Norfolk Vanguard and Norfolk Boreas Offshore Wind Farms

Geoarchaeological and Archaeological Monitoring (Onshore)

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Summary

Wessex Archaeology (WA) was commissioned by Norfolk Vanguard Ltd and Norfolk Boreas Ltd to undertake a programme of geoarchaeological and archaeological monitoring of further engineering-led Site Investigation (SI) works along the route of the Norfolk Vanguard and Norfolk Boreas Onshore Cable Routes (including proposed landfall and substation sites).

SI works (cable percussion boreholes, cone penetration tests and trial pits) were undertaken at locations across the onshore project area. The SI works were an engineering-led program involving (geo)archaeological collaboration with the engineers. Where possible, SI interventions were located away from known areas of high archaeological potential. However, the Happisburgh Landfall boreholes are near to Happisburgh 1, an internationally significant Lower Palaeolithic site (Lewis et al. 2019).

All Happisburgh Landfall cable percussion boreholes were subject to permanent geoarchaeological monitoring.

Cable percussion boreholes at Necton were subject to geoarchaeological review prior to SI works commencing (WA 2020a). The locations were all considered to have low geoarchaeological potential. Daily draft SI logs from these locations were subject to geoarchaeological assessment to consider whether geoarchaeological site attendance was required. This daily review confirmed that no deposits with significant geoarchaeological potential were present in these locations.

Cone Penetration Tests (CPTs) were not subject to geoarchaeological monitoring. All trial pits were subject to an archaeological watching brief.

Geoarchaeological monitoring of cable percussion boreholes and archaeological watching brief of trial pits established the nature of the geoarchaeological resource present in SI locations across the proposed cable routes. This comprises sequences of Pleistocene and Holocene sediments.

Possible early Middle Pleistocene (MIS 13; 524–478 Ka) alluvial deposits were identified in two boreholes at the Happisburgh Landfall. These are overlain by Anglian glaciogenic deposits of the Happisburgh Formation (MIS 12; 478-424 Ka) and underlain by likely marine sands of the Wroxham Crag (2.4->0.6 MA). The possible alluvial deposits may be the stratigraphic equivalent to the upper grey sand and organic mud of the Low Lighthouse Member of the Cromer Forest Bed Formation (CF-bF) at Happisburgh 1, which have produced internationally significant Lower Palaeolithic archaeology and paleoenvironmental evidence (Lewis et al. 2019). Intact UT100 and disturbed bulk samples were recovered from the possible alluvial deposits and underlying, likely marine, sands.

Stage 3 palaeoenvironmental assessment of samples from the Happisburgh Landfall is recommended. This will enable the presence/absence of CF-bF deposits to be established and their palaeoenvironmental potential to be assessed. Assessment should include samples taken from postulated marine sands of the Wroxham Crag in order to clearly define the stratigraphic separation between marine sands of the Wroxham Crag, and potential alluvial deposits of the CF-bF. Based on the results of the Stage 3 assessment, further targeted geoarchaeological boreholes may be required to map deposits of the CF-bF and to take further palaeoenvironmental samples.

Anglian glaciogenic deposits are present across the proposed cable routes. These have generally low geoarchaeological and archaeological potential. No further geoarchaeological or archaeological investigations of these deposits are likely to be required.

Upper Pleistocene terrace deposits of the River Wensum were identified in an SI trial pit at Elsing Lane. Review of broadly equivalent deposits in the area suggests that these river terrace deposits may include sediments of Ipswichian (MIS 5e; 123-111 kya) and Devensian (MIS 5d-2; 111-11.7

Kya) date. These deposits have the potential to include units which preserve significant palaeoenvironmental data (pollen, plant macro-fossils, non-marine molluscs and vertebrate remains) and Palaeolithic archaeology. Full and further specialist review of the results of and reports from the previous phases of engineering-led SI for the Projects is recommended to better understand and establish the level of this potential. This should be supplemented by consideration of results of archaeological evaluation trial trenching undertaken by Headland Archaeology in 2020/21; although restricted in their depth, c. 20-25 archaeological trial trenches were undertaken in the wider vicinity of the River Wensum. It is anticipated that construction related HDD pits either side of the Wensum may also form a later focus and provide a potential opportunity to assess Pleistocene deposits at this location.

