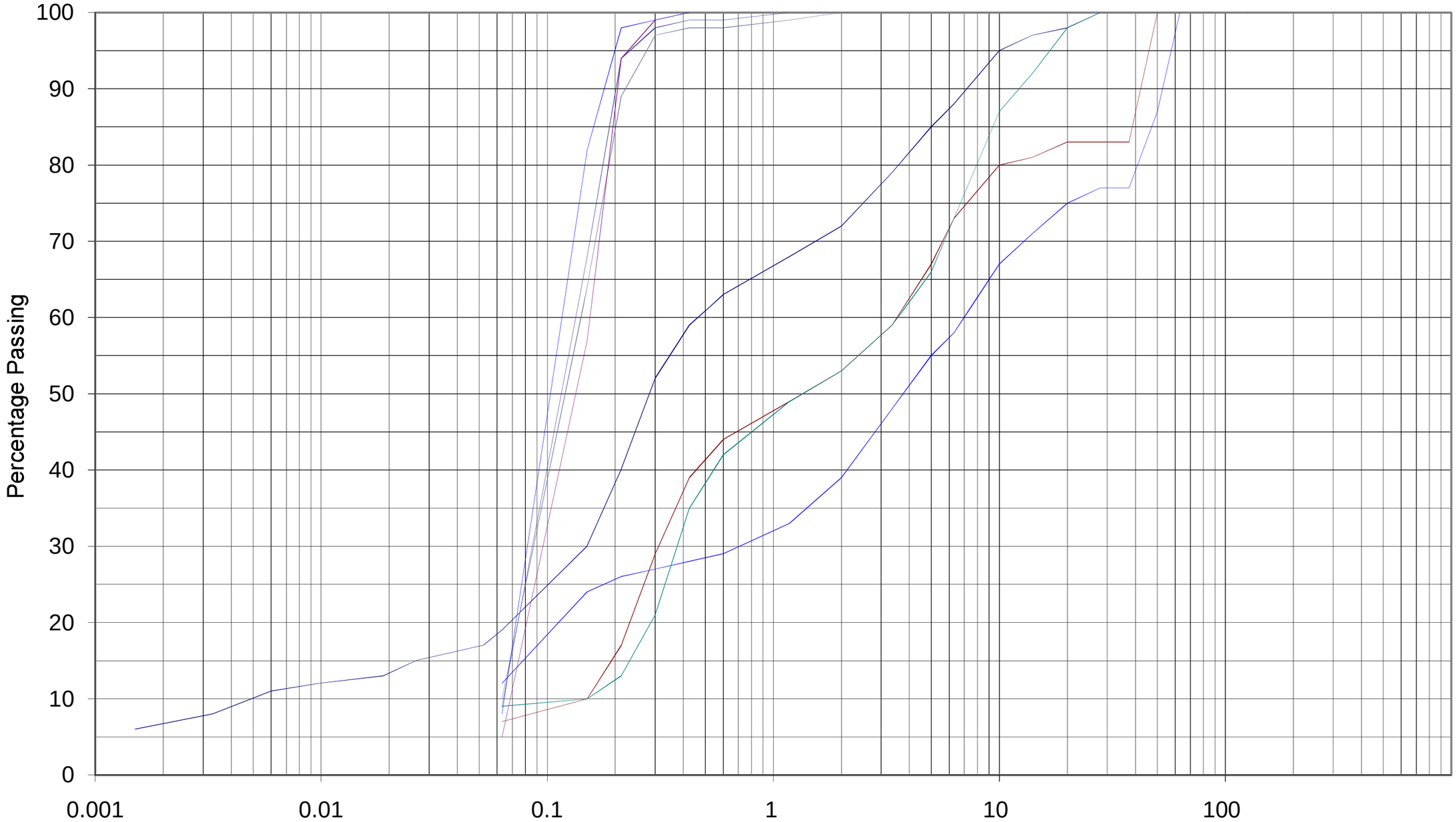
# Particle Size Distribution Curves - Sands & Gravels




| Project: Humber Multi-User Terminal | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | | |
| Scale: NTS | Drawn: JMB | Chk: BJ | Date: OCTOBER 2010 | Job No: 027559 | Figure No: 16 | Rev: 00 |

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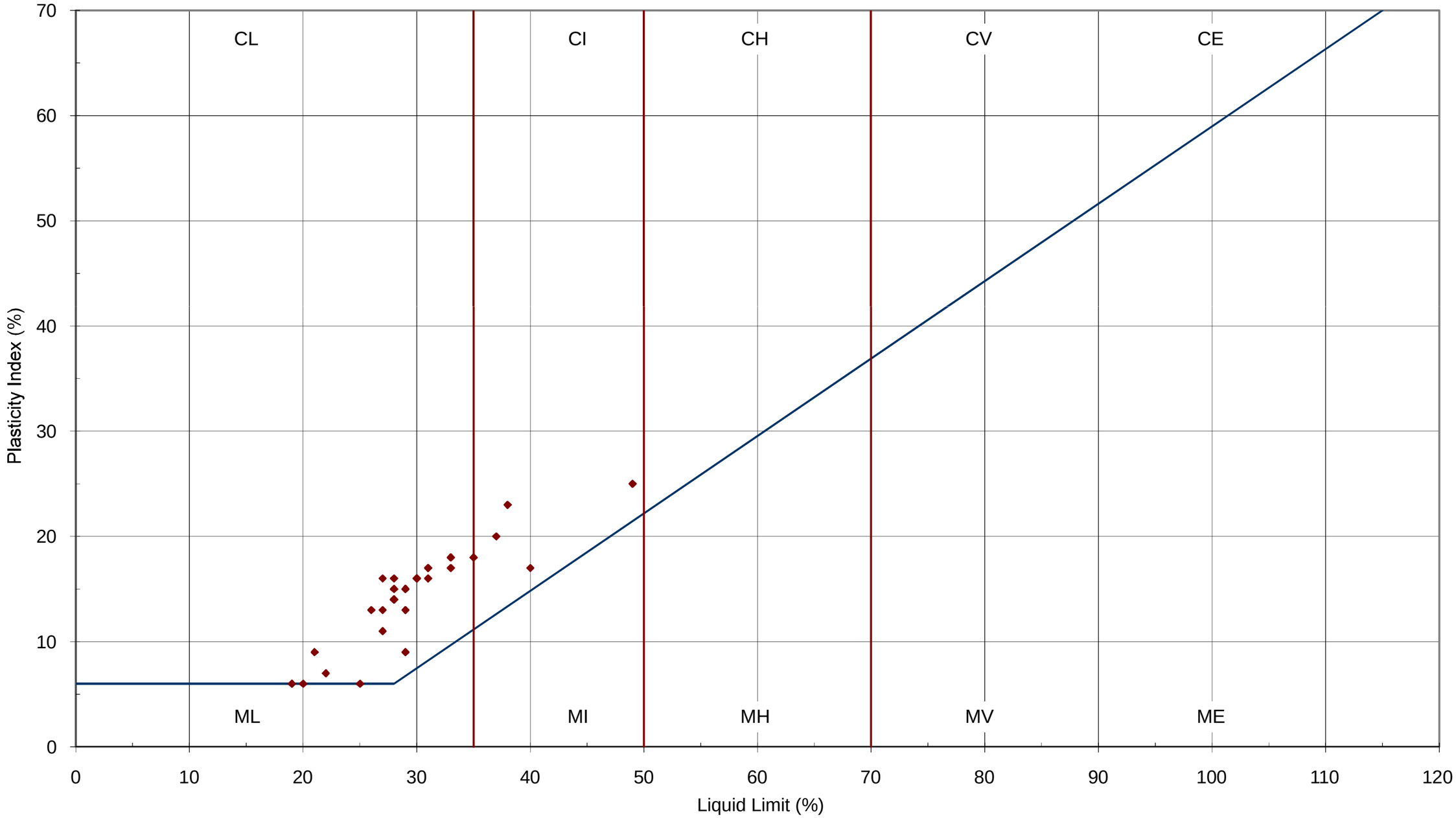
# Atterberg Limits - Glacial Till




| | | | | | | |
|---|---|---|---|---|---|---|
| **Project: Humber Multi-User Terminal** | | | | | | |
| Scale: NTS | Drawn: JMB | Chk: BJ | Date: OCTOBER 2010 | Job No: 027559 | Figure No: 17 | Rev: 00 |

