Immingham Green Energy Terminal

TR030008

Volume 6

6.4 Environmental Statement Appendices

Appendix 14.G: Report on Geoarchaeological Survey and monitoring of Geotechnical Investigations

Planning Act 2008

Regulation 5(2)(a)

Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009 (as amended)

September 2023

Infrastructure Planning

Planning Act 2008

The Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009 (as amended)

Immingham Green Energy Terminal

Development Consent Order 2023

Appendix 14.G: Report on Geoarchaeological Survey and monitoring of Geotechnical Investigations

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Regulation Reference	APFP Regulation 5(2)(a)
Planning Inspectorate Case Reference	TR030008
Application Document Reference	TR030008/APP/6.4
Author	Associated British Ports Air Product BR

Version	Date	Status of Version
Revision 1	21 September 2023	DCO Application

NH3 Immingham Green Energy Terminal

Geoarchaeological Borehole Survey and Watching Brief on GI Works

Document Ref.:271001.03
May 2023

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Document Information

Document title	NH3 Immingham Green Energy Terminal
Document subtitle	Geoarchaeological Borehole Survey and Watching Brief
Document reference	271001.03
Commissioned by	AECOM Ltd (Leeds)
Address	5th Floor 2 City Walk Leeds LS11 9AR
Site location	Land off Kings Road, Immingham, North Lincolnshire, DN40 1QT
County	Lincolnshire
National grid reference (NGR)	NGR 519890, 414605 (TA 19890 14605)
Planning authority	North East Lincolnshire Council
Museum name	North East Lincolnshire Museums Service
Museum accession code	GRIMS:2022.023
OASIS Id	wessexar1-511909
WA project code	271001
Dates of fieldwork	18th – 30th January 2023 (borehole survey); 21st November 2022 – 26th January 2023 (watching brief)
Fieldwork directed by	Liz Chambers (geoarchaeology); John Hirst, Owen Jenkins, Michael Keech, Jack Needham, Phil Roberts (watching brief)
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Quality Assurance

Issue number & date		Status	Author	Approved by
1	14/04/2023	Draft	DY/LC/JB	ADB
2	03/05/2023	Revised draft following client review	DY/LC/JB	ADB
3	15/05/2023	Minor edits	DY/LC/JB	ADB

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Summary

A programme of geoarchaeological borehole survey and deposit modelling, and an archaeological watching brief of Geotechnical Investigation (GI) works, was undertaken at NH3 Immingham Green Energy Terminal in advance of proposed development comprising an ammonia import terminal forming part of the proposed Green Energy Terminal. The geoarchaeological borehole survey was focused on the West Site, with the archaeological watching brief encompassing the West Site, Pipeline Corridor and East Site. The geoarchaeological borehole survey and watching brief were undertaken in accordance with an overarching WSI (AECOM 2022). The work was designed to provide information on the geoarchaeological and archaeological resource likely to be impacted by the proposed development and facilitate an informed decision with regard to any further archaeological and geoarchaeological work that may be required. In addition, two borehole transects in the West Site targeted a possible palaeochannel feature identified in a previous geophysical survey.

No archaeological finds or features were identified during the archaeological watching brief on the GI works which comprised a total of 40 geotechnical test pits. Overlying the bedrock, the sequence of superficial geological deposits recorded at the Site comprised Pleistocene glacial till, overlain by a sequence of Holocene alluvium formed under the influence of rising sea levels during the Holocene. In places the Holocene alluvial sequence includes peat and organic-rich units. The sequence was capped by modern made ground towards the centre of the Site, and modern topsoil elsewhere.

Till was widespread across the Site, typically over 10m in thickness, with a variable surface generally ranging from around 5.0 to 6.0 m below ground level (bgl) to around 10 to 12 m bgl in the East of the Site. The till present within the Site is likely to be of Late Devensian date (MIS 2; 15-26 Kya). Within the overlying Holocene alluvial sequence, minerogenic alluvium was widespread across the Site, generally present at ground level in the West Site, and between ground level and around 2.0 m bgl in the eastern part of the Site. Peat, generally present in thicknesses of less than 1 m, was recorded at elevations between c. -3 and -5 m OD across the West Site. Peat was absent in the eastern part of the Site with the exception of boreholes E-BH26A, E-BH34 and E-BH35. Organic-rich alluvium was recorded more widely across the Site and was generally present at elevations between c. 0.0 and -4.0 m OD.

Transects 1 and 2 targeted a possible palaeochannel identified during a previous geophysical survey of the Site. In these boreholes and the resultant deposit models there is no clear evidence in the surface of the till for an early Holocene palaeochannel cut in to these deposits, and no clear evidence for a distinct alluvial sequence infilling a palaeochannel. The distribution and extent of peat and organic alluvium within the Holocene alluvial sequence is relatively evenly distributed across the Site, rather than being focussed within this possible palaeochannel feature. However, the absence of evidence for an early Holocene channel here does not discount the possibility of a later channel cutting through the alluvial sequence, perhaps related to a dendritic channel typical of tidal mudflats, or a tributary channel draining east towards the Humber.

Depending on the construction design and likely depth of impact, the proposed works may impact deposits of high geoarchaeological potential, as outlined above. The impact of the development proposals upon these deposits will need to be assessed in order to establish the need for, scale and scope of any further geoarchaeological and archaeological evaluation of the Site.

Acknowledgements

Wessex Archaeology thanks AECOM for commissioning the work detailed in this report. We are grateful to Ground Technology Ltd for undertaking the borehole survey under the supervision of Wessex Archaeology and for undertaking the geotechnical investigations. The fieldwork was managed on site by Liz Chambers, for the geoarchaeological borehole survey and John Hirst, Owen Jenkins, Michael Keech, Jack Needham and Phil Roberts, for the archaeological watching brief. Deposit modelling was undertaken by Liz Chambers, Jon Badger and Dr Daniel Young. The report was compiled by Dr Daniel Young and reviewed by Dr Alex Brown. Figures were produced by Amy Wright. The project was managed on behalf of Wessex Archaeology by Dr Alex Brown, for the geoarchaeological borehole survey and by Emily Eastwood, for the archaeological watching brief.

NH3 Immingham Green Energy Terminal

Geoarchaeological Borehole Survey and Watching Brief on GI Works

1 INTRODUCTION

1.1 Project and planning background

1.1.1 Wessex Archaeology has been commissioned by AECOM ('the client') to produce a report outlining the results of a geoarchaeological borehole survey and watching brief on Ground Investigation (GI) works at NH3 Immingham Green Energy Terminal, Immingham, North Lincolnshire (the 'Site'). The Site is centred on National Grid Reference (NGR) 519780 414720 (TA 19780 14720) (**Figure 1**).

1.1.2 The proposed development comprises an ammonia import terminal forming part of the proposed Green Energy Terminal at Immingham. The geoarchaeological borehole survey was focused on the West Site, with the geotechnical watching brief focusing on the West Site, Pipeline Corridor and East Site.

1.1.3 Previous non-intrusive archaeological work included two geophysical surveys (Pre-Construct Geophysics 2011 and Bunn 2013) and a desk-based assessment (AECOM 2022a). An archaeological trial trench evaluation, undertaken as part of a staged approach to determining the archaeological potential of the development area, was completed in March 2023 and is reported in Wessex Archaeology (2023a). Other works within this larger programme include further geophysical survey (Wessex Archaeology 2023b), the results of which will be reported separately.

1.1.1 The geoarchaeological borehole survey and watching brief was undertaken in accordance with an overarching written scheme of investigation (WSI) which detailed the aims, methodologies and standards to be employed (AECOM 2022). The Archaeological Officer for North East Lincolnshire approved the WSI, on behalf of the Local Planning Authority (LPA), prior to fieldwork commencing. A subsequent WSI (Wessex Archaeology 2022) and Method Statement (Wessex Archaeology 2023c) was prepared for the geoarchaeological borehole survey and watching brief on the GI works.

1.1.2 The program of geoarchaeological works was designed to provide information on the geoarchaeological and archaeological resource likely to be impacted by the proposed development and facilitate an informed decision with regard to any further archaeological and geoarchaeological work that may be required; or the formation of a mitigation strategy (to offset the impact of the development on the archaeological resource) or a management strategy.

1.2 Scope of works

1.2.1 The overarching WSI for the works initially called for a total of 37 boreholes located along three transects, two of which were located at the West Site and one in the Pipeline Corridor (AECOM 2022).

1.2.2 Following consultation with AECOM, the scope of the geoarchaeological works was reduced to 21 boreholes (with a contingency for an additional three boreholes where required) as outlined within the WSI (Wessex Archaeology 2022) and Method Statement (Wessex Archaeology 2023c) prepared by Wessex Archaeology.

1.2.3 The number of purposive geoarchaeological boreholes was reduced to reflect the fact that additional GI works were being conducted by the client across the West Site and Pipeline Corridor, with the resultant GI logs reviewed by a geoarchaeologist and incorporated in to the final deposit model. The data used in the deposit model is shown in **Appendix 3**.

1.2.4 Two of the three proposed transects (west and central) are located on the West Site and target a possible palaeochannel identified in geophysical surveys (Pre-Construct Geophysics 2011 and Bunn 2013). The East transect was located along the Pipeline Corridor in order to characterise the sequence of superficial geological deposits in this area of the Site. The three transects include the following boreholes:

- West transect: BH1 to BH7
- Central transect: BH8 to BH14
- East transect: BH15 to BH21

1.2.5 Upon commencing the works it was necessary to descope the East transect due to access issues. It is anticipated that these boreholes (BH15 to BH21) will be undertaken at a later date, provisionally scheduled for June 2023. A total of 14 of the proposed 21 purposive geoarchaeological boreholes (BH1 to BH14) were therefore undertaken from January – February 2023, all on the West Site (**Figure 3**). The outstanding seven boreholes will be undertaken once access issues have been resolved, later in 2023.

1.2.6 In additional to the purposive geoarchaeological borehole survey, an archaeological watching brief was undertaken on GI test pits took across the West Site and East Site (**Table 1** and **Figure 3**). A total of forty test pits were excavated and monitored between 21st of November 2022 and the 26th of January 2023. Due to their comparatively shallow depth, the test pits were not included in the geoarchaeological deposit model.

Table 1 Monitored GI test pits

Test pit	Easting	Northing	Site
E-TP01	520818.294	415111.8654	East Site
E-TP01SA	520817.1644	415110.1687	
E-TP02	520745.0008	415198.7296	
E-TP03	520900.4911	415186.4794	
E-TP04	520815.6151	415245.6987	
W-TP01	519732.7809	414279.761	West Site
W-TP02	519738.0262	414330.9186	
W-TP02S	519734.8899	414326.1847	
W-TP03	519697.5779	414353.6973	
W-TP04	519760.0166	414381.3183	
W-TP05	519697.3485	414421.0161	
W-TP06A	519678.2706	414441.987	
W-TP06B	519677.5179	414443.502	
W-TP07	519766.0883	414444.221	
W-TP08	519832.9712	414351.5928	
W-TP09	519932.1562	414423.4468	

W-TP10	520044.5057	414527.9997	
W-TP11A	519873.8317	414523.4832	
W-TP11B	519875.4162	414522.0835	
W-TP12	519702.4208	414528.0176	
W-TP13	519693.4125	414608.9283	
W-TP14	519808.5534	414603.9128	
W-TP15A	519980.0773	414598.2657	
W-TP15B	519979.7485	414596.2208	
W-TP16	520113.5901	414573.1386	
W-TP17	520229.3925	414675.4271	
W-TP18	520173.6847	414618.6285	
W-TP19	520193.6949	414703.3632	
W-TP191S	520197.4453	414709.3319	
W-TP21	520065.8012	414708.4039	
W-TP222	519733.1486	414331.0871	
W-TP222S	519732.9095	414331.6784	
W-TP23	520083.5383	414670.4471	
W-TP24	520012.5604	414657.9273	
W-TP26	519938.2686	414762.096	
W-TP27A	519884.6338	414671.564	
W-TP27B	519883.0918	414670.6996	
W-TP28	519775.9788	414659.796	
W-TP29	519723.2663	414768.8729	
W-TP30	519834.1307	414809.1924	
W-TP31	519879.6023	414842.9196	
E-TP01	520818.294	415111.8654	
E-TP01SA	520817.1644	415110.1687	
E-TP02	520745.0008	415198.7296	

1.3 Scope of document

1.3.1 To help frame archaeological and geoarchaeological investigations of this nature, Wessex Archaeology has developed a four-stage approach, encompassing different levels of investigation appropriate to the results obtained, accompanied by formal reporting of the results at the level achieved. The borehole survey reported on here represents Stage 2 of this process (**Table 2**).

1.3.2 In format and content, the work follows the methodology set out within the WSI (AECOM 2022; Wessex Archaeology 2022; 2023c), and conforms to current best practice, including the guidance in *Management of Research Projects in the Historic Environment* (MoRPHE, Historic England 2015a), the Chartered Institute for Archaeologists' (CIfA) *Standard and guidance for archaeological field evaluation* (CIfA 2014a), Historic England's technical guide to Geoarchaeology: Using Earth Sciences to Understand the Archaeological Record (Historic England 2015b) and Deposit Modelling and Archaeology (Historic England 2020).

Table 2 Staged approach to geoarchaeological investigations

Stage 1: Geoarchaeological Desk-based Assessment (GDBA) and deposit modelling	A Geoarchaeological Desk-Based Assessment (GDBA) examines a range of data (published and unpublished ("grey literature"), LiDAR, historic maps) and models existing Ground Investigation (GI) data to inform on the possible Palaeolithic archaeological and geoarchaeological potential of a site. The GDBA may include, dependant on the site and complexity of a site, a Geoarchaeological Landscape Characterisation (GLC) which divides a study area into different zones (Geoarchaeological Characterization Zones – GCZs) based on variations in deposits and potential. The GDBA establishes the requirements for and scope of Stage 2 archaeological and geoarchaeological field elevation. Should Stage 2 evaluation be required, appropriate and proportionate recommendations for each GCZ are provided.
Stage 2: Geoarchaeological monitoring of GI works and/or Geoarchaeological borehole survey	Field evaluation to establish the geoarchaeological and archaeological potential of Quaternary deposits within an evaluation area, which informs on the requirements and scope of further works at Stage 2 (e.g. purposive borehole survey), Stage 3 palaeoenvironmental assessment and/or Stage 4 mitigation. The principal methods of geoarchaeological evaluation are through monitoring of Ground Investigation (GI) works or targeted boreholes. A geoarchaeological evaluation report is produced, which includes deposit modelling (where sufficient data allows) and recommendations for further work at Stage 2 or Stage 3 if required. Further works may include additional interventions (stepped trenches, test pits or boreholes) to retain additional/suitable samples for assessment.
Stage 3: Palaeoenvironmental assessment	Palaeoenvironmental samples recovered during Stage 2 are assessed to inform on the archaeological and geoarchaeological potential of deposits and guide the scope and need for Stage 4 analysis. A report is produced outlining the palaeoenvironmental potential of the deposits including targeted and proportionate recommendations for Stage 4 analysis.
Stage 4: Palaeoenvironmental analysis	Based on the results of the Stage 3 palaeoenvironmental assessment, palaeoenvironmental analysis on selected deposits/samples may be required. In addition to full analysis of suitable samples identified during the assessment. work at Stage 4 may include additional scientific dating where appropriate/required. A final analysis report is provided on completion of mitigation program. Where appropriate, this may include recommendations for publication or other forms of dissemination.
Publication	The scope and location of a publication report will be agreed in consultation with the client and LPA advisor. The publication report may comprise a note in a local journal or a larger publication article or monograph, dependant on the significance of the archaeological and geoarchaeological work.

1.4 Location, topography and geology

1.4.1 The Site covers an area of 47.37 hectares (ha) of mixed industrial and commercial development located alongside Kings Road and Queens Road at Immingham, located on the southern shores of the Humber Estuary, North East Lincolnshire.

1.4.2 The West Site comprises an area of land totalling 21.79 ha formed by three former agricultural fields centred on Ordnance Survey National Grid Reference (OS NGR) TA

19890 14605. The northern boundary is represented by Kings Road (A1173) and an electrical sub-station in the north-western corner and is demarcated by a wire fence. Queens Road (also A1173) runs along the eastern boundary with residential and commercial properties adjacent to the Site. A short tarmac access road has been constructed from Kings Road into the Site.