Holocene alluvium is present at several locations along the proposed cable routes (Lyngate Road, River Wensum Crossing, River Bure Crossing, Wendling Carr, and Stream Crossing, Necton). This alluvium has the potential to seal Holocene archaeological evidence, potentially covering multiple periods. Again full and further review of the results of and reports from the previous phases of engineering-led SI for the Projects is recommended to better understand and establish the level of this potential. The results of archaeological evaluation trial trenching undertaken by Headland Archaeology in 2020/21 should also be considered as part of this review. It is also anticipated that construction related HDD pits either side of the River Wensum, River Bure and Wendling Carr may also form a later focus and provide a potential opportunity for assessing the Holocene deposits present at these locations.

Peats within alluvium have significant potential to provide paleoenvironmental evidence for changing Holocene environment, climate, and human land-use practices. Monitoring of SI works has established peat is present at Lyngate Road, within a tributary of the River Ant, whilst previous SI monitoring (WA 2018) also recorded peat deposits at the River Wensum Crossing. Bulk samples were obtained from the top and bottom of the peat at Lyngate Road during this phase of monitoring. Stage 3 palaeoenvironmental assessment (e.g. pollen and plant macrofossils) of these samples is recommended to assess potential, and to try to establish a chronology for the deposits.

Peats may also be present at other locations along the cable routes where alluvial deposits occur. To investigate this possibility, and to establish the potential of any peat, in the first instance full and further review of the results of and reports from the previous phases of engineering-led SI for the Projects is recommended, augmented with consideration of the results of archaeological evaluation trial trenching undertaken by Headland Archaeology in 2020/21.

Any further requirements / subsequent recommendations for justified and proportionate targeted geoarchaeological-specific site interventions, such as additional targeted test pits and/or boreholes, outside of the engineering-led works, should be determined following the completion and reporting of the initial exercises as described above. This is in line with the Outline Written Schemes of Investigation for both Projects where by there is a commitment to implementing a ‘scheme-wide approach to geoarchaeology and the palaeoenvironment’ in the post-consent stages. The Projects preferences remain to implement joined up and coordinated approaches to any further survey and investigation works, e.g. associated with any additional engineering-led SI and also subsequently facilitating opportunities, where possible and practical, to gain a better understanding of identified deeper deposits of interest, where relevant, in association with construction-related ground works, specifically targeted on e.g. HDD crossing locations.

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Norfolk Vanguard and Norfolk Boreas Offshore Wind Farms

Geoarchaeological and archaeological monitoring

1 INTRODUCTION

1.1 Project and planning background

1.1.1 Vattenfall Wind Power Limited is developing the Norfolk Vanguard and Norfolk Boreas Offshore Wind Farms projects (herein referred to as 'Norfolk Vanguard' and 'Norfolk Boreas' or 'the Projects'). The offshore wind farms are on adjacent sites located between approximately 47km and 73km from the Norfolk coastline. The offshore wind farms will be connected to the shore by offshore export cables installed within a shared offshore cable route from the wind farm to a landfall point at Happisburgh South. From there, onshore cables will transport power over approximately 60km along a shared onshore cable route to the co-located onshore project substations at Necton, Norfolk.

1.1.2 Wessex Archaeology (WA) was commissioned by Norfolk Vanguard Ltd and Norfolk Boreas Ltd to undertake a programme of further geoarchaeological and archaeological monitoring of engineering-led Site Investigation (SI) works (GHD 2020) along the route of the Norfolk Vanguard and Norfolk Boreas (the Projects) Onshore Cable Routes (including proposed landfall and substation sites).

1.1.3 The cable routes run for approximately 60 km from the cable landfall at Happisburgh (NGR 638891 330424) to the substation at Necton (NGR 590089 310395) (**Figure 1**).