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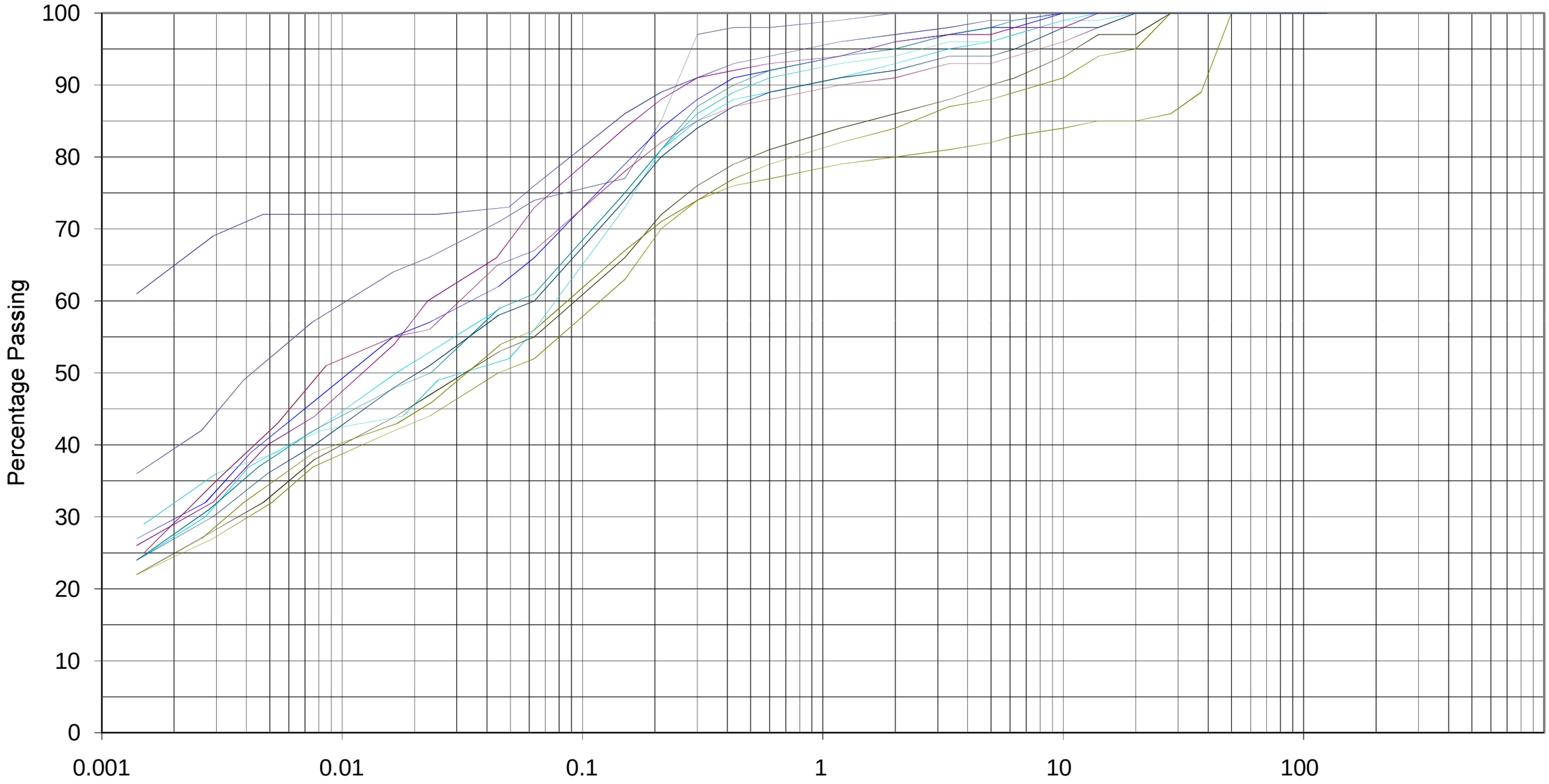
# Particle Size Distribution Curves - Glacial Till




| Clay | Fine | Medium | Coarse | Fine | Medium | Coarse | Fine | Medium | Coarse | Cobbles | Boulders |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | SILT | | | SAND | | | GRAVEL | | | | |

**Project: Humber Multi-User Terminal**

| Scale: NTS | Drawn: JMB | Chk: BJ | Date: OCTOBER 2010 | Job No: 027559 | Figure No: 18 | Rev: 00 |
|---|---|---|---|---|---|---|

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Email:brian.jackson@burohappold.com

# APPENDIX 3: Soil coring logs

| | | | |
|---|---|---|---|
| Project Name | Killingholme Marine Stage 1 GI | Exploratory Hole Log | Hole ID. |
| Project No. | F15842 | | VC01 |
| Engineer | Roger Tym & Partners | | Sheet 1 of 1 |
| Client | Yorkshire Forward | | |

| | | | |
|---|---|---|---|
| Ground Level | - | Coordinates | - |
| Hole Type | VC | Inclination | Vertical |

| Description of Strata | Legend | Depth Below G.L. | Datum Level | Sampling Details | Sampling Dia. | Blow Count And Sample Recovery TCR | SCR | RQD | In Situ Test Details | Install-ation |
|---|---|---|---|---|---|---|---|---|---|---|
| Soft grey mottled dark grey slightly sandy SILT. Sand is fine and medium. | | | | | | | | | | |
| | | 0.48 | | | | | | | | |
| Brown and dark grey clayey gravelly fine to coarse SAND. Gravel is subrounded to rounded fine to medium of chalk and flint.<br>from 0.67m to 0.72m 1 No persistent thin (<40mm) bed of soft dark grey silt | | 0.80 | | | | | | | | |
| Light brown fine to coarse SAND and subangular to rounded fine to medium occasionally coarse GRAVEL of chalk and light brown flint.<br>from 1.61m to 1.67m 1 No impersistent thick (<60mm) lense of light brown fine to coarse sand<br><br>from 2.15m to 2.17m 1 No persistent thin (<20mm) lense of brown fine and medium sand | | | | | | | | | | |
| | | 3.10 | | | | | | | | |
| Exploratory hole complete at 3.10 m. | | | | | | | | | | |

NOTES: All depths in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key

Log Print Date And Time: 29/07/2010 16:24:55

SOIL ENGINEERING

| | | | |
|---|---|---|---|
| Project Name | Killingholme Marine Stage 1 GI | Exploratory Hole Log | Hole ID. |
| Project No. | F15842 | | VC02 |
| Engineer | Roger Tym & Partners | | Sheet 1 of 1 |
| Client | Yorkshire Forward | | |

| | | | |
|---|---|---|---|
| Ground Level | - | Coordinates | - |
| Hole Type | VC | Inclination | Vertical |

| Description of Strata | Legend | Depth Below G.L. | Datum Level | Sampling Details | Sampling Dia. | Blow Count And Sample Recovery TCR | SCR | RQD | In Situ Test Details | Install-ation |
|---|---|---|---|---|---|---|---|---|---|---|
| Soft locally firm dark grey slightly sandy SILT. Sand is fine to coarse. | | 0.30 | | | | | | | | |
| Grey and brown slightly silty gravelly fine to coarse SAND. Gravel is subangular to rounded fine and medium of chalk and flint. | | 0.48 | | | | | | | | |
| Yellowish brown and light brown fine to coarse SAND and subangular to subrounded occasionally rounded fine to medium rarely coarse GRAVEL of chalk and light grey flint.<br>from 0.69m to 0.82m recovered as light brown slightly gravelly fine to coarse sand. Gravel is subrounded fine to medium of chalk<br>from 1.00m to 1.20m light grey and light brown | | 1.20 | | | | | | | | |
| Light grey and light brown fine to coarse SAND and angular to subrounded fine to medium GRAVEL of chalk and light brown flint.<br>at 1.23m 1 No medium gravel sized pocket of light brown fine to medium sand<br>at 1.48m 3 No angular to subangular coarse gravel sized fragments of black flint<br>from 1.57m to 1.61m 1 No coarse gravel sized pocket of dark brown and black fine to coarse sand with medium organic content<br>at 1.75m 1 No angular medium gravel sized pink shell fragment | | 2.22 | | | | | | | | |
| Grey slightly silty slightly gravelly fine to medium SAND. Gravel is subangular to subrounded fine to medium of chalk and flint.<br>from 3.35m to 3.67m gravelly. Gravel is angular to subrounded fine to medium of chalk, flint and white shell fragments<br>at 3.54m 1 No subrounded coarse gravel sized whole bivalve shell<br>from 3.80m to 3.94m with frequent angular to subangular fine gravel sized white shell fragments<br>from 5.25m to 5.35m and 5.45m to 5.58m gravelly. Gravel is angular to subrounded fine to medium of chalk, flint and white shell fragments<br>at 5.52m 1 No subangular coarse gravel sized fragment of sandstone | | 5.60 | | | | | | | | |
| Stiff locally firm brown slightly gravelly CLAY. Gravel is subangular to subrounded fine to medium rarely coarse of chalk, flint and quartzite. With occasional fine to medium gravel sized pockets of black silt.<br>at 5.77m 1 No subrounded coarse gravel sized fragment of sandstone | | 6.00 | | | | | | | | |
| Exploratory hole complete at 6.00 m. | | | | | | | | | | |