1.4.3 The Pipeline Corridor (approx. 3.95 ha) crosses an area that has mostly already been impacted by industrial development alongside Queens Road, including parts that are currently unused. At the eastern end the corridor continues along the edge of a narrow belt of woodland between Laporte Road and the Humber Estuary and is under a Tree Protection Order. It is centred on NGR TA 20646 15035.

1.4.4 The East Site (approx. 8.91 ha) is a former works site/storage area within Immingham Port which is currently covered in hardstanding. It is centred on NGR TA 20874 15355.

1.4.5 The underlying bedrock geology across the Site, as mapped by the British Geological Survey (BGS), consists of the Cretaceous (93.9 to 83.6 million years ago (Mya)) Burnham Chalk Formation (BGS GeoIndex). Superficial deposits are recorded in the Site by the BGS. These include Tidal Flat Deposits – Clay and Silt. These deposits are principally Holocene (11.7 thousands of years (Kya) to present) in date, but may be underlain by deposits of Late Pleistocene date, principally glacial Till.

2 ARCHAEOLOGICAL BACKGROUND

2.1 Introduction

2.1.1 The archaeological background of the Proposed Scheme, which covers a 1.6 km study area for non-designated assets, and a 2 km study area for designated heritage assets and includes a summary of previous archaeological investigations, has been presented in detail as part of a Heritage Desk-Based Assessment (AECOM July 2022). The following baseline information is summarised from this document.

2.1.2 There are no World Heritage Sites, scheduled monuments, Grade I or II* listed buildings, conservation areas, registered parks and gardens, registered battlefields or protected wreck sites within the 2 km study area for designated heritage assets.

2.1.3 There is one Grade II listed building located within the 2km study area (approx. 1.57 km to the north-west of the Site) namely the Immingham War Memorial [NHLE 1455139] which is located at the junction with Humberville Road.

2.2 Previous investigations

Geophysical Survey (Pre-Construct Geophysics 2011)

2.2.1 Geophysical survey within part of the DCO site boundary did not identify any significant archaeological features. However, various anomalies were detected which likely relate to buried paleoenvironmental features (former tidal channels and pools), although it is possible some could relate to possible medieval salt production sites and salterns. Recent former land boundaries, land drains, services and ground disturbance were also identified.

2.2.2 In 2011 an archaeological geophysical survey on land next to Queens Road (east of the West Site) recorded mostly variations reflecting the presence of modern features, including boundary fencing, a gas pipeline and miscellaneous ferrous rich objects (Pre-Construct Geophysics 2011).

Geophysical Survey (Bunn 2013)

2.2.3 Subsequent archaeological geophysical survey at the West Site (Bunn 2013) identified various anomalies which likely relate to buried paleoenvironmental features (former tidal channels, pools and salt marsh). Some of the feature identified could relate to possible medieval salt production sites on the edge or close to the former tidal channels. Recent former land boundaries, land drains, services and ground disturbance were also identified.

Archaeological trial trench evaluation (Wessex Archaeology 2023a)

2.2.4 An archaeological trial trench evaluation undertaken at the Site in January and February 2023 (Wessex Archaeology 2023a) comprised a total of 107 trial trenches, with no significant archaeological features, deposits or artefacts encountered. In addition, no deposits suitable for environmental sampling were encountered. Remains of parts of the extant drainage system were recorded.

2.2.5 Only one anomaly identified by a geophysical survey (Bunn 2013) was located by the evaluation; a drain in trench 3. Potential salterns, also identified by the geophysical survey (ibid.) were targeted by trenches 3 and 4 but no evidence for them were found. It was considered likely that variations in the natural deposits were the cause of these geophysical anomalies.

Geophysical survey (Wessex Archaeology 2023e)

2.2.6 A geophysical survey was carried out on a parcel of arable agricultural land measuring 10.9 ha in size and located approximately 1.5 km north-east of the West Site. Several large linear features and one rectilinear feature were identified. Given the known features in the surrounding area and the strength of the signal it is possible these relate to World War II defensive features however other origins such as earlier archaeological features or more modern land management and/or drainage features could not be entirely ruled out.

2.2.7 Two smaller curvilinear features were identified in the west of the site with the potential to relate to archaeological ditched features. However, a natural origin could not be ruled out.

2.2.8 Strong geological responses reflecting the intertidal environment and alluvial processes have been identified across the site. This is most strong in the southern half of the site, but with some channels crossing the northern half. The northern half of the site exhibited fewer natural variations, but more ferrous responses indicating the two sections may have undergone slightly different formation processes, potentially the northern area having been used agriculturally for a longer period of time.

2.2.9 Two larger areas of increased magnetic response are apparent within the site. Modern origins are expected for these, with the one in the south potentially being related to the previous flood defences, or potentially a previously recorded bomb crater.

2.3 Archaeological and historical context

Prehistoric (800,000 BC to AD43)

2.3.1 The earliest evidence of prehistoric date is a pair of ditches located about 1.1 km south-east of the Site. These were found to contain flintwork of Neolithic (4,000 – 2,500 BC) or Bronze Age (2,500 – 700 BC) origin and may have been dug to flank a trackway. This suggests prehistoric occupation in the area. There are several undated cropmark sites recorded on the HER, including an area of possible enclosures, a sub-circular feature, (possibly a prehistoric ring ditch) and a number of linear features all sited to the south of Kiln Lane Industrial Site. Undated peat deposits were recorded in a historic geological borehole alongside North Beck Drain.

2.3.2 The numerous pollen studies from across the Humber wetlands demonstrate that clearance of woodland on the associated dry ground occurred from the late Bronze Age. Prior to this, the dryland vegetation would have been a mix of woodland habitats that developed over the course of the Holocene. From around 10 Kya this will have been characterised by a mixed oak, hazel, elm, lime and alder woodland, with alder dominating the wetlands and lime more prevalent on drier free-draining soils. Although woodland clearance is apparent in pollen sequences from the Neolithic, they are mostly small-scale and impermanent, and support the archaeological evidence reflecting temporary and seasonal activity within the wetlands at that time.

2.3.3 However, archaeological finds of prehistoric date have been made at several locations within the Humber wetlands, including several timber trackways (Fletcher et al 1999), fragments of a sewn plank boat from North Ferriby (Wright et al 2001) and a plank boat of Late Bronze Age/early Iron Age date from the River Ancholme at Brigg (c. 12 km south of the Site).

Romano-British (AD 43–410)

2.3.4 At the Stallingborough Interchange, a high-status Romano-British settlement and industrial site has been recorded about 1.4 km south-west of the Proposed Development. Undated cropmarks of rectangular ditched enclosures (about 1.1 km to the south-east of the Site at Kiln Lane Trading Estate) may form part of the Romano-British landscape.

Early medieval (AD 410 to 1066)

2.3.5 No heritage assets of early medieval date are recorded within the study area.

Medieval (AD 1066-1540)

2.3.6 A possible deserted medieval settlement near Mauxhall Farm (about 1.4 km south-west of the Proposed Development) is visible on aerial photography. The remains include ridge and furrow cultivation features, trackways and possible building platforms. Ridge and furrow earthworks are recorded at Stallingborough, roughly 2 km south of the evaluation area. Alluvial layers from Stallingborough show that the Site was prone to flooding which may explain why the location appears to have been farmed but never occupied.

Post-Medieval (AD 1540-1900)

2.3.7 Aerial photographs recorded the remains of post-medieval field boundaries and narrow ridge and furrow cultivation features at Habrough Marsh, around 900 m north of the Site. They also recorded the presence of either singular or a series of drainage ditches.

2.3.8 Historic Ordnance Survey (OS) maps reveal several woodland features, osier (willow plantation) and a blow well at Stallingborough 1.25 km to the south of the Site. Additionally, the historic maps reveal a series of post-medieval roads and trackways which may have their origins in the medieval period: North Moss Lane, Kiln Lane and Laporte Road, amongst others.

2.3.9 Together with OS maps the aerial photographs record historic flood defences across the study area, including at Immingham (about 1.5 km to the north-west of the Site), Kiln Lane Trading Estate (about 1.3 km to the south-east) and at Habrough Marsh (about 1 km to the north). Features associated with coastal navigation and transportation (e.g. Stallingborough Ferry, around 0.4 km to the east of the Site) are visible on the historic map alongside several buildings pre-dating the docks.

2.3.10 Several woodland features are shown on historic OS maps, including Long Strip and Fox Covert. Other landscape features are also recorded, including an osier (willow plantation) at Reeds Meer, a mere at Stallingborough, and a blow well (spring) also at Stallingborough.

Modern (AD 1901 to present)

2.3.11 Aerial photographs and historic OS maps record historic flood defences across the study area, including at Immingham, Kiln Lane Trading Estate, and Harborough Marsh. Historic OS maps also record the presence of several features associated with coastal navigation and transportation, including Stallingborough Ferry and the site of a coastguard station. In addition, the maps show several buildings that reflect the rural and coastal character of the area prior to the development of the docks.

2.3.12 The construction of Immingham Docks, approximately 1.5 km to the north, was begun in 1906 and completed in 1912. It was established by the Humber Commercial Railway and Dock Company in association with the Great Central Railway. A temporary settlement or workers' village, known as 'Tin Town', comprising a series of corrugated tin hut, was established for the dock construction workers (located about 0.6 km to the west). A coaling stage and a grain store are associated with historic development and operation of the docks. In addition, there are several records relating to the use and expansion of the transportation infrastructure associated with the dock and port at Immingham. The dock was a submarine base for British D-class submarines during World War I and was later used in the 1930s for cruise ships.

2.3.13 There are numerous features relating to World War II activity in and around the docks at Immingham, including gun emplacements, anti-landing obstacles, barrage balloon sites, and other buildings and installations. Evidence of German bombing raids is also represented by several lines of small circular hollows (possible bomb craters) on aerial photographs.

2.3.14 The single Grade II listed building mentioned earlier (the Immingham War Memorial (NHLE 1455139)) located 1.57 km to the north-west of the Site dates to this period, as do a row of locally listed terraced houses located on Queens Road adjacent to the West Site.

2.3.15 The Site is located in the coastal marsh character zone, which is dominated by industrial works, particularly installations related to the petrochemical industry and docks at Immingham. Only the western part of the DCO site boundary retains any historic character which is related to post-medieval agriculture.

3 GEOARCHAEOLOGICAL SETTING

3.1 Introduction

3.1.1 The superficial deposits in the Site may include deposits with geoarchaeological and/or archaeological potential of both Pleistocene and Holocene date. These epochs form parts of the Quaternary, a period covering the last 2.6 Mya, and defined by repeated fluctuations between cold (glacial) and warm (interglacial) climate stages (**Table 2**).

3.1.2 Where age estimates are available for deposits these are expressed in Mya, Kya and within the Holocene epoch as either years Before Present (BP), Before Christ (BC) and Anno Domini (AD). Where radiocarbon dates are included, they are quoted as calibrated (cal.) BC or AD. These dates are supplemented where relevant with the comparable Marine Isotope Stage (MIS) where odd numbers indicate an interglacial period and even numbers a glacial period.

Table 3 British Quaternary chronostratigraphy

Geological Period	Chronostratigraphy		Age (Kya)	MIS
Holocene	Holocene interglacial		11.7–present	1
Late Pleistocene	Devensian Glaciation	Loch Lomond Stadial	11.7–12.9	2 – 5d
		Windermere Interstadial	12.9–15	
		Dimlington Stadial	15–26	
		Upton Warren Interstadial	40–43	
		Early Devensian	60–110	
	Ipswichian interglacial		115–130	5e
Middle Pleistocene		Unnamed cold stage	130–374	6
		Avery interglacial		7
		Unnamed cold stage		8
		Purfleet interglacial		9
		Unnamed cold stage		10
	Hoxnian interglacial		374–424	11
	Anglian glaciation		424–478	12
	Cromerian Complex		478–780	13 – 19

3.2 Geoarchaeological background

3.2.1 The geoarchaeological background relating to Site was assessed in the WSI (Wessex Archaeology 2022). A summary of the results is presented below. Additional sources of information are referenced, as appropriate.

3.2.2 The Quaternary geology across the Site is mapped by the BGS as tidal flat deposits. These deposits are principally Holocene (11.7 Kya to present) in date but may be underlain by Late Pleistocene deposits of , including glacial Till.

3.2.3 The superficial deposits in the area of the Site are heavily influenced by natural processes occurring since the latter stages of the last Ice Age, both directly and through changes in sea level. During the latter stages of the last Ice Age, the Humber Estuary and surrounding area was covered by an ice lobe (North Sea Lobe) extending down the eastern margins of the North Sea Basin as far as North Norfolk. This deposited extensive till and glaciofluvial sands and gravels across the region, as well as contemporary aeolian (windblown) coversands that are often found overlying glaciolacustrine deposits in the Vale of York.

3.2.4 Following the retreat of the ice sheet at c. <13 Kya the Humber Estuary would have been largely dry land, extending eastward to Doggerland in what would become the North Sea. As global climate continued to warm, sea levels rose and Doggerland became a land of rivers, wetlands and marshes. As woodlands and other flora flourished so did the range of

mammals, fish and birds, supporting Mesolithic communities and populating some of the richest hunting and fishing grounds in Europe.

3.2.5 Submerged palaeochannels in the North Sea were first identified in detail as part of the Mapping Doggerland project (Gaffney et al. 2007), revealing an extensive drainage network that was buried below the seabed across large parts of the southern North Sea. This palaeochannel network extends into the Humber Estuary, and geomorphological analysis has demonstrated that the palaeochannels evolved from high energy braided rivers at the end of the last glaciation to more sinuous and stable rivers as climate warmed; until they became estuaries and, were finally inundated by post-glacial sea-level rise.

3.2.6 The rapid rise in sea-levels created steep-sided valleys up to 9m deep (Van de Noort 2004), now largely infilled with Holocene sediment – such as the River Ancholme located to the west of the Site. Large numbers of lakes were formed across the Humber region within depressions left in the till and from which palynological data has been recovered extending back to the Late Glacial period (e.g., Beckett 1975; Gilbertson 1984; Walker et al 1993).

3.2.7 The Holocene evolution of the Humber and its tributaries is well understood through the important work of the Humber Wetlands Project (summarised in Van de Noort 2004) and the NERC (Natural Environment Research Council) funded Land-Ocean Interaction Study (Shennan and Andrews 2000). These projects established that the development of the Humber, its tributaries (including the River Trent) and associated wetlands has largely arisen as a consequence of natural inter-linked processes of post-glacial sea-level rise, fluctuating Holocene sea levels, and climate change.

3.2.8 Sea-level rise resulted in the development of a series of resource-rich wetlands along the Humber and its tributaries, including coastal, estuarine, brackish and semi-terrestrial wetland habitats. By around 6000 BC, sea-levels were c. 17 m below current levels and intertidal environments were largely restricted to the outer Humber Estuary. However, by the late Mesolithic, c. 5000 BC, intertidal influence is likely to have reached the lower reaches of the tributaries draining into the Humber.

3.2.9 Extensive floodplains developed along the margins of the Humber and its tributaries as sediments accumulated under rising sea-levels. Within the tributaries there is a consistent picture of the development of riparian wetland habitats, apparent in the formation of peat layers from the late Mesolithic, with pollen analysis of peat layers showing the development of alder carr woodland and reedswamp (Van de Noort and Ellis 1998, Van de Noort 2004).

3.2.10 Existing GI data in the vicinity of the Site record sequences of estuarine alluvium, locally including lenses of peat, which increase in depth to the east towards the Humber Estuary, overlying possible till deposits and chalk bedrock. The Holocene sequence varies between approximately 5 to 10m in depth.

3.2.11 A possible palaeochannel was identified during the geophysical survey within the centre of the West Site, oriented approximately west to east and c. 50m in width. Palaeochannels act as important capture points for palaeoenvironmental remains and archaeological evidence. Palaeochannels may include organic-rich deposits, including peat (either formed during periods of variable water flow, linked to broader ocean-land interactions or infilling and capping the channel during their final phases) and are therefore of geoarchaeological potential.

3.2.12 By the Bronze Age, c. 1500 cal. BC, the wetlands of the Humber would have reached their maximum extent, dominated by estuarine mudflats and saltmarsh habitats. Consequently,

where peat deposits are present, they are likely to date between the late Mesolithic and middle Bronze Age.

3.2.13 The numerous pollen studies from across the Humber wetlands demonstrate that clearance of woodland on the associated dry ground occurred from the late Bronze Age. Prior to this, the dryland vegetation would have been a mix of woodland habitats that developed over the course of the Holocene. From around 10 Ka this will have been characterised by a mixed oak, hazel, elm, lime and alder woodland, with alder dominating the wetlands and lime more prevalent on drier free-draining soils. Although woodland clearance is apparent in pollen sequences from the Neolithic, they are mostly small-scale and impermanent, and support the archaeological evidence reflecting temporary and seasonal activity within the wetlands at that time.