NOTES: All depths in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key

Log Print Date And Time: 29/07/2010 16:25:07



SOIL ENGINEERING

| | | | |
|---|---|---|---|
| Project Name | Killingholme Marine Stage 1 GI | Exploratory Hole Log | Hole ID. |
| Project No. | F15842 | | VC03 |
| Engineer | Roger Tym & Partners | | Sheet 1 of 1 |
| Client | Yorkshire Forward | | |

| | | | |
|---|---|---|---|
| Ground Level | - | Coordinates | - |
| Hole Type | VC | Inclination | Vertical |

| Description of Strata | Legend | Depth Below G.L. | Datum Level | Sampling Details | Sampling Dia. | Blow Count And Sample Recovery TCR | SCR | RQD | In Situ Test Details | Install-ation |
|---|---|---|---|---|---|---|---|---|---|---|
| Soft dark grey mottled grey slightly sandy SILT. Sand is fine and medium. | | | | | | | | | | |
| from 0.33m to 0.50m recovered as brown slightly silty fine to coarse sand | | | | | | | | | | |
| at 0.52m 1 No subrounded coarse gravel sized fragment of chalk | | 0.58 | | | | | | | | |
| Brown and light grey sandy subangular to subrounded fine to medium occasionally coarse GRAVEL of chalk and light brown flint. With low cobble content. Cobbles are subangular to subrounded of chalk and black flint. | | 0.89 | | | | | | | | |
| Stiff brown slightly gravelly CLAY. Gravel is subangular to rounded fine to medium of chalk, sandstone and mudstone. | | | | | | | | | | |
| at 1.91m 1 No persistent thin (<20mm) lense of brown fine to medium sand | | | | | | | | | | |
| from 1.96m to 2.10m recovered as light brown slightly gravelly fine to coarse sand. Gravel is subrounded fine to medium of chalk | | 2.10 | | | | | | | | |
| Light grey and light brown sandy subangular to rounded fine to medium GRAVEL of chalk and occasional flint. Sand is fine to coarse. | | 2.60 | | | | | | | | |
| at 2.16m, 2.38m and 2.45m 1 No persistent thin (<15mm) lense of firm brown mottled light brown silt | | | | | | | | | | |
| Exploratory hole complete at 2.60 m. | | | | | | | | | | |

NOTES: All depths in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key

Log Print Date And Time: 29/07/2010 16:25:22

| | | | |
|---|---|---|---|
| Project Name | Killingholme Marine Stage 1 GI | Exploratory Hole Log | Hole ID. VC04 |
| Project No. | F15842 | | Sheet 1 of 1 |
| Engineer | Roger Tym & Partners | | |
| Client | Yorkshire Forward | | |

| | | | |
|---|---|---|---|
| Ground Level | - | Coordinates | - |
| Hole Type | VC | Inclination | Vertical |

| Description of Strata | Legend | Depth Below G.L. | Datum Level | Sampling Details | Sampling Dia. | Blow Count And Sample Recovery TCR | SCR | RQD | In Situ Test Details | Install-ation |
|---|---|---|---|---|---|---|---|---|---|---|
| Reddish brown and brown slightly gravelly fine to coarse SAND. Gravel is subangular to subrounded fine of chalk. | | 0.14 | | | | | | | | |
| Soft locally firm dark grey slightly sandy SILT. Sand is fine and medium. | | 0.58 | | | | | | | | |
| Dark grey and brown slightly silty fine to coarse SAND and subangular to subrounded fine to coarse GRAVEL of flint and chalk.<br>from 1.10m to 1.20m with low cobble content. Cobbles are subangular to subrounded of chalk and sandstone | | 1.40 | | | | | | | | |
| Light grey and brown sandy angular to subangular fine to coarse GRAVEL of chalk, light brown flint and sandstone. Sand is fine to coarse. | | 2.70 | | | | | | | | |
| Firm to stiff brown slightly gravelly CLAY. Gravel is subangular to subrounded fine to coarse of chalk, light brown flint and rare sandstone.<br>from 3.30m to 4.00m stiff. Gravel is fine to medium<br>at 3.93m and 3.97m 2 No persistent thin (<10mm) lenses of brown fine to medium sand | | 4.10 | | | | | | | | |
| Exploratory hole complete at 4.10 m. | | | | | | | | | | |

NOTES: All depths in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key

Log Print Date And Time: 29/07/2010 16:25:33

SOIL ENGINEERING

A trading name of VINCI Construction UK Limited

| | | | |
|---|---|---|---|
| Project Name | Killingholme Marine Stage 1 GI | Exploratory Hole Log | Hole ID. |
| Project No. | F15842 | | VC05 |
| Engineer | Roger Tym & Partners | | Sheet 1 of 1 |
| Client | Yorkshire Forward | | |

| | | | |
|---|---|---|---|
| Ground Level | - | Coordinates | - |
| Hole Type | VC | Inclination | Vertical |

| Description of Strata | Legend | Depth Below G.L. | Datum Level | Sampling Details | Sampling Dia. | Blow Count And Sample Recovery TCR | SCR | RQD | In Situ Test Details | Install-ation |
|---|---|---|---|---|---|---|---|---|---|---|
| Soft dark grey and brown sandy SILT. Sand is fine to medium. | | | | | | | | | | |
| at 0.85m 1 No persistent thick lense of black silty peat from 0.85m to 1.25m frequent persistent thin to thick lenses of fine to medium brown sand | | 1.25 | | | | | | | | |
| Brown and grey slightly silty fine to coarse SAND with frequent persistent thick lenses of black peat and fine to medium brown sand. Slight organic odour. | | | | | | | | | | |
| Grey slightly silty slightly gravelly fine to coarse SAND. Gravel is subangular to subrounded fine to medium of chalk. | | 3.45<br>3.70 | | | | | | | | |
| Structureless CHALK composed of greyish white gravelly clayey silt. Gravel is very weak low to medium density white with occasional black specks subangular to subrounded fine to coarse. (Grade Dm) | | 4.40 | | | | | | | | |
| Exploratory hole complete at 4.40 m. | | | | | | | | | | |

NOTES: All depths in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key

Log Print Date And Time: 29/07/2010 16:25:43

SOIL ENGINEERING

| | | | |
|---|---|---|---|
| Project Name | Killingholme Marine Stage 1 GI | Exploratory Hole Log | Hole ID. |
| Project No. | F15842 | | VC06 |
| Engineer | Roger Tym & Partners | | Sheet 1 of 1 |
| Client | Yorkshire Forward | | |

| | | | |
|---|---|---|---|
| Ground Level | - | Coordinates | - |
| Hole Type | VC | Inclination | Vertical |

| Description of Strata | Legend | Depth Below G.L. | Datum Level | Sampling Details | Sampling Dia. | Blow Count And Sample Recovery TCR | SCR | RQD | In Situ Test Details | Install-ation |
|---|---|---|---|---|---|---|---|---|---|---|
| Reddish brown and brown fine to coarse SAND. | | | | | | | | | | |
| | | 0.26 | | | | | | | | |
| Soft locally firm greyish brown and dark grey sandy SILT. Sand is fine to coarse. With occasional to frequent persistent thick (<50mm) lenses of brown fine to coarse sand. | | | | | | | | | | |
| | | 3.20 | | | | | | | | |
| Light brown slightly silty fine to coarse SAND. With frequent persistent thick lenses (<50mm) of black pseudofibrous peat. Slight organic odour. | | | | | | | | | | |
| from 4.55m to 4.63m slightly gravelly. Gravel is subangular to rounded fine to medium of chalk, black flint and white shell fragments | | | | | | | | | | |
| | | 4.90 | | | | | | | | |
| Light brown slightly silty fine to coarse SAND. | | | | | | | | | | |
| | | 5.30 | | | | | | | | |
| Exploratory hole complete at 5.30 m. | | | | | | | | | | |