3.2.14 However, archaeological finds of prehistoric date have been made at several locations within the Humber wetlands, including several timber trackways (Fletcher et al 1999), fragments of a sewn plank boat from North Ferriby (Wright et al 2001) and a plank boat of Late Bronze Age/early Iron Age date from the River Ancholme at Brigg (c. 12 km south of the Site).

3.2.15 Records of late Holocene environmental change are somewhat constrained due to the effects of post-medieval drainage, peat cutting and erosion, but sea-level rise continued until around 500 cal. BC before a phase of marine regression during the late Iron Age and Romano-British period (Long et al 1998). This regressive phase allowed for an expansion in settlement across previously wet areas with evidence for activity on what would have been elevated dry locations along the wetland margin.

3.2.16 Many settlement sites were abandoned by the 4th century AD as a result of renewed sea-level rise, with little evidence for human activity until 11th century AD, followed by progressive embankment of the wetlands from the 12th century (Sheppard 1966). The process of embankment had a significant effect in constraining the estuary and resulting in an increased tidal range and accelerated erosion rates.

4 AIMS AND OBJECTIVES

4.1.1 The aims and objectives of the borehole survey and geotechnical watching brief follow those outlined within AECOM (2022) and the WSI (Wessex Archaeology 2022) and method statement (Wessex Archaeology 2023c), and are presented below.

4.2 Overarching aims

4.2.1 The aims and objectives of the borehole survey and wider geoarchaeological works, outlined in AECOM (2022) were as follows:

Geoarchaeological borehole survey

- Identify the presence of peat deposits within the redline boundary of the Site;
- Assess the geoarchaeological potential of the peat deposits if present;
- Produce a geoarchaeological deposit model of the Site to detail the sequence and distribution of sub-surface deposits across the area;
- Determine the location, nature, extent, date, state of preservation, significance and complexity of geoarchaeological and paleoenvironmental sequences;

- provide information within the limitations of the investigation, regarding the paleoenvironmental and the paleo-topography of the Site and place the results into the context of the wider landscape; and,

- aid further evaluation and understanding of the archaeological potential within the Proposed Scheme limits.

Archaeological watching brief on GI works

4.2.1 The objectives of the watching brief, also defined in the WSI (AECOM 2022), were to:

- determine the presence or absence of archaeological features, deposits, structures, artefacts or ecofacts within the specified works area;

- record and establish, within the constraints of the works, the extent, character, date, condition and quality of any surviving archaeological remains (a preservation by record);

- place any identified archaeological remains within a wider historical and archaeological context in order to assess their significance; and

- make available information about the archaeological resource on the Site by preparing a report on the results of the watching brief.

- minimise or mitigate impact to archaeological remains identified through avoidance;
- assess the depth of topsoil and subsoil overlying deposits within which archaeological remains may occur;
- record the character and sequence of the deposits within each GI intervention;
- inform the baseline evidence for any Environmental Impact Assessment that would be carried out for the proposed scheme;
- provide information that may assist in development of an appropriate archaeological strategy as the proposed scheme progresses.

4.3 Overarching objectives

4.3.1 In order to achieve the above aims, the general objectives of the evaluation are to:

- Undertake 21 purposive boreholes across the West Site and Pipeline corridor, with a contingency for a further 3 purposive boreholes in the event deposits of geoarchaeological potential are revealed during parallel GI works;
- Undertake an archaeological watching brief on the GI works, including a total of 40 geotechnical test pits;
- Identify the presence/absence, nature and distribution of Quaternary deposits within the evaluation area, in particular peat and other organic rich deposits;
- Record Quaternary sediment sequences and obtain representative samples from suitable deposits, where appropriate;
- Establish the potential of deposits to preserve archaeology and/or paleoenvironmental evidence;

- Correlate available GI data to develop a deposit model for the Site, including where appropriate Digital Elevation Models (DEMs), thickness plots and representative transects;
- Place the results of the evaluation within a wider archaeological and geoarchaeological context, including consideration of the possible significance of archaeological and geoarchaeological resources in relation to national and regional research priorities and agendas, and
- Report on the results and make recommendations for further work, where appropriate

4.4 Site-specific objectives

4.4.1 The significance and preservation of superficial deposits across the Site, which in places may be associated with archaeological remains, will have an important bearing on the ability of any retained samples to contribute towards addressing Specific Research Objectives (SROs).

4.4.2 These SROs can reflect tangible actions to be addressed during the delivery of the works, and/or that are relevant to themes outlined in the relevant regional archaeological research frameworks (EMHERF).

4.4.3 Specific Research Objectives include the following

- Maximise recovery of geoarchaeological significant deposits
- Refine our understanding of the physical landscape through the program of GI monitoring and deposit modelling
- Understand past landscape change during the Holocene, particularly in relation to sea-level rise and changes in land-sea / wetland-dryland configurations
- Identify evidence for past settlement and human activity
- Examine evidence for exploitation, use and/or management of the landscape within the wetland

5 METHODOLOGIES

5.1 Introduction

5.1.1 Health and safety override archaeological considerations in all works since, as stated in CIfA guidance, *Health and Safety regulations and requirements cannot be ignored no matter how imperative the need to record archaeological information; hence Health and Safety will take priority over archaeological matters* (CIfA 2014a, 11).

5.1.2 All works were undertaken in accordance with the detailed methods set out within the WSI (AECOM 2022; Wessex Archaeology 2022; 2023c). Any significant variations to these methods were agreed in writing with the Archaeological Officer for North East Lincolnshire, and the client, prior to being implemented. The fieldwork was carried out under the supervision of experienced geoarchaeological and archaeological specialists.

5.1.3 All boreholes and test pits were set out using GNSS in the approximate positions shown in **Figure 3**. The borehole locations were tied in to the Ordnance Survey (OS) National Grid and Ordnance Datum (OD) (Newlyn), as defined by OSGM15 and OSTN15.

5.1.4 Before excavation began, the area of the boreholes was walked over and visually inspected to identify the location of any below/above-ground services. All borehole and test pit

locations were scanned before and during excavation with a Cable Avoidance Tool (CAT) to verify the absence of any live underground services.

5.2 Geoarchaeological borehole survey

5.2.1 An experienced member of the Wessex Archaeology geoarchaeology team monitored the excavation of targeted geoarchaeological boreholes undertaken using a dynamic sampling rig (Pioneer type) operated by experience geotechnical drillers from Ground Technology Services Ltd. Sleeved cores 1.50 m in length and 100 mm in diameter were extracted.

5.2.2 A total of 21 boreholes (BH1–BH21) were to be drilled at the proposed locations shown in **Appendix 3** and **Figure 3**. The final number of the boreholes was adjusted to 14 (BH1–BH14) due to access restrictions in the East transect (see Section **1.2**). The remaining seven boreholes on the East transect are due to be undertaken in June 2023.

5.2.3 Hand-dug test pits were excavated to a depth of 1.2m below ground level (bgl) prior to drilling. All hand-dug test pits were monitored by the attending geoarchaeologist and recorded as described below. The attending geoarchaeologist liaised closely with the geotechnical drillers in order to ensure effective communication was maintained throughout the works.

5.3 Geotechnical watching brief

5.3.1 The watching archaeologist monitored all mechanical excavations within the specified area, comprising total of 40 geotechnical test pits (**Figure 3** and **Table 1**). The attending archaeologist liaised closely with the geotechnical engineer and drillers to ensure effective communication was maintained throughout the works.

5.3.2 The Archaeological Officer for North East Lincolnshire monitored all works on behalf of the LPA. Any variations to the WSI, if required to better address the project aims, were agreed in advance with the client and the Archaeological Officer for North East Lincolnshire. The Archaeological officer also signed off all works as complete at the conclusion of the fieldwork.

5.4 Survey

5.4.1 A Leica GNSS connected to Leica's SmartNet service surveyed the 'as dug' location of all boreholes and test pits. All survey data is recorded in OS National Grid coordinates and heights above OD (Newlyn), as defined by OSTN15and OSGM15, with a three-dimensional accuracy of at least 50 mm.

5.5 Recording

5.5.1 Quaternary deposits present were recorded by the supervising geoarchaeologist using Wessex Archaeology's pro forma recording system. Descriptions included information such as:

- *Depth*
- *Texture*
- *Composition*
- *Colour*
- *Inclusions*
- *Structure*

- *Shape and nature of contacts between deposits*

5.5.2 Sediment logs, presenting the results of the work (including a description of the deposits encountered at the various depths) are provided in **Appendix 1**.

5.5.3 Interpretations of Quaternary deposits included, where possible, probable depositional environments and formation processes. Consideration was given to the suitability of deposits/samples for scientific dating methods.

5.5.4 All samples taken were individually numbered. The location, size, stratigraphic context, purpose and whether retained or processed on site was also recorded.

5.5.5 A full photographic record was made of the excavations, using digital cameras equipped with an image sensor of not less than 10 megapixels. This recorded both the detail and the general context of the principal archaeological, lithological and stratigraphic features, during the watching brief.

5.5.6 Digital images were subject to managed quality control and curation processes which will embed appropriate metadata within the image and ensure long term accessibility of the image set. Photographs were also taken of all areas, including access routes, to provide a record of conditions prior to and on completion of the evaluation.

5.6 Deposit modelling

5.6.1 A total of 87 stratigraphic logs were reviewed for deposit modelling purposes, including a total of 73 logs arising from the GI works in the wider area of the Site and the 14 new purposive geoarchaeological boreholes (see **Figure 3** and **Appendix 3**). Only those stratigraphic records with sufficiently detailed descriptive terminology and location data (including surface elevation) were included in the model. The deposit modelling was undertaken following the guidelines in Historic England (2020).

5.6.2 All available data points were entered into industry standard geological utilities software (Rockworks™ 23). Each stratigraphic unit was given a colour and pattern allowing cross correlation and grouping of the different sedimentary units. The grouping of these deposits is based on lithological descriptions, which define distinct depositional environments referred to as ‘stratigraphic units’ (e.g. alluvium, peat etc.).

5.6.3 Sedimentary units from the boreholes were classified into seven stratigraphic units: (1) modern soil profile, (2) made ground, (3) alluvium, (4) organic alluvium, (5) peat, (6) glacial till and (7) bedrock. The classified data for groups 1 to 7 were then input into a database within the RockWorks 23™ program. Models of surface height were generated using an inverse-distance weighted (IDW) algorithm for glacial till (**Figure 5**), with a thickness model generated for the peat (**Figure 6**).

5.6.4 Two-dimensional stratigraphic profiles (‘transects’) of selected interventions across the Site have also been generated using RockWorks 23™. These include two north-south transects perpendicular to the potential palaeochannel feature identified in Bunn (2013) (**Figures 6** and **7**) and a SW-NE transect targeting the eastern part of the Site (**Figure 8**). These transects show the main stratigraphic units and their lateral and vertical variability across these areas of the Site.

5.6.5 Where data points are not uniformly distributed over the area of investigation the reliability of the models is variable. In order to account for this, the modelling algorithm has been adjusted to include a maximum distance cut-off filter, so that only those areas for which

sufficient stratigraphic data is present will be included in the model. As a result, a distance cut-off filter equivalent to a 50 m radius was applied to the surface of the till and thickness of the peat.

5.6.6 The key aims of the modelling were to interpret the data, identify the probable depositional environments represented, and determine areas of higher and/or lower geoarchaeological potential where further work may be required (e.g. deposits with potential for the recovery of significant archaeological and palaeoenvironmental remains).

6 RESULTS

6.1 Introduction

6.1.1 This section summarises the results of the 14 purposive geoarchaeological boreholes (Appendix 1), monitoring of the GI works and integrates these into the results of the post fieldwork deposit modelling exercise (above, 5.6).

6.1.2 The final results of the geoarchaeological deposit modelling, comprising surface elevation models for the till (**Figure 4**) and thickness models for the peat (**Figure 5**), two stratigraphic profiles (transects) aligned perpendicular to the palaeochannel indicated in the geophysical survey (Bunn 2013), and one transect aligned SW-NE, are shown in **Figures 6** to **8**.

6.2 Watching brief on GI works

6.2.1 A total of 40 geotechnical test pits were monitored and recorded by the attending archaeologist during the watching brief on GI works.

6.2.2 A predominately dark greyish brown silty clay topsoil deposit was recorded in each test pit with depths averaging up to 0.4 m below ground level. The pits were excavated to a depth of up to 3.0 m and in each case the topsoil was seen to overlay a series of up to three distinct alluvial deposits. No clearly defined peat deposits were encountered.

6.2.3 No archaeological finds or features were identified during the archaeological watching brief on the GI works, which comprised a total of 40 geotechnical test pits (**Appendix 2**).

6.3 Stratigraphic sequence

6.3.1 The full sequence of superficial geological deposits recorded during the borehole survey and monitoring of the GI works, and forming the basis of the deposit modelling, comprises:

- Modern soil profile/made ground (modern)
- Alluvium (Holocene)
- Organic alluvium (Holocene)
- Peat (Holocene)
- Glacial till (Late Pleistocene)
- Bedrock (Cretaceous)

6.3.2 More detail on the variability and composition of these deposits is described below, with a consideration of their geoarchaeological and archaeological potential outlined in **Section 7**.

Bedrock

6.3.3 The bedrock, beginning as a white, silty chalk gravel, transitioning into high density fractured yellowish white chalk with marls (the Burnham Formation) was not reached in any of the

purposive geoarchaeological boreholes, but was recorded in the deeper geotechnical boreholes undertaken as part of the GI works across the Site.

6.3.4 In these boreholes the surface of the bedrock was generally encountered at elevations between c. 18 and 22 m below Ordnance Datum (-18 to -22 m OD) and at depths between c. 18.0 to 24.0 m below ground level (m bgl) (see **Figures 6** to **8**).

Glacial till

6.3.5 Deposits of variable composition, but generally comprising firm sandy silt, silty clays or clays with frequent gravel clasts, including small to large, subrounded and rounded, chalk and possible flint/quartz pebbles and stones, were recorded directly overlying the bedrock across the Site. This unit was typically over 10 m thick (with an average thickness of c. 12 m), with a variable upper surface generally ranging from c. -4 m OD in the west (c. 5.0 to 6.0 m bgl) to c. -8 m OD in the east (c. 10 to 12 m bgl) of the Site (see **Figures 4** and **6**-**8**).

6.3.6 These deposits are interpreted as glacial diamicton (till); on the basis that the area of the Site was glaciated during the last ice age (the Devensian; MIS 4-2), this unit is likely to have been deposited by the advancing Late Devensian ice sheet that reached its maximum extent in this area during the Late Glacial Maximum (LGM) at c. 23 Kya and c. 17 Kya.

6.3.7 Transects 1 and 2 are aligned broadly perpendicular to the possible palaeochannel feature highlighted in Bunn (2013), with the approximate extent of this feature highlighted in those transects (see **Figures 6** and **7**). There is no clear evidence in the surface of the till for an early Holocene palaeochannel cut in to these deposits (see **Section 7**).

Minerogenic alluvium

6.3.8 Deposits of variously sandy or slightly gravelly silty clay were recorded widely across the Site, including in all 14 of the geoarchaeological boreholes. The alluvium overlies the till, its upper surface generally present at ground level (elevations between c. 1.0 and 2 m OD) in the West Site (see **Figures 6** and **7**), and between ground level and c. 2.0 m bgl (c. 3.0 and 4.0 m OD) in the eastern part of the Site (see **Figure 8**).

6.3.9 These deposits represent sediment accumulating under the influence of rising post-glacial sea-levels, deposited within a range of settings from early Holocene channel systems through to mud flats and salt marsh environments within the succeeding extensive intertidal floodplains of the Humber Estuary.

Peat

6.3.10 Firm to soft, black richly organic laminated silts are present in five of the geoarchaeological boreholes (BH8, BH9, BH11, BH13, BH14), and 12 of the GI boreholes (E-BH26A, E-BH34, E-BH35, W-BH26, W-BH29, W-BH32, W-BH34, W-BH35, W-BH25, W-BH04, W-BH18 and W-BH09. The thickness and distribution of these deposits is shown in **Figure 5**. In all interventions where it was encountered, peat directly overlies glacial till, and is sealed beneath alluvium or organic alluvium.