NOTES: All depths in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key

Log Print Date And Time: 29/07/2010 16:25:56



SOIL ENGINEERING

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|---|---|---|---|
| Project Name | Killingholme Marine Stage 1 GI | Exploratory Hole Log | Hole ID. |
| Project No. | F15842 | | VC07 |
| Engineer | Roger Tym & Partners | | Sheet 1 of 1 |
| Client | Yorkshire Forward | | |

| | | | |
|---|---|---|---|
| Ground Level | - | Coordinates | - |
| Hole Type | VC | Inclination | Vertical |

| Description of Strata | Legend | Depth Below G.L. | Datum Level | Sampling Details | Sampling Dia. | Blow Count And Sample Recovery TCR | SCR | RQD | In Situ Test Details | Install-ation |
|---|---|---|---|---|---|---|---|---|---|---|
| Soft black and dark grey slightly sandy SILT. | | | | | | | | | | |
| | | 0.90 | | | | | | | | |
| Brown and dark brown slightly silty fine to medium SAND with frequent persistent thick (<10mm) lenses of black pseudofibrous peat. Slight organic odour. | | | | | | | | | | |
| | | 2.60 | | | | | | | | |
| Exploratory hole complete at 2.60 m. | | | | | | | | | | |

NOTES: All depths in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key

Log Print Date And Time: 29/07/2010 16:26:07

SOIL ENGINEERING

| | | | |
|---|---|---|---|
| Project Name | Killingholme Marine Stage 1 GI | Exploratory Hole Log | Hole ID. |
| Project No. | F15842 | | VC08 |
| Engineer | Roger Tym & Partners | | Sheet 1 of 1 |
| Client | Yorkshire Forward | | |

| | | | |
|---|---|---|---|
| Ground Level | - | Coordinates | - |
| Hole Type | VC | Inclination | Vertical |

| Description of Strata | Legend | Depth Below G.L. | Datum Level | Sampling Details | Sampling Dia. | Blow Count And Sample Recovery TCR | SCR | RQD | In Situ Test Details | Install-ation |
|---|---|---|---|---|---|---|---|---|---|---|
| Soft locally firm brown mottled dark grey sandy SILT. Sand is fine and medium. | | | | | | | | | | |
| | | 0.45 | | | | | | | | |
| Light brown and brown slightly silty slightly gravelly fine to coarse SAND. Gravel is subrounded to rounded fine to medium of chalk. | | | | | | | | | | |
| from 0.92m to 0.95m 1 No thin (<30mm) lense of dark grey pseudofibrous peat | | | | | | | | | | |
| from 2.55m to 2.75m 5 No persistent thin (<10mm) lenses of black amorphous peat | | | | | | | | | | |
| from 3.10m to 4.70m with occasional impersistent thin (<10mm) lenses of black amorphous peat | | | | | | | | | | |
| | | 4.70 | | | | | | | | |
| Exploratory hole complete at 4.70 m. | | | | | | | | | | |

NOTES: All depths in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key

Log Print Date And Time: 29/07/2010 16:26:17



SOIL ENGINEERING

| | | | |
|---|---|---|---|
| Project Name | Killingholme Marine Stage 1 GI | Exploratory Hole Log | Hole ID. |
| Project No. | F15842 | | VC09 |
| Engineer | Roger Tym & Partners | | Sheet 1 of 1 |
| Client | Yorkshire Forward | | |

| | | | |
|---|---|---|---|
| Ground Level | - | Coordinates | - |
| Hole Type | VC | Inclination | Vertical |

| Description of Strata | Legend | Depth Below G.L. | Datum Level | Sampling Details | Sampling Dia. | Blow Count And Sample Recovery TCR | SCR | RQD | In Situ Test Details | Install-ation |
|---|---|---|---|---|---|---|---|---|---|---|
| Reddish brown and brown slightly gravelly fine to coarse SAND. Gravel is subrounded to rounded fine to coarse of black flint. | | 0.15 | | | | | | | | |
| Soft brown and dark grey slightly silty fine to medium SAND. With frequent persistent thick (<20mm) lenses of black amorphous peat. from 0.67m to 0.74m 1 No persistent thin bed (<70mm) of reddish brown slightly gravelly fine to coarse sand. Gravel is subangular to subrounded fine to medium of red sandstone and chalk | | 1.12 | | | | | | | | |
| Soft locally firm brown mottled dark brown slightly sandy SILT. Sand is fine and medium. | | 1.95 | | | | | | | | |
| Brown and grey slightly silty slightly gravelly fine to coarse SAND. Gravel is subrounded to rounded fine to medium occasionally coarse of chalk and black flint. from 2.50m to 2.70m with occasional impersistent thin (<10mm) lenses of black amorphous peat | | 2.70 | | | | | | | | |
| Exploratory hole complete at 2.70 m. | | | | | | | | | | |

NOTES: All depths in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key

Log Print Date And Time: 29/07/2010 16:26:30

SOIL ENGINEERING

| | | | |
|---|---|---|---|
| Project Name | Killingholme Marine Stage 1 GI | Exploratory Hole Log | Hole ID. |
| Project No. | F15842 | | VC10 |
| Engineer | Roger Tym & Partners | | Sheet 1 of 1 |
| Client | Yorkshire Forward | | |

| | | | |
|---|---|---|---|
| Ground Level | - | Coordinates | - |
| Hole Type | VC | Inclination | Vertical |

| Description of Strata | Legend | Depth Below G.L. | Datum Level | Sampling Details | Dia. | Blow Count And Sample Recovery TCR | SCR | RQD | In Situ Test Details | Install-ation |
|---|---|---|---|---|---|---|---|---|---|---|
| Brown and dark grey silty fine to coarse SAND. | | | | D001 0.20-0.40 | | | | | | |
| from 0.80m to 1.00m soft black silt | | | | | | | | | | |
| | | | | L002 1.50-1.70 | | | | | | |
| from 1.60m to 1.80m brown slightly silty fine to coarse sand | | | | | | | | | | |
| | | 1.90 | | L003 1.90-2.00 | | | | | | |
| Firm to stiff brown slightly gravelly CLAY. Gravel is subangular to subrounded fine to coarse of chalk, mudstone, sandstone and flint. | | 2.25 | | D004 2.25-2.35 | | | | | | |
| from 1.90m to 2.20m 2 No coarse gravel sized pockets of black fine to coarse sand | | | | | | | | | | |
| Structureless CHALK composed of grey mottled greenish grey slightly sandy gravelly silt. Gravel is very weak low density white stained yellowish brown subangular to subrounded fine to medium occasionally coarse. (Grade Dm) | | 3.20 | | | | | | | | |
| Exploratory hole complete at 3.20 m. | | | | | | | | | | |

NOTES: All depths in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key

SOIL ENGINEERING

Log Print Date And Time: 29/07/2010 16:26:42

| | | | |
|---|---|---|---|
| Project Name | Killingholme Marine Stage 1 GI | Exploratory Hole Log | Hole ID. VC11 |
| Project No. | F15842 | | |
| Engineer | Roger Tym & Partners | | Sheet 1 of 1 |
| Client | Yorkshire Forward | | |

| | | | |
|---|---|---|---|
| Ground Level | - | Coordinates | - |
| Hole Type | VC | Inclination | Vertical |

| Description of Strata | Legend | Depth Below G.L. | Datum Level | Sampling Details | Dia. | Blow Count And Sample Recovery TCR | SCR | RQD | In Situ Test Details | Install-ation |
|---|---|---|---|---|---|---|---|---|---|---|
| Brown gravelly fine to coarse SAND. Gravel is angular to subrounded fine to coarse of flint and sandstone. | | 0.30 | | D001 0.30-0.45<br>D002 0.45-0.55 | | | | | | |
| Firm to stiff reddish brown mottled light bluish grey slightly gravelly CLAY. Gravel is subangular to subrounded fine to coarse of chalk and mudstone. | | | | L003 0.75-1.00 | | | | | | |
| from 1.00m to 1.12m occasional coarse gravel sized pockets of black sandy silt. Sand is fine to medium | | 1.12 | | L004 1.00-1.12<br>D005 1.12-1.25<br>D006 1.25-1.35<br>L007 1.35-1.58 | | | | | | |
| Stiff locally firm brown mottled grey gravelly CLAY. Gravel is subangular to rounded fine to medium rarely coarse of chalk, flint, sandstone and mudstone. | | | | D008 2.00-2.20 | | | | | | |
| | | 2.20 | | | | | | | | |
| Exploratory hole complete at 2.20 m. | | | | | | | | | | |

NOTES: All depths in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key

Log Print Date And Time: 29/07/2010 16:26:52

| | | | |
|---|---|---|---|
| Project Name | Killingholme Marine Stage 1 GI | Exploratory Hole Log | Hole ID. |
| Project No. | F15842 | | VC12 |
| Engineer | Roger Tym & Partners | | Sheet 1 of 1 |
| Client | Yorkshire Forward | | |

| | | | |
|---|---|---|---|
| Ground Level | - | Coordinates | - |
| Hole Type | VC | Inclination | Vertical |

| Description of Strata | Legend | Depth Below G.L. | Datum Level | Sampling Details | Sampling Dia. | Blow Count And Sample Recovery TCR | SCR | RQD | In Situ Test Details | Install-ation |
|---|---|---|---|---|---|---|---|---|---|---|
| Reddish brown and brown slightly gravelly fine to coarse SAND. Gravel is subrounded to rounded fine occasionally medium of chalk. | | 0.40 | | | | | | | | |
| Brown and light brown slightly silty fine to coarse SAND.<br>from 0.45m to 0.50m 3 No medium to coarse gravel sized pockets of black pseudofibrous peat. Slightly organic odour<br>at 0.80m 1 No persistent thick (<15mm) lamination of black amorphous peat<br>from 0.95m to 1.00m 3 No subrounded to rounded coarse gravel sized fragments of black flint<br>from 1.50m to 1.70m silty with frequent persistent thick (<10mm) lamination of black amorphous peat<br>at 1.65m 1 No subrounded medium gravel sized fragment of chalk<br>from 2.00m to 2.40m soft black slightly sandy silt. Sand is fine to medium | | | | D001 1.20-1.45<br>D002 1.80-2.00 | | | | | | |
| Brown slightly silty fine to coarse SAND.<br>from 4.10m to 4.30m slightly gravelly. Gravel is subangular to subrounded fine to medium of chalk | | 3.90<br>4.30 | | | | | | | | |
| Exploratory hole complete at 4.30 m. | | | | | | | | | | |

NOTES: All depths in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key

Log Print Date And Time: 29/07/2010 16:27:05

SOIL ENGINEERING

| | | | |
|---|---|---|---|
| Project Name | Killingholme Marine Stage 1 GI | Exploratory Hole Log | Hole ID. |
| Project No. | F15842 | | VC13 |
| Engineer | Roger Tym & Partners | | Sheet 1 of 1 |
| Client | Yorkshire Forward | | |

| | | | |
|---|---|---|---|
| Ground Level | - | Coordinates | - |
| Hole Type | VC | Inclination | Vertical |

| Description of Strata | Legend | Depth Below G.L. | Datum Level | Sampling Details | Sampling Dia. | Blow Count And Sample Recovery TCR | SCR | RQD | In Situ Test Details | Install-ation |
|---|---|---|---|---|---|---|---|---|---|---|
| Brown and dark grey slightly silty fine to coarse SAND. | | | | | | | | | | |
| from 0.20m to 0.30m and 0.70m to 0.80m 2 No persistent thin (<100mm) beds of black amorphous peat | | | | D001 0.80-1.00 | | | | | | |
| | | | | L002 1.30-1.55 | | | | | | |
| from 1.55m to 1.63m black slightly sandy angular to subrounded fine to medium gravel of chalk and white shell fragments. Sand is fine to coarse | | 1.63 | | D003 1.90-2.00 | | | | | | |
| Structureless CHALK composed of white mottled cream slightly gravelly silt. Gravel is very weak low density white with occasional yellowish brown staining subangular to subrounded fine to coarse. (Grade Dm) | | | | | | | | | | |
| from 2.15m to 2.40m yellowish brown mottled white | | | | | | | | | | |
| from 2.60m to 2.70m greenish grey mottled white | | | | L004 3.00-3.25 | | | | | | |
| | | 3.37 | | | | | | | | |
| Structureless CHALK composed of slightly sandy silty angular to subrounded fine to coarse gravel with low cobble content. Cobbles are subrounded. Clasts are very weak to weak low rarely medium density white stained yellowish brown and with occasional black specks. Matrix is white mottled cream. (Grade Dm) | | 3.80 | | | | | | | | |
| Exploratory hole complete at 3.80 m. | | | | | | | | | | |

NOTES: All depths in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key

Log Print Date And Time: 29/07/2010 16:27:16

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|---|---|---|---|
| Project Name | Killingholme Marine Stage 1 GI | Exploratory Hole Log | Hole ID. |
| Project No. | F15842 | | VC14 |
| Engineer | Roger Tym & Partners | | Sheet 1 of 1 |
| Client | Yorkshire Forward | | |

| | | | |
|---|---|---|---|
| Ground Level | - | Coordinates | - |
| Hole Type | VC | Inclination | Vertical |

| Description of Strata | Legend | Depth Below G.L. | Datum Level | Sampling Details | Sampling Dia. | Blow Count And Sample Recovery TCR | SCR | RQD | In Situ Test Details | Install-ation |
|---|---|---|---|---|---|---|---|---|---|---|
| Brown and dark grey slightly sandy subangular to rounded fine to coarse GRAVEL of sandstone and chalk. Sand is fine to coarse. | | 0.25 | | D001 0.00-0.25<br>L002 0.25-0.48 | | | | | | |
| Firm to stiff brown slightly sandy slightly gravelly CLAY. Sand is fine to medium. Gravel is subrounded to rounded fine to medium of chalk, sandstone, flint and mudstone.<br>at 0.65m 1 No tube (<10mm) infilled with decomposed wood | | | | D003 0.80-1.00<br>L004 1.00-1.15<br>D005 1.60-1.80 | | | | | | |
| | | 1.80 | | | | | | | | |
| Exploratory hole complete at 1.80 m. | | | | | | | | | | |

NOTES: All depths in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key

Log Print Date And Time: 29/07/2010 16:27:29

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|---|---|---|---|
| Project Name | Killingholme Marine Stage 1 GI | Exploratory Hole Log | Hole ID. |
| Project No. | F15842 | | VC15 |
| Engineer | Roger Tym & Partners | | Sheet 1 of 1 |
| Client | Yorkshire Forward | | |

| | | | |
|---|---|---|---|
| Ground Level | - | Coordinates | - |
| Hole Type | VC | Inclination | Vertical |

| Description of Strata | Legend | Depth Below G.L. | Datum Level | Sampling Details | Dia. | Blow Count And Sample Recovery TCR | SCR | RQD | In Situ Test Details | Install-ation |
|---|---|---|---|---|---|---|---|---|---|---|
| Reddish brown and brown slightly gravelly slightly silty fine to coarse SAND. Gravel is subrounded to rounded fine to medium of white gastropods. | | 0.26 | | D001 0.30-0.40 | | | | | | |
| Brown and dark brown slightly silty fine to coarse SAND. at 0.31m and 0.49m 2 No persistent thick (<30mm) laminations of black amorphous peat | | 1.30 | | L002 1.30-1.55 | | | | | | |
| Dark brown silty fine to medium SAND with frequent persistent thick (<10mm) laminations of black amorphous peat. | | | | D003 1.80-2.00 | | | | | | |
| | | 2.20 | | D004 2.15-2.25 | | | | | | |
| Dark grey and brown sandy angular to subangular fine to coarse GRAVEL of flint and chalk. Sand is fine to coarse. at 2.30m 2 No subangular to subrounded coarse gravel sized fragments of chalk | | 2.36 | | B005 2.36-2.50 | | | | | | |
| Dark brown clayey subangular to subrounded fine to coarse GRAVEL of chalk and rare flint. | | 2.60 | | | | | | | | |
| Exploratory hole complete at 2.60 m. | | | | | | | | | | |