6.3.11 The Peat is present in localised areas of the West Site at elevations between c. -3 and -5 m OD (c. 4.5 to 7.0 m bgl) (see **Figures 6** and **7**); where recorded, it is generally present in thicknesses of less than 1 m (**Figure 5**). Peat is generally absent in the eastern part of the Site, recorded only in boreholes E-BH26A, E-BH34 and E-BH35 in this area (see **Figure 5**).

6.3.12 These peat units are indicative of transitions to semi-terrestrial conditions on the floodplain supporting the growth of wetland vegetation such as that found growing in reed swamp,

sedge fen or fen carr, likely as a response to a reduction in rates of relative sea level rise. The distribution of the peat deposits indicates that they were likely growing either in floodplain hollows or within a network of narrow dendritic channels, typical of those found in mudflats. There is no evidence within the borehole sequences for a concentration of peat deposits within the possible palaeochannel feature highlighted by Bunn (2013).

Organic alluvium

6.3.13 Firm to soft black/dark grey laminated silts with frequent organic material and comminuted (occasionally whole) mollusc shells were present in all 14 of the geoarchaeological boreholes and 28 of the GI boreholes, at various elevations within the Holocene alluvial sequence.

6.3.14 These deposits were broadly distributed across both the West Site and Pipeline Corridor, and were generally present at elevations between c. 0.0 and -4.0 m OD (c. 1.0 to 5.0 m bgl; see **Figures 6** to **8**). These deposits likely represent sediment accumulation in low energy environments, potentially including slow-moving or deactivated channels and within freshwater backswamp or more vegetated saltmarsh environments. Organic rich muds are distinct from alluvium which will often contain a minor organic component that is typically derived from in-washed plant fragments or the roots of plants growing in saltmarsh or swamp.

Made ground

6.3.15 A unit of modern made ground capped the sequence in the central part of the Site in boreholes RSK_BH01, RSK_BH02, RSK_WS01, RSK_WS02, RSK_WS03, RSK_WS04 and RSK_WS05, and towards the east of the Site in borehole E-BH26A. The made ground was between 1.2 m (RSK_WS01, RSK_WS02, E-BH26A) and 2.4 m thick (RSK-BH01) and generally comprised brick, concrete and chalk in a matrix of gravelly clay.

Modern soil profile

6.3.16 A firm dark greyish brown clay silt modern topsoil was recorded in all 14 geoarchaeological boreholes and 66 of the GI boreholes, generally up to 0.6 m thick.

7 DISCUSSION

7.1 Summary

7.1.1 A programme of geoarchaeological borehole survey and deposit modelling, and an archaeological watching brief on GI works, was undertaken at NH3 Immingham Green Energy Terminal, Immingham, North Lincolnshire in advance of proposed development comprising an ammonia import terminal forming part of the proposed Green Energy Terminal at Immingham. The geoarchaeological borehole survey was focused on the West Site, with the archaeological watching brief focusing on the West Site, Pipeline Corridor and East Site.

7.1.2 The geoarchaeological borehole survey and watching brief was undertaken in accordance with an overarching WSI (AECOM 2022), and was designed to provide information on the geoarchaeological and archaeological resource likely to be impacted by the proposed development and facilitate an informed decision with regard to any further archaeological and geoarchaeological work that may be required. In addition, borehole transects in the West Site targeted a possible palaeochannel feature identified in a previous geophysical survey (Bunn 2013).

7.1.3 No archaeological finds or features were identified during the archaeological watching brief on the GI works, which comprised a total of 40 geotechnical test pits in the West Site and East Site. This includes the proposed paleochannel which was also not identified by the works. In general, the deposits encountered were deemed to have a low archaeological potential for informing on past environments and early human activity within the Site, although small areas of Peat and Organic Alluvium encountered across the Site retain some potential to yield information on these areas of investigation.

7.2 Sedimentary sequence and depositional environment

7.2.1 The sequence of superficial geological deposits recorded at the Site, overlying the Cretaceous chalk bedrock, comprises Pleistocene glacial till, and a sequence of Holocene alluvium formed under the influence of rising sea levels during the Holocene. In places the Holocene alluvial sequence includes peat and organic-rich units. The sequence was capped by modern made ground towards the centre of the Site, and modern topsoil elsewhere.

7.2.2 The glacial till at the Site was typically over 10m in thickness, with a variable surface generally ranging from c. -4 m OD in the west to c. -8 m OD in the east. The superficial geology of North Lincolnshire and North Yorkshire was strongly influenced by glaciation during the Devensian (MIS 4-2; 110-11.7 Kya), with the North Sea Ice Lobe being interpreted as the source of glacial till within the Site. The North Sea Ice Lobe is dated to the Dimlington Stadial (MIS 2; 15-26 Kya), with the maximum extent of the glacial advance dated to approximately 17 Ka (Bateman et al 2015).

7.2.3 Following the retreat of the ice sheet (after c. 13 Ka) sea levels in the area rose rapidly, creating steep-sided valleys up to 9m deep (Van de Noort 2004), now largely infilled with Holocene sediment. Sea-level rise resulted in the development of a series of resource-rich wetlands along the Humber and its tributaries, including coastal, estuarine, brackish and semi-terrestrial wetland habitats; by around 8 Ka, sea-levels were c. 17 m below current levels and intertidal environments were largely restricted to the outer Humber Estuary. However, by the late Mesolithic, intertidal influence is likely to have reached the lower reaches of the tributaries draining into the Humber.

7.2.4 The sequence of Holocene estuarine alluvium at the Site is largely minerogenic, representing sediment accumulating under the influence of rising post-glacial sea-levels, and deposited within a range of settings from early Holocene channel systems through to mud flats and salt marsh environments within the succeeding extensive intertidal floodplains of the Humber Estuary.

7.2.5 Organic-rich alluvium and relatively thin (<1.0 m thick) peat deposits are recorded within the alluvium at the Site. The peat deposits are generally recorded directly overlying the till at the base of the Holocene alluvial sequence, and are present at variable elevations between c. -3.0 and -5.0 m OD, and likely represent reed swamp environments forming between phases of estuarine saltmarsh and mud flats in response to background sea-level rise. Peat is generally absent in the eastern part of the Site, recorded only in borehole E-BH26A, E-BH34 and E-BH35 in this area.

7.2.6 Peat deposits are widespread throughout the Humber Estuary and its tributaries, generally dating from the late Mesolithic to the Bronze Age, with those deposits often thinner closer to the foreshore of the Humber where marine and estuarine conditions would have largely prevailed and increasing in thickness towards the interior of the intertidal wetlands. Basal peats occurring at similar elevations to the present Site (c. -2.0 to -3.0 m OD) at South Ferriby (4.3km west of Barton upon Humber) have been dated to approximately 5000 cal

BC at -3 m OD (Van de Noort & Fletcher 2000). Such deposits are of high archaeological and geoarchaeological potential.

7.2.7 The continued accumulation of largely minerogenic estuarine alluvium at the Site, recorded to a level of c. 1-2 m OD, can be correlated with widespread alluviation in the Humber Estuary. Tidal influence became more prominent in the area as sea levels continued to rise, with tidal encroachment increasing from the coast and travelling further inland starting from the Bronze Age at c. 8000 BC, with encroachment at Holderness in 5000 cal BC, the lower Ancholme Valley in 4000 cal BC, and the Humberhead Levels in 2300 cal BC (Van de Noort & Fletcher 2000).

7.2.8 Recent geoarchaeological investigations east of Barton-upon-Humber (Wessex Archaeology 2023d), c. 10 km to the northeast of the Site on the right bank of the Humber, revealed a sequence of Pleistocene glacial or pro-glacial deposits (including till), overlain by a sequence of Holocene alluvium. Organic-rich units were recorded within the alluvium at elevations between c. -4.0 and 0.0 m OD, with rare (recorded in two locations) and thin (<0.3 m thick) peat units at elevations between c. -2 and -3 m OD (Wessex Archaeology 2023d).

Possible palaeochannel feature

7.2.9 Transects 1 and 2 targeted a possible palaeochannel identified during a previous geophysical survey of the Site (Bunn 2013). In these boreholes and the resultant deposit models there is no clear evidence in the surface of the till for an early Holocene palaeochannel cut in to these deposits, and no clear evidence for a distinct alluvial sequence infilling a palaeochannel. The distribution and extent of peat and organic alluvium within the Holocene alluvial sequence is relatively evenly distributed across the Site, rather than being focussed within this possible palaeochannel feature.

7.2.10 However, the absence of evidence for an early Holocene channel here does not discount the possibility of a later channel cutting through the alluvial sequence, perhaps related to a dendritic channel typical of tidal mudflats, or a tributary channel draining east towards the Humber. The absence of peat and organic alluvium within the alluvial sequence in boreholes W-BH24 and W-BH28 provides tentative evidence for subsequent fluvial erosion of such deposits. However, such channels are typically hard to identify in the sedimentary data available in borehole logs.

8 CONCLUSION AND RECOMMENDATIONS

8.1 Summary

8.1.1 No archaeological finds or features were identified during the archaeological watching brief on the GI works. The key results of the geoarchaeological monitoring and archaeological watching brief, and the geoarchaeological and archaeological potential of the revealed deposits, are summarised below and in **Table 4**.

Table 4 Summary of geoarchaeological and archaeological potential

Stratigraphic unit	Geoarchaeological potential	Archaeological potential
Till	Low	Low
Minerogenic alluvium	Low	Low
Organic alluvium	Moderate	Moderate
Peat	High	High
Made ground	None	None

**moderate potential where fine-grained or organic sub-units are identified*
***potential for reworked artefacts or in-situ artefacts in fine-grained or organic sub-units*

8.1.2 **Till** was widespread across the Site, typically over 10m in thickness, with a variable surface generally ranging from c. -4 m OD in the west to c. -8 m OD in the east of the Site. The till present within the Site is likely to be associated with the maximum extent of the glacial advance of the North Sea Ice Lobe during the Dimlington Stadial (MIS 2; 15-26 Kya).

8.1.3 Till itself has limited archaeological and geoarchaeological potential, however, it may seal and preserve underlying stratigraphy containing archaeological sites, artefacts and/or associated palaeoenvironmental remains.

8.1.4 **Minerogenic alluvium** was widespread across the Site, generally present at elevations between c. 1.0 and -5 m OD in the West Site, and between c. 1.5 and -10 m OD in the eastern part of the Site. These deposits represent the accumulation of estuarine alluvium in tidal flats and saltmarsh under the influence of rising sea levels during the Holocene.

8.1.5 The geoarchaeological potential of minerogenic alluvium is low, although it still has the potential to contain or partially mask archaeology. Although alluvium contains palaeoenvironmental remains such as pollen and plant macrofossils, these are often poorly preserved and of uncertain source area transported fluvially over potentially large areas. Alluvium also lacks suitable material of secure context for radiocarbon dating.

8.1.6 However, targeted investigation of microfaunal remains contained in alluvium (e.g. diatoms, foraminifera and ostracods) can be useful for understanding the balance between marine and freshwater environments, particularly in relation to alluvium contained in early Holocene channels and where associated peat or organic-rich deposits provide datable horizons.

8.1.7 **Peat**, generally present in thicknesses of less than 1 m, was recorded at elevations between c. -3 and -5 m OD across the West Site. Peat was generally absent in the eastern part of the Site, recorded only in boreholes E-BH26A, E-BH34 and E-BH35 in this area. The geoarchaeological and archaeological potential of peat deposits is high. Peat contains a range of botanical remains (e.g. pollen and plant macrofossils) preserved in the waterlogged anoxic (oxygen-free) conditions, representing important archives of information on past climate and palaeoenvironmental change and the impact of human communities on the landscape.

8.1.8 **Organic-rich alluvium** was recorded more widely across the Site and was generally present at elevations between c. 0.0 and -4.0 m OD. The geoarchaeological potential of organic-rich alluvium is similar to that of peat deposits, though in selected sequences the organic component is largely detrital and of limited geoarchaeological potential.

8.2 Recommendations

8.2.1 Depending on the construction design and likely depth of impact, the proposed works may impact deposits of high geoarchaeological potential (peat and organic rich alluvium), as outlined above. The impact of the development proposals upon these deposits will need to be assessed in order to establish the need for, scale and scope of any further geoarchaeological and archaeological evaluation of the Site. However, it is noted that these deposits are largely too deeply buried to be evaluated by conventional archaeological trial trenching, and palaeoenvironmental assessment of the retained boreholes may therefore be considered as an appropriate means for mitigating impact on these deposits.

8.2.2 Core samples of deposits of high geoarchaeological potential (principally the peat units) have been retained from the boreholes shown in **Table 5**. Any recommendations for targeted palaeoenvironmental assessment of these deposits should be focussed on a suitable distribution of these boreholes.

Table 5 Samples retained for further assessment

Borehole	Top of peat (m bgl)	Base of peat (m bgl)	Core samples retained (m bgl)
BH8	5.33	5.57	0.0 to 6.0
BH9	5.37	5.53	0.0 to 6.0
BH11	5.94	6.36	0.0 to 7.0
BH13	5.62	6.00	0.0 to 6.0
BH14	6.55	6.96	0.0 to 7.0

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APPENDICES

Appendix 1 Borehole sediment logs

Site Code: 271001	Site Name: Immingham IGET	Borehole ID: 1
Coordinates (NGR) X:	Coordinates (NGR) Y:	Level (top): 1.70 m OD
Length:	Width:	Depth: 5.70 m

Context Number	Description	Interpretation	Depth m bgl	Depth m OD	Samples
11	firm 10YR 4/2 clay silt. diffuse/unclear lower boundary, trends into unit below. as others with arbitrary measurement of unit as lower boundary unclear.	modern soil profile	0-0.15	1.70-1.55	
12	firm 7.5YR 3/3 silt with moderate to frequent iron staining throughout. diffuse lower boundary, trends into unit below.	alluvium	0.15-2.00	1.55 to -0.30	
13	soft silt, mottled black and 10YR 3/2 (mottled/layered throughout unit) with frequent black organic smears throughout, occasional preserved small whole twigs/roots, patch of preserved organic material (wood fragments and whole twigs/roots) at 2.65-2.70m, very occasional medium bivalve shell fragments. strong laminations. sharp, straight lower boundary.	organic alluvium	2.00-5.20	-0.30 to -3.50	
14	very firm 10YR 5/2 slightly sandy silt with occasional to moderate preserved organic material (fragments and whole wood), moderate to frequent small to large subrounded and rounded pebbles and occasional stones (chalk, occasional quartz?), patches of sand at 5.25 and 5.40m. these units show mixing and incorporation of material from surrounds etc.	glacial till	5.20-5.70	-3.50 to -4.00	

Site Code: 271001	Site Name: Immingham IGET	Borehole ID: 2
Coordinates (NGR) X:	Coordinates (NGR) Y:	Level (top): 1.63 m OD
Length:	Width:	Depth: 7.20 m

Context Number	Description	Interpretation	Depth m bgl	Depth m OD	Samples
21	firm 10YR 4/2 clay silt. diffuse/unclear lower boundary, trends into unit below. as others with arbitrary measurement as lower boundary is unclear.	modern soil profile	0-0.15	1.63 to 1.48	
22	firm 10YR 4/2 and mottled grey and orange silt with occasional preserved organic material (wood fragments) and frequent iron staining. trends into unit below around 2.00m. diffuse lower boundary. [NO RECOVERY 1.20-1.27m]	alluvium	0.15-2.00	1.48 to -0.37	
23	fairly firm 2.5Y 4/1 silt with frequent organic material (black smears and black root channels). strong laminations. lower boundary not present. [COMPROMISED RECOVERY 2.80-3.00m, 4.20-4.50m NO RECOVERY 2.70-2.80m]	organic alluvium	2.00-4.20	-0.37 to -2.57	
24	soft black/dark grey silt with very occasional comminuted small mollusc shells. very similar to unit above but no woody inclusions/channel markings/infill. strong laminations. sharp, straight lower boundary.	organic alluvium/proto peat	4.20-6.52	-2.57 to -4.89	
25	very firm 10YR 5/2 slightly sandy silt with occasional to moderate preserved organic material (fragments and whole wood), moderate to frequent small to large subrounded and rounded pebbles and occasional stones (chalk, occasional quartz?).	glacial till	6.52-7.20	-4.89 to -5.57	

Site Code: 271001	Site Name: Immingham IGET	Borehole ID: 3
Coordinates (NGR) X:	Coordinates (NGR) Y:	Level (top): 1.79 m OD
Length:	Width:	Depth: 7.20 m

Context Number	Description	Interpretation	Depth m bgl	Depth m OD	Samples
31	firm 10YR 4/2 clay silt. diffuse/unclear lower boundary, trends into unit below.	modern soil profile	0-0.20	1.79 to 1.59	
32	firm 10YR 3/3 silt with moderate organic material (black smears) and moderate to frequent iron staining. trends into unit below and area of mixing 2.20-2.55m. strong laminations. gradual lower boundary.	alluvium (oxidised)	0.20-2.33	1.59 to -0.54	
33	soft, sticky black silt (some mixing with unit above), from 4.40m onwards has some lighter layers interleaved (see photo). Occasional preserved organic material (root channels at top of unit, smears throughout), very occasional comminuted bivalve shells around 5.40-5.50m. strong laminations. sharp lower boundary. [NO RECOVERY 2.70-3.35m, 4.29-4.30m, 5.70-6.30m Compromised recovery 3.35-3.70m, 6.30-6.60m]	organic alluvium, possibly showing seasonal deposition?	2.33-7.05	-0.54 to -5.26	
34	very firm 10YR 5/2 slightly sandy silt with occasional to moderate preserved organic material (fragments and whole wood), moderate to frequent small to large subrounded and rounded pebbles and occasional stones (chalk, occasional quartz?). these units show mixing and incorporation of material from surrounds etc.	glacial till	7.05-7.20	-5.26 to -5.41	

Site Code: 271001	Site Name: Immingham IGET	Borehole ID: 4
Coordinates (NGR) X:	Coordinates (NGR) Y:	Level (top): 1.55 m OD
Length:	Width:	Depth: 7.20 m

Context Number	Description	Interpretation	Depth m bgl	Depth m OD	Samples
41	firm 10YR 4/2 clay silt. diffuse/unclear lower boundary, trends into unit below. as others, arbitrary measurement as lower boundary unclear.	modern soil profile	0-0.20	1.55 to 1.35	
42	fairly firm 2.5Y 4/2 silt with occasional preserved organic material (wood fragments), moderate roots and moderate iron staining. clear lower boundary, trends into unit below. moderately laminated.	alluvium	0.20-2.15	1.35 to -0.60	
43	fairly firm, sticky dark grey silt with very occasional comminuted bivalve shell, moderate organic material (wood fragments, black smears). strong laminations. abrupt lower boundary.	organic alluvium	2.15-5.80	-0.60 to -4.25	
44	firm 10YR 4/1 slightly sandy silt, increasing in sand content with depth, with occasional bands of large bivalve shells (mostly comminuted) and occasional small mollusc shells with sand at top of unit, occasional preserved organic material (wood fragments). sharp lower boundary (liner split in casing at boundary). laminated 10YR 3/2 silt to 6.00m with the shells and possibly abrupt lower boundary. slight mixing with unit below from 6.40m.	glacial till	5.80-6.53	-4.25 to -4.98	
45	very firm 10YR 5/2 slightly sandy silt with occasional to moderate preserved organic material (fragments and whole wood), moderate to frequent small to large subrounded and rounded pebbles and occasional stones (chalk, occasional quartz?). these units show mixing and incorporation of material from surrounds etc.	glacial till	6.53-7.20	-4.98 to -5.65	

Site Code: 271001	Site Name: Immingham IGET	Borehole ID: 5
Coordinates (NGR) X:	Coordinates (NGR) Y:	Level (top): 1.31 m OD
Length:	Width:	Depth: 7.20 m

Context Number	Description	Interpretation	Depth m bgl	Depth m OD	Samples
51	firm 10YR 4/2 clay silt. diffuse/unclear lower boundary, trends into unit below. as others, arbitrary measurement as lower boundary unclear.	modern soil profile	0-0.20	1.31 to 1.11	
52	firm mottled orange and grey silt with moderate to frequent iron staining throughout. diffuse lower boundary.	alluvium	0.20-2.10	1.11 to -0.79	
53	soft, sticky dark grey silt with occasional preserved organic material (wood fragments, black smears) increasing towards base of unit (wood at 5.42-5.48m), very occasional small mollusc shells. strong laminations. abrupt lower boundary, marked by later of woody detritus. [NO RECOVERY 2.70-3.05m COMPROMISED RECOVERY 3.05-3.50m, 4.20-4.50m]	slightly organic alluvium	2.10-5.48	-0.79 to -4.17	
54	friable grey silty sand/sandy silt (increasing in sand content with depth) with occasional preserved organic material (wood fragments). mixing with unit below from 6.10-6.30m with similar woody detritus in both units. abrupt lower boundary.	glacial till	5.48-6.28	-4.17 to -4.94	
55	very firm 10YR 5/2 slightly sandy silt with occasional to moderate preserved organic material (fragments and whole wood), moderate to frequent small to large subrounded and rounded pebbles and occasional stones (chalk, occasional quartz?). these units show mixing and incorporation of material from surrounds etc.	glacial till	6.28-7.20	-4.94 to -5.89	

Site Code: 271001	Site Name: Immingham IGET	Borehole ID: 6
Coordinates (NGR) X:	Coordinates (NGR) Y:	Level (top): 1.55 m OD
Length:	Width:	Depth: 5.70 m

Context Number	Description	Interpretation	Depth m bgl	Depth m OD	Samples
61	firm 10YR 4/2 clay silt. diffuse/unclear lower boundary, trends into unit below.	modern soil profile	0-0.20	1.55 to 1.35	
62	firm 10YR 4/2 silt with occasional roots running down profile, frequent iron staining throughout. trends into unit below. possibly laminated. gradual lower boundary.	alluvium	0.20-2.30	1.35 to -0.75	
63	soft silt 2.5Y 4/1 trending into 2.5Y 3/1 with occasional preserved organic material (wood fragments, roots/leaves?, black smears), very occasional medium to large bivalve shell. large fragment of wood at 5.10-5.15m (see photo). trends into and mixes with unit below (5.23-5.30m). strong laminations. clear/diffuse lower boundary. [Compromised recovery 4.20-4.70m]	organic alluvium	2.30-5.25	-0.75 to -3.70	
64	very firm 10YR 5/2 slightly sandy silt with occasional to moderate preserved organic material (fragments and whole wood), moderate to frequent small to large subrounded and rounded pebbles and occasional stones (chalk, occasional quartz?). these units show mixing and incorporation of material from surrounds etc.	glacial till	5.25-5.70	-3.70 to -4.15	

Site Code: 271001	Site Name: Immingham IGET	Borehole ID: 7
Coordinates (NGR) X:	Coordinates (NGR) Y:	Level (top): 1.27 m OD
Length:	Width:	Depth: 5.70 m

Context Number	Description	Interpretation	Depth m bgl	Depth m OD	Samples
71	firm 10YR 4/2 clay silt. diffuse/unclear lower boundary, trends into unit below.	modern soil profile	0-0.20	1.27 to 1.07	
72	fairly firm, sticky 10YR 4/2 silt with moderate organic material (rootlets), grey along root channels. moderate iron staining throughout. trends into unit below. possibly laminated. clear lower boundary.	alluvium	0.20-1.90	1.07 to -0.63	
73	soft, sticky 2.5Y 3/1 silt with moderate organic material (black smears), occasional small mollusc shells (bivalve and gastropod). lower boundary marked by layer of woody detritus from 4.46 (includes whole leaves or stem covers) 2.50-3.20m mottled 10YR 4/2 and 2.5Y 3/1 silt. strong laminations. sharp lower boundary. VOID 4.62-4.68m. [Compromised recovery 2.70-3.00m, 4.20-4.30m]	organic alluvium	1.90-4.68	-0.63 to -3.41	
74	very firm 10YR 5/2 slightly sandy silt with occasional to moderate preserved organic material (fragments and whole wood), moderate to frequent small to large subrounded and rounded pebbles and occasional stones (chalk, occasional quartz?). mixing with unit above from 4.68-4.98m (includes woody material from above).	glacial till	4.68-5.70	-3.41 to -4.43	

Site Code: 271001	Site Name: Immingham IGET	Borehole ID: 8
Coordinates (NGR) X:	Coordinates (NGR) Y:	Level (top): 1.90 m OD
Length:	Width:	Depth: 7.20 m

Context Number	Description	Interpretation	Depth m bgl	Depth m OD	Samples
81	firm 10YR 4/3 clay silt. trends into unit below, lower boundary unclear.	modern soil profile	0-0.15	1.90 to 1.75	
82	firm 10YR 5/2 silt with occasional organic smears and moderate iron staining, trending into 10YR 3/2 silt with depth, with iron staining along root channels/voids, trending into more mottled orange and grey (10YR 4/3) with moderate iron staining. strong laminations. diffuse lower boundary, trends into unit below.	alluvium	0.15-2.05	1.75 to -0.15	
83	sticky 10YR 3/1 silt with frequent black organic smears and fragments, trending into 7.5YR 3/1 sticky silt with very occasional large whole bivalve shells. strong laminations, especially to towards base of unit where there is possible mixing with unit below (5.10-5.33m, see photo) incorporating preserved organic material (wood fragments). abrupt lower boundary.	organic alluvium, possible seasonal deposition	2.05-5.33	-0.15 to -3.43	
84	firm yet soft black silt with woody detritus and possible whole leaves? abrupt lower boundary.	peat	5.33-5.57	-3.43 to -3.67	
85	firm black silt, possibly laminated. sharp lower boundary.	alluvium	5.57-5.66	-3.67 to -3.76	
86	sticky blue grey slightly sandy silt, becoming brown at base of unit. sharp lower boundary. [NO RECOVERY 4.20-4.40m]	glacial till	5.66-5.89	-3.76 to -3.99	
87	very firm 10YR 5/2 slightly sandy silt with occasional to moderate preserved organic material (fragments and whole wood), moderate to frequent small to large subrounded and rounded pebbles and occasional stones (chalk, occasional quartz?). mixed with unit above 5.89-6.00m. [NO RECOVERY 6.96-7.20m]	glacial till	5.89-7.20	-3.99 to -5.30	

Site Code: 271001	Site Name: Immingham IGET	Borehole ID: 9
Coordinates (NGR) X:	Coordinates (NGR) Y:	Level (top): 1.65 m OD
Length:	Width:	Depth: 7.20 m

Context Number	Description	Interpretation	Depth m bgl	Depth m OD	Samples
91	firm 10YR 4/2 clay silt. diffuse/unclear lower boundary, trends into unit below.	modern soil profile	0-0.20	1.65 to 1.45	
92	as BH8 in inspection pit. firm 10YR 4/3 silt with moderate iron staining. trends into unit below. diffuse lower boundary.	alluvium	0.20-1.50	1.45 to 0.15	
93	sticky 2.5Y 3/2 silt with frequent organic material (black along root channels, smears), very occasional large whole bivalve shells c.5m. darker 3.56-3.76m. some mixing with unit below - preserved organic material (wood fragments). strong laminations. sharp lower boundary [NO RECOVERY 4.20-4.60 Compromised recovery 4.60-4.80m].	organic alluvium	1.50-5.37	0.15 to -3.72	
94	firm soft black silt with frequent woody detritus and preserved organic material (roots/twigs?). abrupt lower boundary.	peat	5.37-5.53	-3.72 to -3.88	
95	sticky very dark brown very slightly sandy silt trending into slightly silty sand with depth. occasional preserved organic material (wood fragments, roots, moss?), mixing with unit below from 5.95m. abrupt lower boundary.	glacial till	5.53-6.05	-3.88 to -4.40	
96	very firm 10YR 5/2 slightly sandy silt with occasional to moderate preserved organic material (fragments and whole wood), moderate to frequent small to large subrounded and rounded pebbles and occasional stones (chalk, occasional quartz?). sand layer 6.65-6.82m. these units show mixing and incorporation of material from surrounds etc.	glacial till	6.05-7.20	-4.40 to -5.55	

Site Code: 271001	Site Name: Immingham IGET	Borehole ID: 10
Coordinates (NGR) X:	Coordinates (NGR) Y:	Level (top): 1.56 m OD
Length:	Width:	Depth: 8.70 m

Context Number	Description	Interpretation	Depth m bgl	Depth m OD	Samples
101	soft/sticky 10YR 4/2 clay silt with no inclusions. trending into mottled clay silt (orange and grey) or could be moderate iron staining.	modern soil profile	0-0.20	1.56 to 1.36	
102	sticky/soft 10YR 3/1 silt with moderate organic material (wood fragments, possible roots), occasional small bivalve shells towards base of unit. strong laminations. clear lower boundary. possible slight change at 1.55m to even softer, slightly darker silt].	organic alluvium/proto peat?	0.20-4.87	1.36 to -3.31	
103	sticky 10YR 3/3 silt with occasional to moderate preserved organic material (wood). strong laminations. sharp lower boundary.	organic alluvium	4.87-5.33	-3.31 to -3.77	
104	sticky, slightly firm GLEY2 4/5B clay (trending into slightly sandy silt towards base of unit) with moderate small to large subrounded and rounded pebbles and stones (chalk, quartz?) and pea gravel sized. sharp lower boundary.	glacial till	5.33-6.80	-3.77 to -5.24	
105	fairly firm sand	glacial till	6.80-8.70	-5.24 to -7.14	

Site Code: 271001	Site Name: Immingham IGET	Borehole ID: 11
Coordinates (NGR) X:	Coordinates (NGR) Y:	Level (top): 1.63 m OD
Length:	Width:	Depth: 8.70 m

Context Number	Description	Interpretation	Depth m bgl	Depth m OD	Samples
111	firm, sticky 7.5YR 4/1 clay silt. trends into unit below	modern soil profile	0-0.15	1.63 to 1.48	
112	sticky 10YR 4/3 silt (grey silt along veins) with occasional preserved organic material (wood fragments). strong laminations. clear/diffuse lower boundary.	alluvium (possibly 2 units 0.15-2.00m and 2.00-5.94m)	0.15-2.00	1.48 to -0.37	
113	10YR 3/1 silt from c.2m with moderate preserved organic material (wood fragments, wood and roots). strong laminations. abrupt lower boundary.	organic alluvium	2.00-5.94	-0.37 to -4.31	
114	large wood fragments 5.94-6.12m onto mostly comminuted wood and some black silt. sharp lower boundary.	peat	5.94-6.36	-4.31 to -4.73	
115	sticky, firm 2.5Y 3/1 silty clay/clay with occasional small to large subrounded and rounded pebbles and stones and pea gravel sized lithics (chalk, very occasional quartz?).	glacial till	6.36-8.70	-4.73 to -7.07	

Site Code: 271001	Site Name: Immingham IGET	Borehole ID: 12
Coordinates (NGR) X:	Coordinates (NGR) Y:	Level (top): 1.69 m OD
Length:	Width:	Depth: 7.20 m

Context Number	Description	Interpretation	Depth m bgl	Depth m OD	Samples
121	fairly firm 10YR 4/2 clay silt. trends into unit below	modern soil profile	0-0.20	1.69 to 1.49	
122	fairly firm 2.5Y 4/2 silt, some mottling, which could be iron staining. diffuse lower boundary.	alluvium	0.20-2.20	1.49 to -0.51	
123	soft 2.5Y 4/2 silt and black silt. strong laminations. clear lower boundary. [NO RECOVERY 2.50-2.70m] [COMPROMISED RECOVERY 2.70-3.00m]	alluvium, possibly seasonally deposited	2.20-3.30	-0.51 to -1.61	
124	sticky, soft black silt with occasional preserved organic material (wood fragments, roots), very occasional small mollusc shells and comminuted shell (bivalves) - increasing towards base of unit with larger bivalve shells present. clear lower boundary. strong laminations. [NO RECOVERY 4.20-4.50m]	organic alluvium/proto peat	3.30-5.35	-1.61 to -3.66	
125	fairly firm sand and silt (50:50) increasing sand content with depth with occasional preserved organic material (rootlets), occasional while and comminuted shell, moderate small to large subrounded and rounded pebbles and small to medium stones (chalk, occasional quartz?). abrupt lower boundary.	glacial till	5.35-6.95	-3.66 to -5.26	
126	firm 7.5YR 4/4 clay with moderate small to large subrounded and rounded pebbles and pea gravel sized lithics (chalk).	glacial till	6.95-7.20	-5.26 to -5.51	

Site Code: 271001	Site Name: Immingham IGET	Borehole ID: 13
Coordinates (NGR) X:	Coordinates (NGR) Y:	Level (top): 1.69 m OD
Length:	Width:	Depth: 7.20 m