NOTES: All depths in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key

Log Print Date And Time: 29/07/2010 16:27:43

| | | | |
|---|---|---|---|
| Project Name | Killingholme Marine Stage 1 GI | Exploratory Hole Log | Hole ID. |
| Project No. | F15842 | | VC16 |
| Engineer | Roger Tym & Partners | | Sheet 1 of 1 |
| Client | Yorkshire Forward | | |

| | | | |
|---|---|---|---|
| Ground Level | - | Coordinates | - |
| Hole Type | VC | Inclination | Vertical |

| Description of Strata | Legend | Depth Below G.L. | Datum Level | Sampling Details | Dia. | Blow Count And Sample Recovery TCR | SCR | RQD | In Situ Test Details | Install-ation |
|---|---|---|---|---|---|---|---|---|---|---|
| Reddish brown and brown slightly gravelly fine to coarse SAND. Gravel is subrounded to rounded fine occasionally medium of chalk. | | 0.25 | | D001 0.00-0.25<br>L002 0.25-0.50<br>D003 0.50-0.70<br>L004 0.70-0.95 | | | | | | |
| Firm to stiff brown mottled dark grey gravelly CLAY. Gravel is subangular to subrounded fine to medium occasionally coarse of chalk, sandstone and flint. | | 1.30 | | D005 1.20-1.30 | | | | | | |
| Structureless CHALK composed of white mottled grey and light yellowish brown gravelly silt. Gravel is very weak to weak to weak low to medium density white stained yellowish brown subangular to subrounded fine to coarse. (Grade Dm) | | | | D006 1.80-2.00<br>L007 2.10-2.35 | | | | | | |
| | | 3.40 | | | | | | | | |
| Exploratory hole complete at 3.40 m. | | | | | | | | | | |

NOTES: All depths in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key

Log Print Date And Time: 29/07/2010 16:27:55

| | | | |
|---|---|---|---|
| Project Name | Killingholme Marine Stage 1 GI | Exploratory Hole Log | Hole ID. |
| Project No. | F15842 | | VC17 |
| Engineer | Roger Tym & Partners | | Sheet 1 of 1 |
| Client | Yorkshire Forward | | |

| | | | |
|---|---|---|---|
| Ground Level | - | Coordinates | - |
| Hole Type | VC | Inclination | Vertical |

| Description of Strata | Legend | Depth Below G.L. | Datum Level | Sampling Details | Sampling Dia. | Blow Count And Sample Recovery TCR | SCR | RQD | In Situ Test Details | Install-ation |
|---|---|---|---|---|---|---|---|---|---|---|
| Firm brown slightly gravelly sandy CLAY. Gravel is subangular to subrounded fine to medium of chalk. Sand is fine with rare pockets of greenish grey clayey peat (20mm). | | 0.20 | | | | | | | | |
| Brown slightly clayey gravelly fine to coarse SAND. Gravel is subangular to subrounded fine to medium of chalk, flint and sandstone.<br>from 0.32m to 0.35m 1 No very thin bed of firm brown sandy clay. Sand is fine to medium | | 0.82 | | | | | | | | |
| Firm to stiff slightly sandy slightly gravelly CLAY. Sand is fine and medium. Gravel is subangular to rounded of chalk, sandstone, flint and mudstone.<br>from 0.90m to 1.00m sandy fine to coarse<br>from 1.29m to 1.32m 1 No pocket of brown slightly clayey fine to coarse sand (60mm)<br><br>from 2.39m to 2.62m light grey mottled brown gravelly. Gravel is subangular to subrounded fine and medium of chalk | | | | | | | | | | |
| Exploratory hole complete at 4.10 m. | | 4.10 | | | | | | | | |

NOTES: All depths in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key

Log Print Date And Time: 29/07/2010 16:28:06

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|---|---|---|---|
| Project Name | Killingholme Marine Stage 1 GI | Exploratory Hole Log | Hole ID. |
| Project No. | F15842 | | VC18 |
| Engineer | Roger Tym & Partners | | Sheet 1 of 1 |
| Client | Yorkshire Forward | | |

| | | | |
|---|---|---|---|
| Ground Level | - | Coordinates | - |
| Hole Type | VC | Inclination | Vertical |

| Description of Strata | Legend | Depth Below G.L. | Datum Level | Sampling Details | Sampling Dia. | Blow Count And Sample Recovery TCR | SCR | RQD | In Situ Test Details | Install-ation |
|---|---|---|---|---|---|---|---|---|---|---|
| Dark greenish brown sandy SILT. Sand is fine to medium. | | | | | | | | | | |
| | | 0.36 | | | | | | | | |
| Brown clayey gravelly fine to coarse SAND. Gravel is angular to subangular fine and medium of flint, chalk and mudstone. | | | | | | | | | | |
| | | 0.90 | | | | | | | | |
| Firm brown slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is angular to subangular fine and medium of flint and chalk. | | | | | | | | | | |
| from 3.10m to 3.20m stiff locally firm brown slightly sandy gravelly clay. Sand is fine to coarse. Gravel is angular to subangular fine to coarse of chalk and flint | | | | | | | | | | |
| | | 4.30 | | | | | | | | |
| Stiff locally firm slightly gravelly CLAY. Gravel is subrounded to rounded fine and medium of chalk, flint, sandstone and mudstone. | | | | | | | | | | |
| | | 4.70 | | | | | | | | |
| Firm brown slightly gravelly sandy CLAY. Gravel is subangular to subrounded fine to coarse of chalk, flint and sandstone. Sand is fine to coarse. | | | | | | | | | | |
| | | 5.20 | | | | | | | | |
| Exploratory hole complete at 5.20 m. | | | | | | | | | | |

NOTES: All depths in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key

Log Print Date And Time: 29/07/2010 16:28:20

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|---|---|---|---|
| Project Name | Killingholme Marine Stage 1 GI | Exploratory Hole Log | Hole ID. VC19 |
| Project No. | F15842 | | Sheet 1 of 1 |
| Engineer | Roger Tym & Partners | | |
| Client | Yorkshire Forward | | |

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|---|---|---|---|
| Ground Level | - | Coordinates | - |
| Hole Type | VC | Inclination | Vertical |

| Description of Strata | Legend | Depth Below G.L. | Datum Level | Sampling Details | Sampling Dia. | Blow Count And Sample Recovery TCR | SCR | RQD | In Situ Test Details | Install-ation |
|---|---|---|---|---|---|---|---|---|---|---|
| Very soft to soft thickly laminated brown and dark grey slightly sandy silty CLAY with some pockets (10-60mm) of brown fine and medium sand. Sand Is fine and medium. Slight organic odour. | | | | | | | | | | |
| from 1.00m to 1.26m slightly gravelly. Gravel Is angular fine and medium of flint | | 1.26 | | | | | | | | |
| Grey clayey fine and medium SAND. | | 1.64 | | | | | | | | |
| Firm brown mottled grey slightly sandy slightly gravelly CLAY. Sand Is fine to coarse. Gravel Is subangular fine to coarse of mudstone, sandstone, chalk and flint. from 1.78m to 1.86m 1 No pocket (80mm) of grey clayey fine to coarse sand | | 2.20 | | | | | | | | |
| Stiff brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse of chalk, chert , flint and mudstone. | | 3.20 | | | | | | | | |
| Exploratory hole complete at 3.20 m. | | | | | | | | | | |