Context Number	Description	Interpretation	Depth m bgl	Depth m OD	Samples
131	firm 10YR 4/2 clay silt. diffuse/unclear lower boundary, trends into unit below.	modern soil profile	0-0.20	1.69 to 1.49	
132	firm 10YR 4/2 clay silt with silt content increasing with depth but either mottled orange and 10YR 4/2, or frequent iron staining. occasional preserved organic material (roots). diffuse lower boundary.	alluvium	0.20-2.32	1.49 to -0.63	
133	organic smears appearing from 2.23m onwards. unit trends into soft 10YR 4/1 silt with moderate black organic smears/fragments and organic material (roots). trending into 10YR 3/1 with depth. seems lumpy/peddy. strong laminations. abrupt lower boundary.	organic alluvium	2.32-5.62	-0.63 to -3.93	
134	firm dark brown slightly fibrous silt with moderate organic material (wood fragments and roots). trends into unit below, change is around 6.00m. diffuse lower boundary.	peat	5.62-6.00	-3.93 to -4.31	
135	very firm 10YR 5/2 slightly sandy silt with occasional to moderate preserved organic material (fragments and whole wood). from 6.36m moderate to frequent small to large subrounded and rounded pebbles and occasional stones (chalk, occasional quartz?).	glacial till	6.00-7.20	-4.31 to -5.51	

Site Code: 271001	Site Name: Immingham IGET	Borehole ID: 14
Coordinates (NGR) X:	Coordinates (NGR) Y:	Level (top): 1.39 m OD
Length:	Width:	Depth: 7.20 m

Context Number	Description	Interpretation	Depth m bgl	Depth m OD	Samples
141	firm 10YR 5/2 clay silt, trends into unit below with very diffuse lower boundary.	modern soil profile	0-0.20	1.39 to 1.19	
142	firm 10YR 5/2 silt (mottled grey and orange) with frequent iron staining (grey along veins/root canals). darker from 2.70m onwards (10YR 3/2) with moderate organic material smears and fragments from 2.10m onwards, occasional large whole bivalve shells between 1.80 and 2.00m (see photo) and from 4.00-6.10m, very occasional small bivalves 4.20-5.70m. strong laminations. lower boundary unclear. [compromised recovery 4.20-4.50m, 5.70-6.10m].	alluvium	0.20-6.10	1.19 to -4.71	
143	fairly firm, fairly sticky silt with moderate to frequent preserved organic material (wood fragments, roots/leaves?). abrupt lower boundary.	organic alluvium	6.10-6.55	-4.71 to -5.16	
144	firm black organic material (decayed wood etc) and some silt (organics: silt, 70:30). large fragment of wood at 6.78-6.79m. sharp lower boundary.	peat	6.55-6.96	-5.16 to -5.57	
145	firm sandy clay with moderate to frequent small to large subrounded and rounded pebbles and pea gravel sized lithics (chalk).	glacial till	6.96-7.20	-5.57 to -5.81	

Appendix 2 Test Pit sediment logs

TP1 (W-TP01)	Length 3 m	Width 0.65 m	Depth 3 m
Easting	Northing	m OD 0	

Context Number	Fill Of/Filled With	Interpretative Category	Description	Depth BGL
101		Topsoil	Dark greyish brown silty clay. firm and compact with signs of rooting from the vegetation on top of the layer. No inclusions within the layer.	0.00 – 0.50
102		Alluvium	Mid greyish yellow clay. Firm and compacted. Quite sticky. No visible inclusions seen within the layer.	0.50 – 2.30
103		Alluvium	Greyish blue clay soft and sticky. No visible inclusions seen within the layer.	2.30 – 3.00+

TP2 (W-TP02)	Length 3 m	Width 0.65 m	Depth 3 m
Easting	Northing	m OD 0	

Context Number	Fill Of/Filled With	Interpretative Category	Description	Depth BGL
201		Topsoil	Dark greyish brown silty clay, firm and compact with signs of rooting from the vegetation on top of the layer. Small pebble inclusions about 20-30mm sub-rounded pebbles. Can be seen within the section of the layer.	0.00 – 0.80
202		Gravel	Modern mix of gravel, small and sub-rounded pebbles about 10-20mm in size and big sub-rounded stones about 80-90mm all spread along the test pit.	0.80 – 3.00+

TP3 (W-TP03)	Length 3 m	Width 0.65 m	Depth 3 m
Easting	Northing	m OD	

Context Number	Fill Of/Filled With	Interpretative Category	Description	Depth BGL
301		Topsoil	Dark greyish brown silty clay. firm and compact with signs of rooting from the vegetation on top of the layer. No inclusions within the layer.	0.00 – 0.40
302		Subsoil	Light greyish brown. firm and compact just like (3001). small pockets of rooting seen within the layer. No stone inclusions seen in the layer.	0.40 – 0.90
303		Alluvium	Mid greyish yellow clay. Firm and compacted. Quite sticky. No visible inclusions seen within the layer.	0.90 – 1.50

304		Alluvium	Greyish blue clay soft and sticky. No visible inclusions seen within the layer. Quite wet due to hitting water table.	1.50 – 3.00+

TP4 (W-TP04)	**Length 3 m**	**Width 0.65 m**	**Depth 3 m**
Easting	**Northing**	**m OD 0**	

Context Number	**Fill Of/Filled With**	**Interpretative Category**	**Description**	**Depth BGL**
401		Topsoil	Dark greyish brown silty clay, firm and compact with signs of rooting from the vegetation on top of the layer. No inclusions within the layer.	0.00 – 0.40
402		Alluvium	Mid greyish yellow clay. Firm and compacted. Quite sticky. No visible inclusions seen within the layer.	0.40 – 2.30
403		Alluvium	greyish blue clay soft and sticky. No visible inclusions seen within the layer. Water table hit at 1.4m down.	2.30 – 3.00+

TP5 (W-TP05)	**Length 3 m**	**Width 0.65 m**	**Depth 3 m**
Easting	**Northing**	**m OD 0**	

Context Number	**Fill Of/Filled With**	**Interpretative Category**	**Description**	**Depth BGL**
501		Topsoil	Dark greyish brown silty clay, firm and compact with signs of rooting from the vegetation on top of the layer. No inclusions within the layer.	0.00 – 0.30
502		Subsoil	Light greyish brown, firm and compact just like (501). Small pockets of rooting seen within the layer. No stone inclusions seen in the layer.	0.30 – 0.90
503		Alluvium	Mid greyish yellow clay. Firm and compacted. Quite sticky. No visible inclusions seen within the layer.	0.90 – 2.30
504		Alluvium	Greyish blue clay soft and sticky. No visible inclusions seen within the layer. Quite wet due to hitting water table.	2.30 – 3.00+

TP6 (W-TP06)	**Length 3 m**	**Width 0.65 m**	**Depth 3 m**
Easting	**Northing**	**m OD 0**	

Context Number	**Fill Of/Filled With**	**Interpretative Category**	**Description**	**Depth BGL**
601		Topsoil	Dark greyish brown silty clay, firm and compact with signs of rooting from the vegetation on top of the layer. Small stone inclusion within the layer. Small sub-rounded pebbles about 20-30mm in size.	0.00 – 0.30

602		Alluvium	Mid greyish yellow clay. Firm and compacted. Quite sticky. No visible inclusions seen within the layer.	0.30 – 1.00+

TP7 (W-TP07)	**Length 3 m**	**Width 1 m**	**Depth 3 m**
Easting	**Northing**	**m OD 0**	

Context Number	**Fill Of/Filled With**	**Interpretative Category**	**Description**	**Depth BGL**
701		Topsoil	Dark greyish brown silty clay. Firm and compact with signs of rooting from the vegetation on top of the layer. No inclusions within the layer.	0.00 – 0.40
702		Alluvium	Mid greyish yellow silty clay. Firm and compacted. Quite sticky. No visible inclusions seen within the layer.	0.40 – 1.60
703		Alluvium	Greyish blue clay soft and sticky. No visible inclusions seen within the layer. Quite wet due to hitting water table.	1.60 – 3.00+

TP8 (W-TP08)	**Length 3 m**	**Width 0.65 m**	**Depth 3 m**
Easting	**Northing**	**m OD 0**	

Context Number	**Fill Of/Filled With**	**Interpretative Category**	**Description**	**Depth BGL**
801		Topsoil	Dark greyish brown silty clay, firm and compact with signs of rooting from the vegetation on top of the layer. Small sub-rounded pebbles about 10-20mm in size seen within the layer very well spread out.	0.00 – 0.30
802		Subsoil	Light greyish brown, firm and compact just like (801). Small pockets of rooting seen within the layer. No stone inclusions seen in the layer.	0.30 – 0.50
803		Alluvium	Mid greyish yellow clay. Firm and compacted. Quite sticky. No visible inclusions seen within the layer.	0.50 – 1.40
804		Alluvium	Greyish blue clay soft and sticky. No visible inclusions seen within the layer. Quite wet due to hitting water table.	1.40 – 3.00+

TP9	**Length 3.40 m**	**Width 0.70 m**	**Depth 3 m**
Easting	**Northing**	**m OD**	

Context Number	**Fill Of/Filled With**	**Interpretative Category**	**Description**	**Depth BGL**
901		Topsoil	Soft brownish grey silty clay.	0.00 – 0.25
902		Alluvium	Dark brownish grey silty clay, no inclusions.	0.25 – 0.43

903		Alluvium	Mid reddish brown silty clay, no inclusions very sterile, very similar to 902 however much redder and more sandy possible alluvial deposit, land drain found in this layer at 1.10, becomes more sandy as it descends and is more sandy at 1.50 then at 1 meter.	0.43 – 1.80
904		Alluvium	Firm dark bluish black, silty clay with orangey brown mottling.	1.80 – 3.00+

TP10	**Length 3.45 m**	**Width 0.64 m**	**Depth 3.05 m**
Easting	**Northing**	**m OD**	

Context Number	**Fill Of/Filled With**	**Interpretative Category**	**Description**	**Depth BGL**
1001		Topsoil	Mid greenish grey clay. Firm, sticky, plastic. Frequent rooting (grass). No visible inclusions.	0.00 – 0.19
1002		Alluvium	A light to mid blueish grey clay with yellow mottling throughout. Firm, sticky, plastic. No visible inclusions.	0.19 – 0.70
1003		Alluvium	mid brownish yellow clay. Firm, sticky and plastic. No visible inclusions.	0.70 – 2.15
1004		Alluvium	Mid to dark blue grey clay. Soft, very sticky and plastic. No visible inclusions.	2.15 – 3.05+

TP11	**Length 3.50 m**	**Width 0.60 m**	**Depth 3 m**
Easting	**Northing**	**m OD**	

Context Number	**Fill Of/Filled With**	**Interpretative Category**	**Description**	**Depth BGL**
1101		Topsoil	Soft mid Greyish Brown silty clay, waterlogged, no inclusions.	0.00 – 0.25
1102		Alluvium	Firm mid blueish grey, no inclusions, possibly alluvial or boundary between layers.	0.25 – 0.40
1103		Alluvium	Mid reddish brown silty clay, no inclusions very sterile, alluvial deposit, change at 1 meter lens of silt yellow sand before returning to the brown red clay.	0.40 – 2.50
1104		Alluvium	Mid bluish grey silty clay orangey mottling possible sand inclusions.	2.50 – 3.00+

TP12 (W-TP12)	**Length 3 m**	**Width 1 m**	**Depth 3 m**
Easting	**Northing**	**m OD 0**	

Context Number	**Fill Of/Filled With**	**Interpretative Category**	**Description**	**Depth BGL**

1201		Topsoil	Dark greyish brown silty clay, firm and compact with signs of rooting from the vegetation on top of the layer. No inclusions within the layer.	0.00 – 0.40
1202		Alluvium	Mid greyish yellow clay. Firm and compacted. Quite sticky. No visible inclusions seen within the layer.	0.40 – 2.20
1203		Alluvium	Greyish blue clay soft and sticky. No visible inclusions seen within the layer. Quite wet due to hitting water table.	2.20 – 3.00+

TP13 (W-TP13)	**Length 3 m**	**Width 0.65 m**	**Depth 3 m**
Easting	**Northing**	**m OD**	

Context Number	**Fill Of/Filled With**	**Interpretative Category**	**Description**	**Depth BGL**
1301		Topsoil	Dark greyish brown silty clay, firm and compact with signs of rooting from the vegetation on top of the layer. No inclusions within the layer.	0.00 – 0.40
1302		Alluvium	Mid greyish yellow silty clay. Firm and compacted. Quite sticky. No visible inclusions seen within the layer.	0.40 – 2.20
1303		Alluvium	Greyish blue clay soft and sticky. No visible inclusions seen within the layer. Quite wet due to hitting water table.	2.20 – 3.00+

TP14	**Length 3.40 m**	**Width 0.60 m**	**Depth 3.20 m**
Easting	**Northing**	**m OD**	

Context Number	**Fill Of/Filled With**	**Interpretative Category**	**Description**	**Depth BGL**
1401		Topsoil	Soft. Greyish brown. Silty clay. Waterlogged. Abrupt, wavy boundary with alluvium.	0.00 – 0.22
1402		Alluvium	Firm. Bluish grey with reddish brown patches. No inclusions. Sharp, wavy boundary	0.22 – 0.50
1403		Alluvium	Firm. Reddish brown. Silty clay. Homogeneous, no inclusions. Structurally the same as layer 1402 but with a distinct change in colour.	0.50 – 1.80
1404		Organic alluvium	Superficial geology. Firm. Dark bluish grey with orangey brown mottling. Silty clay. Frequent, black streaks throughout, possible organic material.	1.80 – 3.20+

TP15	**Length 3 m**	**Width 0.50 m**	**Depth 3.40 m**
Easting	**Northing**	**m OD**	

Context Number	Fill Of/Filled With	Interpretative Category	Description	Depth BGL
1501		Topsoil	Moderately compact light brownish grey silty clay (30 / 70) with dense grass rooting, no archaeology in layer.	0.00 – 0.42
1502		Alluvium	Moderately compact mid orange brown silty clay (30 / 70).	0.42 – 3.40+

TP16 (W-TP16)	Length 3 m	Width 0.65 m	Depth 3 m
Easting	Northing	m OD 0	

Context Number	Fill Of/Filled With	Interpretative Category	Description	Depth BGL
1601		Topsoil	Dark greyish brown silty clay, firm and compact with signs of rooting from the vegetation on top of the layer. No inclusions can be seen within this layer.	0.00 – 0.50
1602		Alluvium	Mid greyish yellow clay. Firm and compacted. Quite sticky. No visible inclusions seen within the layer. small pockets of rooting can be seen in the layer.	0.50 – 2.10
1603		Alluvium	Dark greyish blue. Quite sticky due to the water table. No inclusions can be seen within this layer.	2.10 – 3.00+

TP17 (W-TP17)	Length 3 m	Width 0.65 m	Depth 3 m
Easting	Northing	m OD 0	

Context Number	Fill Of/Filled With	Interpretative Category	Description	Depth BGL
1701		Topsoil	Dark greyish brown silty clay, firm and compact with signs of rooting from the vegetation on top of the layer. No inclusions within the layer.	0.00 – 0.40
1702		Alluvium	Mid greyish yellow clay. Firm and compacted. Quite sticky. No visible inclusions seen within the layer.	0.40 – 2.20
1703		Alluvium	Greyish blue clay soft and sticky. No visible inclusions seen within the layer. Quite wet due to hitting water table.	2.20 – 3.00+

TP18 (W-TP18)	Length 3 m	Width 0.65 m	Depth 3 m
Easting	Northing	m OD 0	

Context Number	Fill Of/Filled With	Interpretative Category	Description	Depth BGL
1801		Topsoil	Dark greyish brown silty clay, firm and compact with signs of rooting from the vegetation on top of the layer. No inclusions within the layer.	0.00 – 0.60

1802		Alluvium	Mid greyish yellow clay. Firm and compacted. Quite sticky. No visible inclusions seen within the layer.	0.60 – 2.00
1803		Alluvium	Greyish blue clay, soft and sticky. No visible inclusions seen within layer. Quite wet due to hitting water table.	2.00 – 3.00+

TP19 (W-TP19)	**Length 3 m**	**Width 0.65 m**	**Depth 3 m**
Easting	**Northing**	**m OD 0**	