NOTES: All depths in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key

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SOIL ENGINEERING

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|---|---|---|---|
| Project Name | Killingholme Marine Stage 1 GI | Exploratory Hole Log | Hole ID. |
| Project No. | F15842 | | VC20 |
| Engineer | Roger Tym & Partners | | Sheet 1 of 1 |
| Client | Yorkshire Forward | | |

| | | | |
|---|---|---|---|
| Ground Level | - | Coordinates | - |
| Hole Type | VC | Inclination | Vertical |

| Description of Strata | Legend | Depth Below G.L. | Datum Level | Sampling Details | Sampling Dia. | Blow Count And Sample Recovery TCR | SCR | RQD | In Situ Test Details | Install-ation |
|---|---|---|---|---|---|---|---|---|---|---|
| Very soft dark grey mottled brown clayey SILT with some lenses (10-45mm) of brown clayey fine and medium sand. Organic odour noted. | | | | | | | | | | |
| | | 2.20 | | | | | | | | |
| Soft to firm grey silty CLAY with many pockets of black pseudofibrous peat. Organic odour noted. | | 2.50 | | | | | | | | |
| Firm brown sandy organic CLAY with many pockets of black fibrous plant material (roots?) (60-80mm). Sand is fine.<br>at 2.58m 1 No subrounded fine gravel of flint | | 2.80 | | | | | | | | |
| Firm to stiff brown mottled grey slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine and medium of chalk, flint and mudstone.<br>at 2.87m 1 No pocket (20mm) of black fibrous peat<br>at 3.46m 1 No pocket (50mm) of grey fine and medium sand | | 3.80 | | | | | | | | |
| Exploratory hole complete at 3.80 m. | | | | | | | | | | |

NOTES: All depths in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key

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SOIL ENGINEERING
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|---|---|---|---|
| Project Name | Killingholme Marine Stage 1 GI | Exploratory Hole Log | Hole ID. |
| Project No. | F15842 | | VC21 |
| Engineer | Roger Tym & Partners | | Sheet 1 of 1 |
| Client | Yorkshire Forward | | |

| | | | |
|---|---|---|---|
| Ground Level | - | Coordinates | - |
| Hole Type | VC | Inclination | Vertical |

| Description of Strata | Legend | Depth Below G.L. | Datum Level | Sampling Details | Sampling Dia. | Blow Count And Sample Recovery TCR | SCR | RQD | In Situ Test Details | Install-ation |
|---|---|---|---|---|---|---|---|---|---|---|
| Very soft to soft thickly laminated dark grey and brown clayey SILT. Organic odour noted. | | | | | | | | | | |
| from 1.15m to 1.25m with some lenses of brown clayey fine sand (20-45mm) | | | | | | | | | | |
| | | 1.50 | | | | | | | | |
| Soft to firm brown CLAY with many pockets (5-20mm) of black and brown kelp, seaweed and plant remains. Strong organic odour noted. | | | | | | | | | | |
| from 2.60m to 2.68m thick laminations of red brown and light brown decayed plant remains | | | | | | | | | | |
| | | 3.10 | | | | | | | | |
| Firm to stiff brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine and medium of chalk, flint, mudstone and chert. | | | | | | | | | | |
| from 3.85m to 4.00m very clayey fine and medium sand | | | | | | | | | | |
| from 4.42m to 4.55m sandy with some pockets (50mm) of clayey fine and medium sand | | | | | | | | | | |
| | | 4.80 | | | | | | | | |
| Exploratory hole complete at 4.80 m. | | | | | | | | | | |

NOTES: All depths in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key

Log Print Date And Time: 29/07/2010 16:28:58

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|---|---|---|---|
| Project Name | Killingholme Marine Stage 1 GI | Exploratory Hole Log | Hole ID. |
| Project No. | F15842 | | VC22 |
| Engineer | Roger Tym & Partners | | Sheet 1 of 1 |
| Client | Yorkshire Forward | | |

| | | | |
|---|---|---|---|
| Ground Level | - | Coordinates | - |
| Hole Type | VC | Inclination | Vertical |

| Description of Strata | Legend | Depth Below G.L. | Datum Level | Sampling Details | Sampling Dia. | Blow Count And Sample Recovery TCR | SCR | RQD | In Situ Test Details | Install-ation |
|---|---|---|---|---|---|---|---|---|---|---|
| Very soft to soft dark grey and brown sandy SILT. Sand is fine. Organic odour noted. | | 0.37 | | | | | | | | |
| Brown fine and medium SAND. | | 0.55 | | | | | | | | |
| Very soft dark grey slightly sandy clayey SILT. Sand is fine. Organic odour noted. | | 0.70 | | | | | | | | |
| Firm to stiff brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine and medium of flint, chalk and mudstone. | | | | | | | | | | |
| from 1.80m to 1.84m 1 No pocket (40mm) of grey slightly | | 2.14 | | | | | | | | |
| Firm to stiff brown mottled grey and white slightly sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of chalk. (Transitional boundary) | | 2.37 | | | | | | | | |
| Structureless CHALK composed of light greyish white and grey slightly sandy slightly gravelly clay. Gravel is weak medium density white subangular to subrounded. (CIRIA Grade Dm) | | | | | | | | | | |
| | | 3.60 | | | | | | | | |
| Exploratory hole complete at 3.60 m. | | | | | | | | | | |

NOTES: All depths in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key

Log Print Date And Time: 29/07/2010 16:29.09

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|---|---|---|---|
| Project Name | Killingholme Marine Stage 1 GI | Exploratory Hole Log | Hole ID. |
| Project No. | F15842 | | VC23 |
| Engineer | Roger Tym & Partners | | Sheet 1 of 1 |
| Client | Yorkshire Forward | | |

| | | | |
|---|---|---|---|
| Ground Level | - | Coordinates | - |
| Hole Type | VC | Inclination | Vertical |

| Description of Strata | Legend | Depth Below G.L. | Datum Level | Sampling Details | Sampling Dia. | Blow Count And Sample Recovery TCR | SCR | RQD | In Situ Test Details | Install-ation |
|---|---|---|---|---|---|---|---|---|---|---|
| Firm to stiff brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular to rounded fine to coarse of chalk, chert, flint and mudstone.<br>from 0.25m to 0.40m sandy<br><br>from 2.88m to 3.00m 1 No subrounded cobble of sandstone (120mm) | | | | | | | | | | |
| | | 3.55 | | | | | | | | |
| Exploratory hole complete at 3.55 m. | | | | | | | | | | |

NOTES: All depths in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key

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SOIL ENGINEERING

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|---|---|---|---|
| Project Name | Killingholme Marine Stage 1 GI | Exploratory Hole Log | Hole ID. |
| Project No. | F15842 | | VC24 |
| Engineer | Roger Tym & Partners | | Sheet 1 of 1 |
| Client | Yorkshire Forward | | |

| | | | |
|---|---|---|---|
| Ground Level | - | Coordinates | - |
| Hole Type | VC | Inclination | Vertical |

| Description of Strata | Legend | Depth Below G.L. | Datum Level | Sampling Details | Sampling Dia. | Blow Count And Sample Recovery TCR | SCR | RQD | In Situ Test Details | Install-ation |
|---|---|---|---|---|---|---|---|---|---|---|
| Very soft dark grey clayey SILT. (Strong organic odour) | | | | | | | | | | |
| from 0.75m with occasional pockets (10-25mm) of brown clayey sand | | | | | | | | | | |
| from 1.50m to 1.58m with occasional subrounded medium gravel of flint and mudstone | | 1.58 | | | | | | | | |
| Firm to stiff brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular to rounded fine and medium of chalk, flint, chert, sandstone and mudstone. | | | | | | | | | | |
| from 2.20m to 2.34m silty | | 2.40 | | | | | | | | |
| Firm to stiff brown CLAY. | | | | | | | | | | |
| from 3.10m to 3.27m 1 No thin bed of brown clayey fine to coarse sand | | | | | | | | | | |
| from 3.56m to 3.60m slightly sandy. Sand is fine to coarse | | 3.60 | | | | | | | | |
| Exploratory hole complete at 3.60 m. | | | | | | | | | | |