Context Number	**Fill Of/Filled With**	**Interpretative Category**	**Description**	**Depth BGL**
1901		Topsoil	Dark greyish brown silty clay, firm and compact with signs of rooting from the vegetation on top of the layer. No inclusions within the layer.	0.00 – 0.40
1902		Alluvium	Mid greyish yellow clay. Firm and compacted. Quite sticky. No visible inclusions seen within the layer.	0.40 – 2.10
1903		Alluvium	greyish blue clay soft and sticky. No visible inclusions seen within the layer. Water table hit at 1.5m.	2.10 – 3.00+

TP21 (W-TP21)	**Length 3 m**	**Width 0.65 m**	**Depth 3 m**
Easting	**Northing**	**m OD 0**	

Context Number	**Fill Of/Filled With**	**Interpretative Category**	**Description**	**Depth BGL**
2101		Topsoil	Dark greyish brown silty clay, firm and compact with signs of rooting from the vegetation on top of the layer. No inclusions within the layer.	0.00 – 0.30
2102		Alluvium	Mid greyish yellow clay. Firm and compacted. Quite sticky. No visible inclusions seen within the layer. slight mottling on a small patch of the layer.	0.30 – 2.10
2103		Alluvium	Greyish blue clay soft and sticky. No visible inclusions seen within the layer. Quite wet due to hitting water table.	2.10 – 3.00+

TP22 (W-TP02 soakaway)	**Length 3 m**	**Width 0.65 m**	**Depth 3 m**
Easting	**Northing**	**m OD 0**	

Context Number	**Fill Of/Filled With**	**Interpretative Category**	**Description**	**Depth BGL**
2201		Topsoil	Dark greyish brown silty clay, firm and compact with signs of rooting from the vegetation on top of the layer. No inclusions within the layer.	0.00 – 0.30

2202		Subsoil	Light greyish brown, firm and compact just like (2201), small pockets of rooting seen within the layer. No stone inclusions seen in the layer.	0.30 – 0.50
2203		Alluvium	Mid greyish yellow clay. Firm and compacted. Quite sticky. No visible inclusions seen within the layer.	0.50 – 2.10
2204		Alluvium	Greyish blue clay soft and sticky. No visible inclusions seen within the layer. Quite wet due to hitting water table.	2.10 – 3.00+

TP23 (W-TP23)	**Length 3 m**	**Width 0.65 m**	**Depth 3 m**
Easting	**Northing**	**m OD 0**	

Context Number	**Fill Of/Filled With**	**Interpretative Category**	**Description**	**Depth BGL**
2301		Topsoil	Dark greyish brown silty clay, firm and compact with signs of rooting from the vegetation on top of the layer. No inclusions within the layer.	0.00 – 0.40
2302		Alluvium	Mid greyish yellow clay. Firm and compacted. Quite sticky. No visible inclusions seen within the layer.	0.40 – 2.30
2303		Alluvium	Greyish blue clay soft and sticky. No visible inclusions seen within the layer. Quite wet due to hitting water table.	2.30 – 3.00+

TP24	**Length 4.10 m**	**Width 0.60 m**	**Depth 2.50 m**
Easting	**Northing**	**m OD**	

Context Number	**Fill Of/Filled With**	**Interpretative Category**	**Description**	**Depth BGL**
2401		Topsoil	Soft. Greyish brown. Silty clay. Waterlogged.	0.00 – 0.43
2402		Alluvium	Mid reddish brown silty clay, no inclusions very sterile. Large amounts of underground water present at 1.6 meters.	0.43 – 2.50
2403		Alluvium	Firm mid bluish grey, silty clay. trench collapsed at this level.	2.50+

TP26	**Length 2 m**	**Width 0.50 m**	**Depth 3.20 m**
Easting	**Northing**	**m OD**	

Context Number	**Fill Of/Filled With**	**Interpretative Category**	**Description**	**Depth BGL**
2601		Topsoil	Moderately compact mid brownish grey silty clay (30 / 70) with frequent bioturbation and plant rooting.	0.00 – 0.45

2602		Alluvium	Compact mid reddish brown silty clay (20 / 80) with frequent blue clay mottling throughout.	0.45 – 0.60
2603		Alluvium	Very compact dark reddish brown clay (20 / 80).	0.60 – 3.20+

TP27	**Length 3.50 m**	**Width 0.60 m**	**Depth 0.43 m**
Easting	**Northing**	**m OD**	

Context Number	**Fill Of/Filled With**	**Interpretative Category**	**Description**	**Depth BGL**
2701		Topsoil	Soft. Brownish grey. Silty Clay.	0.00 – 0.26
2702		Alluvium	Firm. Reddish grey. Silty clay. No inclusions.	0.26 – 0.43+

TP28	**Length 3.50 m**	**Width 0.60 m**	**Depth 3 m**
Easting	**Northing**	**m OD**	

Context Number	**Fill Of/Filled With**	**Interpretative Category**	**Description**	**Depth BGL**
2801		Topsoil	Soft. Greyish brown. Silty clay. Waterlogged. Sharp, wavy boundary.	0.00 – 0.22
2802		Alluvium	Firm. Bluish grey with orangey brown mottling. Sharp, wavy boundary.	0.22 – 0.40
2803		Alluvium	Firm. Reddish brown. Silty clay. Minerally rich, possible iron staining. Structurally the same as layer 2802 but with a distinct change in colour. Sharp, smooth boundary.	0.40 – 2.10
2804		Organic alluvium	Firm. Dark bluish grey with orangey brown mottling. Silty clay. Frequent, black streaks throughout, possible organic material.	2.10 – 3.00+

TP29	**Length 3 m**	**Width 0.50 m**	**Depth 3.20 m**
Easting	**Northing**	**m OD**	

Context Number	**Fill Of/Filled With**	**Interpretative Category**	**Description**	**Depth BGL**
2901		Topsoil	Moderately compact mid brownish grey silty clay (30 / 70) dense rooting and bioturbation.	0.00 – 0.45
2902		Alluvium	Moderately compact light yellowish red silty clay (20 / 80), no inclusions.	0.45 – 1.20
2903		Alluvium	Compact mid brownish red silty clay (10 / 90) becoming firmer further down before appearing more waterlogged dark grey silty clay at around 3m.	1.20 – 3.20+

TP30	**Length 3.60 m**	**Width 0.60 m**	**Depth 3.11 m**

Easting		Northing		m OD	
Context Number	**Fill Of/Filled With**	**Interpretative Category**	**Description**		**Depth BGL**
3001		Topsoil	Mid greenish grey clay. Firm, sticky and plastic. Frequent rooting (grass). No visible inclusions.		0.00 – 0.16
3002		Alluvium	Mid brownish orange clay with grey mottling throughout. Firm and plastic. No visible inclusions. Becomes softer and more sticky at lower depths.		0.16 – 1.75
3003		Alluvium	mid grey blue clay. Soft, sticky. plastic. No visible inclusions.		1.75 – 3.11+

TP31	Length 2.10 m	Width 0.60 m	Depth 3.10 m
Easting	Northing	m OD	

Context Number	Fill Of/Filled With	Interpretative Category	Description	Depth BGL
3101		Topsoil	Soft. Greyish brown. Silty clay. Waterlogged. Sharp, wavy boundary.	0.00 – 0.22
3102		Alluvium	Firm. Bluish grey with orangey brown mottling. Sharp, wavy boundary.	0.22 – 0.50
3103		Alluvium	Superficial geology. Firm. Reddish brown. Silty clay. Minerally rich, possible iron staining. Structurally the same as layer 3102 but with a distinct change in colour. Abrupt, irregular boundary.	0.50 – 1.90
3104		Organic alluvium	Superficial geology. Firm. Dark bluish grey with orangey brown mottling. Silty clay. Frequent, black streaks throughout, possible organic material.	1.90 – 3.10+

TP33 (E-TP03)	Length 2.50 m	Width 0.60 m	Depth 1.20 m
Easting	Northing	m OD	

Context Number	Fill Of/Filled With	Interpretative Category	Description	Depth BGL
3301		Topsoil	Dark brown clay. Quite firm and very sticky. rooting throughout the fill. No inclusions visible within the fill.	0-0.30
3302		Alluvium	Light greyish brown silt. quite firm with small patches of rooting throughout the layer.	0.30-1.20

TP44 (E-TP04)	Length 2.50 m	Width 0.60 m	Depth 1.20 m
Easting	Northing	m OD	

Context Number	Fill Of/Filled With	Interpretative Category	Description	Depth BGL

4401		Topsoil	Dark brown clay. Quite firm and very sticky. rooting throughout the fill. No inclusions visible within the fill.	0–0.30
4402		Alluvium	Light greyish brown silt. quite firm with small patches of rooting throughout the layer.	0.30–1.20

TP66 (W-TP06B)	**Length 3 m**	**Width 0.65 m**	**Depth 3 m**
Easting	**Northing**	**m OD 0**	

Context Number	**Fill Of/Filled With**	**Interpretative Category**	**Description**	**Depth BGL**
6601		Topsoil	Dark greyish brown silty clay, firm and compact with signs of rooting from the vegetation on top of the layer. No inclusions within the layer.	0.00 – 0.40
6602		Alluvium	Mid greyish yellow clay. Firm and compacted. Quite sticky. No visible inclusions seen within the layer.	0.40 – 2.30
6603		Alluvium	Greyish blue clay soft and sticky. No visible inclusions seen within the layer. Quite wet due to hitting water table.	2.30 – 3.00+

TP101 (E-TP01)	**Length 2 m**	**Width 0.64 m**	**Depth 1.20 m**
Easting	**Northing**	**m OD**	

Context Number	**Fill Of/Filled With**	**Interpretative Category**	**Description**	**Depth BGL**
10101		Topsoil	Dark brown clay. Quite firm and very sticky. rooting throughout the fill. No inclusions visible within the fill.	0.00 – 0.30
10102		Alluvium	Light greyish brown silt. quite firm with small patches of rooting throughout the layer. stony inclusions about 40mm surrounded stones within the layer due to French drain running into the section.	0.30 – 1.20

TP110 (W-TP11B)	**Length 3 m**	**Width 0.50 m**	**Depth 0.85 m**
Easting	**Northing**	**m OD**	

Context Number	**Fill Of/Filled With**	**Interpretative Category**	**Description**	**Depth BGL**
11001		Topsoil	Moderately compact mid brownish grey silty clay (30 / 70) with dense rooting at top of layer.	0.00 – 0.42
11002		Alluvium	Compact mid orange brown silty clay (20 / 80).	0.42 – 0.85+

TP111 (E-TP01 soakaway)	**Length 3 m**	**Width 0.65 m**	**Depth 1.20 m**

Easting		Northing		m OD 0	
Context Number	**Fill Of/Filled With**	**Interpretative Category**	**Description**		**Depth BGL**
11101		Topsoil	Dark greyish brown silty clay, firm and compact with signs of rooting from the vegetation on top of the layer. No inclusions within the layer.		0.00 – 0.40
11102		Alluvium	Mid greyish yellow clay. Firm and compacted. Quite sticky. No visible inclusions seen within the layer.		0.40 – 1.20+

TP150 (W-TP15B)	Length 3 m	Width 0.50 m	Depth 0.82 m
Easting	Northing	m OD	

Context Number	Fill Of/Filled With	Interpretative Category	Description	Depth BGL
15001		Topsoil	Moderately compact mid brownish grey silty clay (30 / 70) dense grass rooting to top of deposit.	0.00 – 0.42
15002		Alluvium	Compact Mid orange brown silty clay (20 / 80) with frequent grey clay mottling.	0.42 – 0.82+

TP191 (W-TP19 soakaway)	Length 3 m	Width 0.65 m	Depth 1.20 m
Easting	Northing	m OD 0	

Context Number	Fill Of/Filled With	Interpretative Category	Description	Depth BGL
19101		Topsoil	Dark greyish brown silty clay, firm and compact with signs of rooting from the vegetation on top of the layer. No inclusions within the layer.	0.00 – 0.40
19102		Alluvium	Mid greyish yellow clay. Firm and compacted. Quite sticky. No visible inclusions seen within the layer.	0.40 – 1.20+

TP222 (W-TP02B)	Length 3 m	Width 0.65 m	Depth 3 m
Easting	Northing	m OD 0	

Context Number	Fill Of/Filled With	Interpretative Category	Description	Depth BGL
22201		Topsoil	Dark greyish brown silty clay, firm and compact with signs of rooting from the vegetation on top of the layer. No inclusions can be seen within this layer.	0.00 – 0.40
22202		Alluvium	Mid greyish yellow clay. Firm and compacted. Quite sticky. No visible inclusions seen within the layer. small pockets of rooting can been seen in the layer probably from the topsoil layer.	0.40 – 2.20

22203		Alluvium	Dark greyish blue. Quite sticky due to the water table. No inclusions can be seen within this layer.	2.20 – 3.00+

TP270 (W-TP27B)	**Length 3.40 m**	**Width 0.60 m**	**Depth 3 m**
Easting	**Northing**	**m OD**	

Context Number	**Fill Of/Filled With**	**Interpretative Category**	**Description**	**Depth BGL**
27001		Topsoil	Soft. Brownish grey. Silty Clay. Clear, wavy boundary.	0.00 – 0.28
27002		Alluvium	Firm. Greyish brown. Silty clay. No inclusions. Sharp, wavy boundary.	0.28 – 0.52
27003		Alluvium	Firm. Reddish brown. Silty clay. Homogeneous. Structurally the same as layer 27002 but with a distinct change in colour. Sharp, smooth boundary.	0.52 – 2.30
27004		Organic alluvium	Firm. Dark bluish grey with orangey brown mottling. Silty clay. Frequent, black streaks throughout, possible organic material.	2.30 – 3.00+

TP2222 (E-TP02)	**Length 2 m**	**Width 0.60 m**	**Depth 1.20 m**
Easting	**Northing**	**m OD**	

Context Number	**Fill Of/Filled With**	**Interpretative Category**	**Description**	**Depth BGL**
22221		Topsoil	Dark brown clay. Quite firm and very sticky. rooting throughout the fill. No inclusions visible within the fill.	0–0.20
22222		Alluvium	Light greyish brown silt. quite firm with small patches of rooting throughout the layer.	0.20–1.20

Appendix 3 Deposit model data

Name	Easting	Northing	Total depth (m)	Elevation (m OD)
BH1	519798.78	414767.45	5.70	1.70
BH2	519795.22	414720.21	7.20	1.63
BH3	519797.79	414664.40	7.20	1.79
BH4	519801.78	414631.50	7.20	1.55
BH5	519795.69	414586.04	7.20	1.31
BH6	519788.72	414528.97	5.70	1.55
BH7	519808.39	414403.90	5.70	1.27
BH8	519905.14	414821.34	7.20	1.90
BH9	519936.68	414790.53	7.20	1.65
BH10	519954.40	414770.18	8.70	1.56
BH11	519958.25	414735.81	8.70	1.63
BH12	519964.64	414677.41	7.20	1.69
BH13	519969.76	414620.95	7.20	1.69
BH14	519978.12	414549.53	7.20	1.39
RSK_BH01	520498.90	414960.70	30.45	3.40
RSK_BH02	520577.90	415018.80	30.00	3.97
RSK_WS01	520460.30	414992.10	5.00	2.83
RSK_WS02	520505.80	415038.10	5.00	3.22
RSK_WS03	520521.90	415006.80	5.00	3.77
RSK_WS04	520609.30	414994.50	5.00	3.83
RSK_WS05	520499.20	414925.90	5.00	3.57
E-BH26A	520802.94	415424.33	21.00	3.88
W-BH26	519912.50	414658.08	19.60	1.79
W-BH29	519854.73	414774.67	18.45	1.71
W-BH32	519770.21	414802.87	21.50	1.63
W-BH34	519816.59	414843.72	30.00	1.70
W-BH35	519893.65	414803.00	28.70	1.71
W-BH31	519758.83	414748.34	31.50	1.64
W-BH30	519815.68	414742.01	31.50	1.70
W-BH33	519775.83	414819.61	34.50	1.75
W-BH27	519854.70	414683.33	31.76	1.61
W-BH28	519804.12	414686.46	31.73	1.72
W-BH14	519808.61	414618.86	31.76	1.84
W-BH25	519958.70	414645.14	31.50	1.78
W-BH04	519887.91	414449.73	31.00	1.46
W-BH13	519769.50	414606.76	31.70	1.83
W-BH18	519989.53	414586.72	31.42	1.49
W-BH06	520031.69	414520.38	33.50	1.76
W-BH17	519889.86	414574.00	31.72	1.70

Name	Easting	Northing	Total depth (m)	Elevation (m OD)
E-BH01	520766.27	415079.87	34.50	2.97
E-BH02	520793.36	415101.55	34.50	2.84
E-BH03	520757.36	415155.03	34.74	3.29
E-BH04	520766.31	415201.00	34.40	3.01
E-BH05	520799.52	415164.67	34.50	3.11
E-BH06B	520803.74	415176.99	24.00	2.93
E-BH07	520801.64	415200.79	55.00	2.90
E-BH08	520802.39	415217.26	43.50	2.82
E-BH09	520804.15	415234.69	34.50	2.99
E-BH10	520836.44	415197.17	33.50	2.92
E-BH11	520839.95	415140.22	35.92	3.08
E-BH12	520844.64	415168.23	36.00	2.99
E-BH13	520894.25	415208.45	17.35	2.94
E-BH14A	520953.06	415254.69	19.50	3.46
E-BH15	520920.39	415278.05	25.50	3.61
E-BH16	520973.17	415316.50	25.50	3.69
E-BH17	521040.37	415341.55	26.80	3.54
E-BH18	520959.64	415364.23	27.00	3.53
E-BH19	520910.84	415348.36	36.00	3.73
E-BH20	520856.81	415308.25	35.11	3.88
E-BH21	520788.71	415321.39	37.50	4.05
E-BH22	520800.63	415351.77	26.95	3.95
E-BH23	520774.36	415355.86	37.50	3.96
E-BH24	520843.80	415375.57	46.50	3.76
E-BH25	520892.72	415391.92	37.66	3.83
E-BH26	520804.46	415427.70	26.00	3.91
W-BH01	519801.34	414357.90	27.30	1.33
W-BH02	519870.46	414400.36	31.50	1.58
W-BH03	519968.89	414460.91	31.50	1.40
W-BH05	519815.93	414462.17	35.50	1.45
W-BH06	520031.85	414520.35	33.50	1.70
W-BH07	519973.64	414520.37	40.50	1.46
W-BH08	519914.66	414534.66	31.50	1.61
W-BH09	519796.91	414494.07	31.50	1.59
W-BH10A	519703.69	414501.30	27.33	1.55
W-BH11	519677.60	414575.43	31.70	1.77
W-BH12	519728.11	414591.74	31.65	1.62
W-BH13	519769.50	414606.76	31.70	1.83
W-BH15	519753.30	414544.78	35.00	1.64
W-BH16	519802.60	414549.78	42.00	1.47

Name	Easting	Northing	Total depth (m)	Elevation (m OD)
W-BH19	520037.19	414605.65	29.25	1.66
W-BH20	520138.68	414597.18	26.68	1.48
W-BH21	520253.81	414672.42	27.45	1.76
W-BH22	520111.54	414714.88	27.00	1.89
W-BH23	520005.26	414637.26	32.82	1.69
W-BH24	519965.33	414695.67	42.00	1.65
W-BH36	519887.17	414858.13	34.50	1.79
W-BH37	519912.63	414480.34	31.50	1.28

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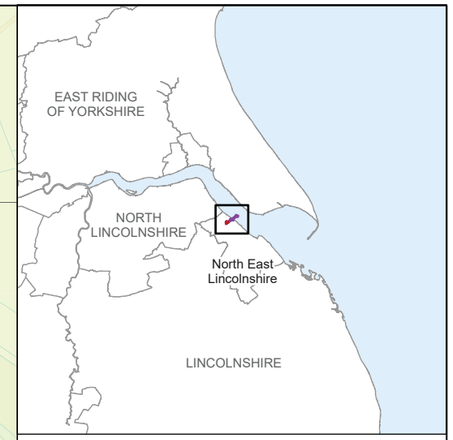
522000
524000
418000
416000
414000
412000

FLAMBOROUGH CHALK FORMATION - CHALK

BURNHAM CHALK FORMATION - CHALK

Manby Road
Immingham
Kings Road
Queens Road
Stallingborough
Great Coates
GRIMSBY
Humberston
CLEETHORPES



Site Boundary
Boundary of Scheme

0 1 km

Date: 13/04/2023	Created by: AW
Scale: 1:25,000 at A3	Revision: 0

Figure 1: Site location with BGS bedrock geology

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524000
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412000

GLACIOFLUVIAL DEPOSITS, DEVENSIAN - SAND AND GRAVEL

BEACH AND TIDAL FLAT DEPOSITS (UNDIFFERENTIATED) - CLAY, SILT AND SAND

BEACH AND TIDAL FLAT DEPOSITS (UNDIFFERENTIATED) - CLAY, SILT AND SAND

TIDAL FLAT DEPOSITS - CLAY AND SILT

BEACH AND TIDAL FLAT DEPOSITS (UNDIFFERENTIATED) - CLAY, SILT AND SAND

TIDAL FLAT DEPOSITS - CLAY AND SILT

TILL, DEVENSIAN - DIAMICTON

TILL, DEVENSIAN - DIAMICTON

Manby Road

Kings Road

Queens Road

Immingham

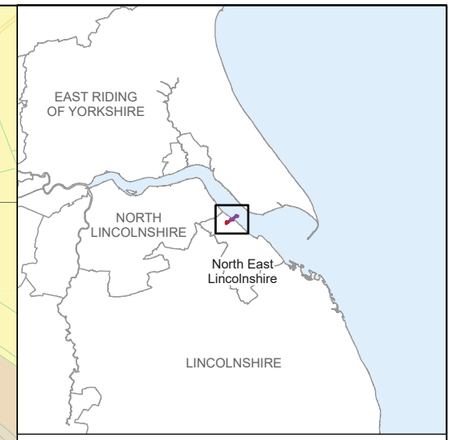
Stallingborough

Great Coates

GRIMSBY

Humberston

CLEETHORPES



Site Boundary

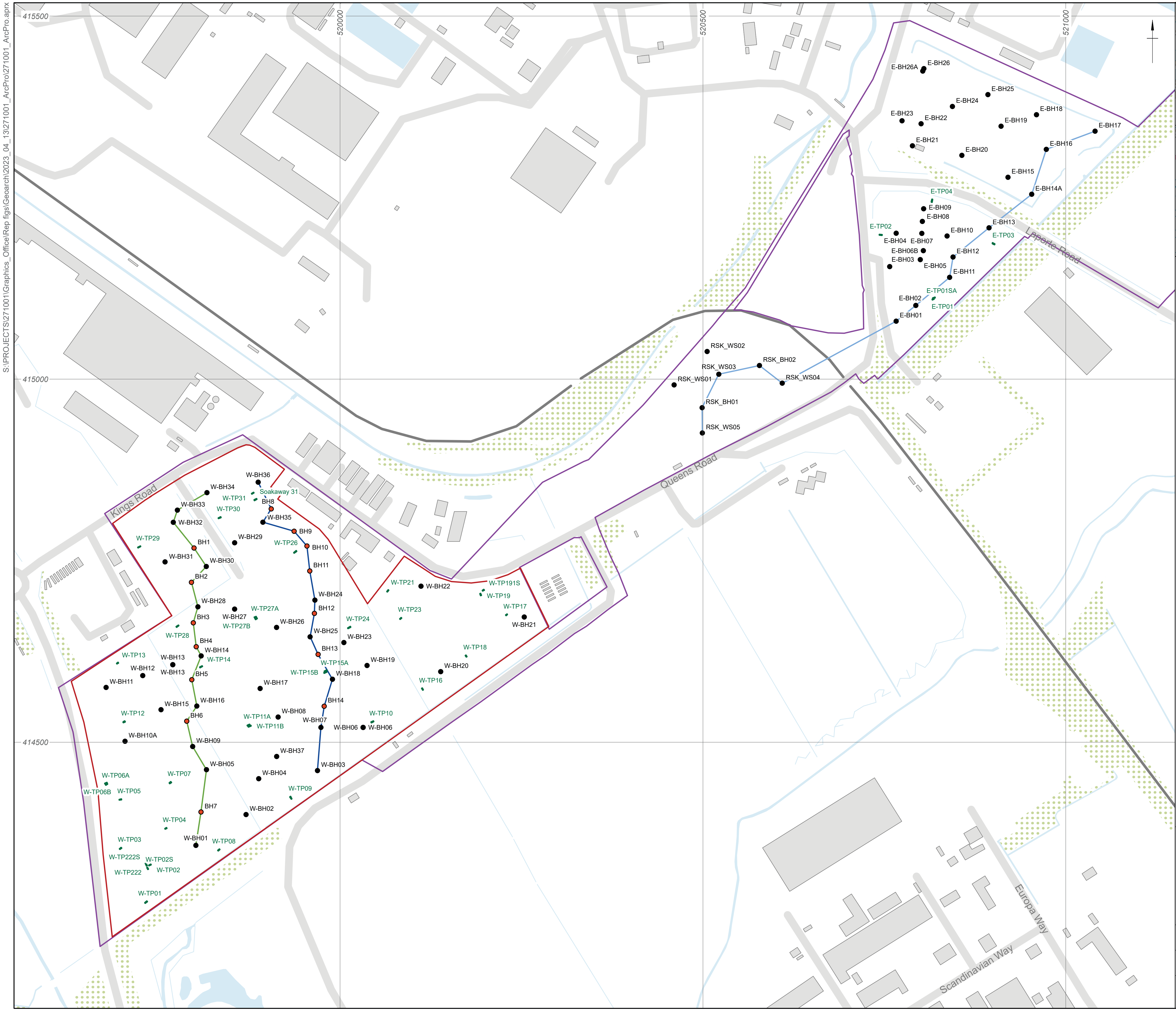
Boundary of Scheme

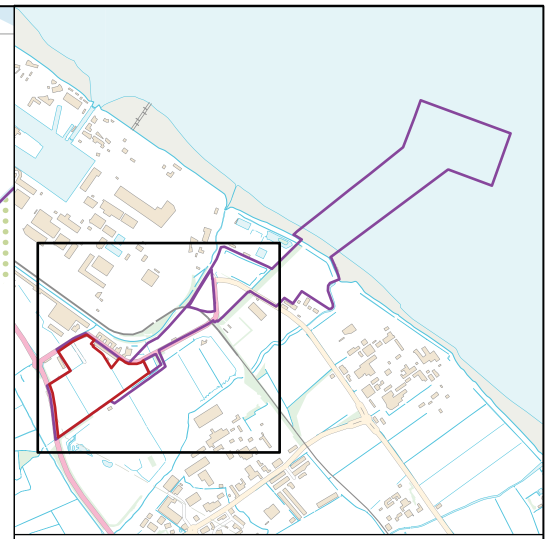
0 1 km

Coordinate system: OSGB 1936 British National Grid

Date: 13/04/2023	Created by: AW	
Scale: 1:25,000 at A3	Revision: 0	

Figure 2: Site location with BGS superficial geology





- Site Boundary
- Boundary of Scheme
- Purposive geoarchaeological boreholes
- GI boreholes
- Monitored GI test pits
- Transect 1
- Transect 2
- Transect 3

0 200 m

Coordinate system: OSGB 1936 British National Grid

Date: 02/05/2023	Created by: AW
Scale: 1:5,000 at A3	Revision: 0

Figure 3: Borehole and transect locations

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415500
520000
520500
521000
415000
414500

Kings Road
Queens Road
Poorle Road
Europa Way
Scandinavian Way

E-BH26A
E-BH26
E-BH25
E-BH24
E-BH23
E-BH22
E-BH18
E-BH19
E-BH17
E-BH21
E-BH20
E-BH16
E-BH15
E-BH14A
E-BH09
E-BH08
E-BH13
E-BH10
E-BH04
E-BH07
E-BH06B
E-BH12
E-BH03
E-BH05
E-BH11
E-BH02
E-BH01

RSK_WS02
RSK_BH02
RSK_WS03
RSK_WS01
RSK_WS04
RSK_BH01
RSK_WS05

W-BH36
W-BH34
W-BH33
W-BH32
BH8
W-BH35
BH9
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W-BH11
W-BH17
W-BH15
W-BH16
BH14
BH6
W-BH08
W-BH07
W-BH06
W-BH06
W-BH10A
W-BH09
W-BH37
W-BH05
W-BH03
W-BH04
BH7
W-BH02
W-BH01

Site Boundary
Boundary of Scheme
Purposive geoarchaeological boreholes
GI boreholes
Transect 1
Transect 2
Transect 3

Surface of Till

-2.00 m OD
-10.70 m OD

0
200 m

Date: 02/05/2023	Created by: AW
Scale: 1:5,000 at A3	Revision: 0

Figure 4: Surface of the till

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415500
520000
520500
521000
415000
414500

E-BH26A
E-BH26
E-BH25
E-BH24
E-BH23
E-BH22
E-BH18
E-BH19
E-BH17
E-BH21
E-BH20
E-BH16
E-BH15
E-BH14A
E-BH09
E-BH08
E-BH13
E-BH10
E-BH04
E-BH07
E-BH06B
E-BH12
E-BH03
E-BH05
E-BH11
E-BH02
E-BH01

RSK_WS02
RSK_WS03
RSK_BH02
RSK_WS01
RSK_WS04
RSK_BH01
RSK_WS05

W-BH36
W-BH34
W-BH33
BH8
W-BH32
W-BH35
BH9
W-BH29
BH1
BH10
W-BH31
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BH11
BH2
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BH12
BH3
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W-BH25
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BH4
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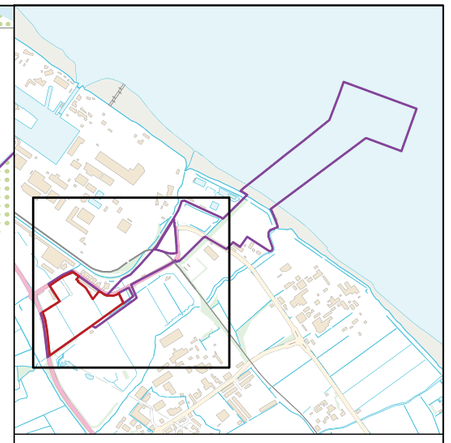
BH13
W-BH13
W-BH19
W-BH12
W-BH13
W-BH18
BH5
W-BH11
W-BH17
BH14
W-BH15
W-BH16
W-BH08
BH6
W-BH07
W-BH06
W-BH06
W-BH10A
W-BH09
W-BH37
W-BH05
W-BH03
W-BH04
BH7
W-BH02
W-BH01

W-BH22
W-BH21
W-BH20

Kings Road
Queens Road
Upperton Road
Europa Way
Scandinavian Way



Site Boundary
Boundary of Scheme
Purposive geoarchaeological boreholes
GI boreholes
Transect 1
Transect 2
Transect 3

Thickness of Peat

1.40 m OD
0.20 m OD

0 200 m

Date: 02/05/2023 | Created by: AW

Scale: 1:5,000 at A3 | Revision: 0

Figure 5: Thickness and distribution of peat

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N

Extent of feature identified in Bunn (2013)

W-BH01
BH7
W-BH05
W-BH09
BH6
W-BH16
BH5
W-BH14
BH4
BH3
W-BH28
BH2
W-BH30
BH1
W-BH32
W-BH33
W-BH34

Depth (m (OD)

Stratigraphy key

- Made ground
- Modern soil profile
- Peat
- Alluvium
- Organic alluvium
- Glacial till
- Bedrock
- Void

Distance (m)

Date: 13/04/2023	Created by: AW	Revision: 0	Scale: NTS at A3

Figure 6: Transect 1

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N

Extent of feature identified in Bunn (2013)

W-BH03 W-BH07 BH14 W-BH18 BH13 W-BH25 BH12 W-BH24 BH11 BH10 BH9 W-BH35 BH8 W-BH36

Depth (m (OD)

Distance (m)

0.0 100.0 200.0 300.0 400.0

Stratigraphy key

- Made ground
- Modern soil profile
- Peat
- Alluvium
- Organic alluvium
- Glacial till
- Bedrock
- Void

Date: 13/04/2023	Created by: AW	Revision: 0	Scale: NTS at A3

Figure 7: Transect 2

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W

E

RSK_WS05

RSK_BH01

RSK_WS03

RSK_BH02

RSK_WS04

E-BH01

E-BH02

E-BH11

E-BH12

E-BH13

E-BH14A

E-BH16

E-BH17

Depth (m (OD)

Distance (m)

0.0 100.0 200.0 300.0 400.0 500.0 600.0 700.0

Stratigraphy key

- Made ground
- Modern soil profile
- Peat
- Alluvium
- Organic alluvium
- Glacial till
- Bedrock
- Void

Date: 13/04/2023	Created by: AW	Revision: 0	Scale: NTS at A3

Figure 8: Transect 3

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