NOTES: All depths in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key

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SOIL ENGINEERING

| | | | |
|---|---|---|---|
| Project Name | Killingholme Marine Stage 1 GI | Exploratory Hole Log | Hole ID. |
| Project No. | F15842 | | VC25 |
| Engineer | Roger Tym & Partners | | Sheet 1 of 1 |
| Client | Yorkshire Forward | | |

| | | | |
|---|---|---|---|
| Ground Level | - | Coordinates | - |
| Hole Type | VC | Inclination | Vertical |

| Description of Strata | Legend | Depth Below G.L. | Datum Level | Sampling Details | Sampling Dia. | Blow Count And Sample Recovery TCR | SCR | RQD | In Situ Test Details | Install-ation |
|---|---|---|---|---|---|---|---|---|---|---|
| Very soft dark grey clayey SILT. (Organic odour noted). | | | | | | | | | | |
| | | 0.55 | | | | | | | | |
| Firm to stiff brown slightly sandy slightly gravelly CLAY with occasional pockets (10-40mm) of brown clayey fine and medium sand. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of chalk and sandstone. from 0.85m to 0.88m 1 No very thin bed of grey silt (possibly drilling induced) | | | | | | | | | | |
| | | 1.32 | | | | | | | | |
| Brown very clayey fine to coarse SAND and subangular to subrounded fine to coarse GRAVEL of chalk and flint. | | | | | | | | | | |
| | | 1.95 | | | | | | | | |
| Firm to stiff brown slightly sandy slightly gravelly CLAY with rare pockets (10-30mm) of brown fine and medium sand. Sand is fine to coarse. Gravel is subangular to rounded fine to coarse of chalk, flint, chert and sandstone. from 2.00m to 2.10m with occasional thick laminations of fine and medium sand | | | | | | | | | | |
| | | 3.17 | | | | | | | | |
| Exploratory hole complete at 3.17 m. | | | | | | | | | | |

NOTES: All depths in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key

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SOIL ENGINEERING

| | | | |
|---|---|---|---|
| Project Name | Killingholme Marine Stage 1 GI | Exploratory Hole Log | Hole ID. |
| Project No. | F15842 | | VC26 |
| Engineer | Roger Tym & Partners | | Sheet 1 of 1 |
| Client | Yorkshire Forward | | |

| | | | |
|---|---|---|---|
| Ground Level | - | Coordinates | - |
| Hole Type | VC | Inclination | Vertical |

| Description of Strata | Legend | Depth Below G.L. | Datum Level | Sampling Details | Sampling Dia. | Blow Count And Sample Recovery TCR | SCR | RQD | In Situ Test Details | Install-ation |
|---|---|---|---|---|---|---|---|---|---|---|
| Thinly laminated grey clayey slightly gravelly SILT. Gravel is subangular fine to coarse of chalk, mudstone and flint. | | | | | | | | | | |
| | | 1.05 | | | | | | | | |
| Firm brown silty slightly gravelly CLAY. Gravel is subangular fine to coarse of mudstone, chalk and flint. | | 1.26 | | | | | | | | |
| | | 1.40 | | | | | | | | |
| Grey slightly sandy slightly gravelly clayey organic SILT. Sand is fine to coarse. Gravel is subangular fine to coarse of chalk, mudstone and flint. | | | | | | | | | | |
| Stiff brown thinly laminated slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular fine to coarse of sandstone, chalk, flint and mudstone. | | | | | | | | | | |
| | | 3.70 | | | | | | | | |
| Exploratory hole complete at 3.70 m. | | | | | | | | | | |

NOTES: All depths in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key

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SOIL ENGINEERING

| | | | |
|---|---|---|---|
| Project Name | Killingholme Marine Stage 1 GI | Exploratory Hole Log | Hole ID. |
| Project No. | F15842 | | VC27 |
| Engineer | Roger Tym & Partners | | Sheet 1 of 1 |
| Client | Yorkshire Forward | | |

| | | | |
|---|---|---|---|
| Ground Level | - | Coordinates | - |
| Hole Type | VC | Inclination | Vertical |

| Description of Strata | Legend | Depth Below G.L. | Datum Level | Sampling Details | Sampling Dia. | Blow Count And Sample Recovery TCR | SCR | RQD | In Situ Test Details | Install-ation |
|---|---|---|---|---|---|---|---|---|---|---|
| Brown slightly clayey gravelly fine to coarse SAND. Gravel is subangular fine to coarse of chalk. | | | | | | | | | | |
| | | 0.45 | | | | | | | | |
| Stiff brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular fine to coarse of flint, mudstone and chalk. | | | | | | | | | | |
| | | 4.90 | | | | | | | | |
| Exploratory hole complete at 4.90 m. | | | | | | | | | | |

NOTES: All depths in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key

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|---|---|---|---|
| Project Name | Killingholme Marine Stage 1 GI | Exploratory Hole Log | Hole ID. |
| Project No. | F15842 | | VC28 |
| Engineer | Roger Tym & Partners | | Sheet 1 of 1 |
| Client | Yorkshire Forward | | |

| | | | |
|---|---|---|---|
| Ground Level | - | Coordinates | - |
| Hole Type | VC | Inclination | Vertical |

| Description of Strata | Legend | Depth Below G.L | Datum Level | Sampling Details | Sampling Dia. | Blow Count And Sample Recovery TCR | SCR | RQD | In Situ Test Details | Install-ation |
|---|---|---|---|---|---|---|---|---|---|---|
| Firm to stiff brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular fine to coarse of chalk, mudstone and flint. | | | | | | | | | | |
| | | 2.00 | | | | | | | | |
| Stiff to very stiff brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular fine to coarse of chalk, mudstone and flint. | | | | | | | | | | |
| from 3.00m to 3.40m mottled grey | | | | | | | | | | |
| | | 4.30 | | | | | | | | |
| Exploratory hole complete at 4.30 m. | | | | | | | | | | |

NOTES: All depths in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key

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SOIL ENGINEERING

| | | | |
|---|---|---|---|
| Project Name | Killingholme Marine Stage 1 GI | Exploratory Hole Log | Hole ID. |
| Project No. | F15842 | | VC29 |
| Engineer | Roger Tym & Partners | | Sheet 1 of 1 |
| Client | Yorkshire Forward | | |

| | | | |
|---|---|---|---|
| Ground Level | - | Coordinates | - |
| Hole Type | VC | Inclination | Vertical |

| Description of Strata | Legend | Depth Below G.L. | Datum Level | Sampling Details | Sampling Dia. | Blow Count And Sample Recovery TCR | SCR | RQD | In Situ Test Details | Install-ation |
|---|---|---|---|---|---|---|---|---|---|---|
| Grey slightly sandy SILT. | | | | | | | | | | |
| | | 0.90 | | | | | | | | |
| Firm to stiff brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular fine to coarse of chalk, flint and mudstone. | | | | | | | | | | |
| | | 2.90 | | | | | | | | |
| Exploratory hole complete at 2.90 m. | | | | | | | | | | |

NOTES: All depths in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key

Log Print Date And Time: 29/07/2010 16:30:28

| | | | |
|---|---|---|---|
| Project Name | Killingholme Marine Stage 1 GI | Exploratory Hole Log | Hole ID. |
| Project No. | F15842 | | VC30 |
| Engineer | Roger Tym & Partners | | Sheet 1 of 1 |
| Client | Yorkshire Forward | | |

| | | | |
|---|---|---|---|
| Ground Level | - | Coordinates | - |
| Hole Type | VC | Inclination | Vertical |

| Description of Strata | Legend | Depth Below G.L. | Datum Level | Sampling Details | Sampling Dia. | Blow Count And Sample Recovery TCR | SCR | RQD | In Situ Test Details | Install-ation |
|---|---|---|---|---|---|---|---|---|---|---|
| Grey and brown thinly laminated slightly sandy slightly gravelly organic SILT. Sand is fine to coarse. Gravel is subangular fine to medium of chalk. | | | | | | | | | | |
| Stiff brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular fine to coarse of chalk, flint and mudstone. | | 1.66 | | | | | | | | |
| Exploratory hole complete at 3.00 m. | | 3.00 | | | | | | | | |

NOTES: All depths in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key

Log Print Date And Time: 29/07/2010 16:30:40

SOIL ENGINEERING

# Humber Field Archaeology

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Project Management • Desk-based Assessment • Field Survey • Excavation
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Humber Field Archaeology is an independently-funded part of the Humber Archaeology Partnership, a partnership serving The East Riding of Yorkshire Council and Kingston upon Hull City Council