1.1.4 SI works were undertaken at locations across the onshore project area. The SI works were an engineering-led program but involved (geo)archaeological collaboration with the engineers. Where possible, SI interventions were located away from known areas of high archaeological potential. However, the Landfall boreholes (**Table 1** and **Figure 1**) are in close proximity to Happisburgh 1, an internationally significant Lower Palaeolithic site (Lewis et al. 2019).

1.1.5 The SI works comprised 34 trial pits, 29 cable percussion boreholes, 4 window samples and 72 static cone penetration tests (CPTs), summarised in **Table 1,** and located on **Figures 2**–**7**.

Table 1 Summary of Site Investigation works

Trial Pit locations	Number	Borehole / CPT locations	Number
Walcott Green	1 TP	Landfall Site	9 (CP)
Happisburgh Road	1 TP		5 (CPT)
Witton Bridge	1 TP	Little London Road / Paston Way	6 (CPT)
Witton Hall Plantation	1 TP	North Walsham Railway	4 (CPT)
Lyngate Road	1 TP	River Bure Wood	4 (CPT)
North Walsham Railway	2 TP	B1149 Crossing	4 (CPT)
Suffield	1 TP	Sheringham Shoal	4 (CPT)
Cromer Road	1 TP	Orsted Cable Crossing	4 (CPT)
Aylsham Road	1 TP	Marriotts Way North	4 (CPT)
Hornsea 1 - 3	3 TP	Marriotts Way South	4 (CPT)

Trial Pit locations	Number
Kerdiston Road	1 TP
Jordan Lane	1 TP
Elsing Lane	1 TP
B1147	1 TP
Mid Norfolk Railway	2 TP
Bradenham Lane East	1 TP
Bradenham Lane West	1 TP
Goggles Lane	1 TP
Access Road	8 TP
Soakaway	4 TP

Borehole / CPT locations	Number
A1067	4 (CPT)
Mid Norfolk Railway	4 (CPT)
Little Wood	2 (CPT)
Wendling Carr	4 (CPT)
Necton	15 (CP)
	6 (CPT)
	4 (WS)
Stream Crossing	8 (CPT)
NV/NB Crossing	6 (CPT)
Dudgeon Cable Crossing	4 (CPT)

1.1.6 The geoarchaeological and archaeological monitoring of SI works was carried out in accordance with an overarching Written Scheme of Investigation (WSI) (WA 2020a) and subsequent addendum (WA 2020b). The addendum to the WSI was required in order to reflect a change in drilling method for several boreholes from cable percussion boreholes to CPTs.

1.1.7 All landfall cable percussion boreholes (BH117-LF–BH123-LF) were subject to permanent geoarchaeological monitoring.

1.1.8 The location of the cable percussion boreholes at Necton (BH 101-LF – BH 115-LF) were subject to geoarchaeological review prior to SI works commencing (WA 2020a). The locations were all considered to have low geoarchaeological potential. Daily draft SI logs from these locations were subject to geoarchaeological assessment in order to consider whether geoarchaeological site attendance was required. This daily review confirmed that no deposits with significant geoarchaeological potential were present in these locations.

1.1.9 In line with the WSI and addendum, cone penetration tests (CPTs) were not subject to geoarchaeological monitoring. Whilst data from CPTs may in some cases prove useful for modelling purposes, there is no geoarchaeological benefit to be gained from their monitoring, as no sediments are retrieved.

1.1.10 All trial pits were subject to an archaeological watching brief.

1.1.11 This geoarchaeological and archaeological monitoring of SI works is part of a staged approach in determining the geoarchaeological and archaeological potential of the cable routes and follows on from a previous phase of SI monitoring (WA 2018).

1.2 Scope of document

1.2.1 The purpose of this report is to provide a detailed description of the results of the geoarchaeological monitoring and archaeological watching brief, to interpret the results within a local, regional or wider geoarchaeological and archaeological context, and assess whether the aims of the investigation have been met.

1.2.2 The presented results will provide further information on the geoarchaeological and archaeological resource that may be impacted by the proposed cable routes and facilitate an informed decision with regard to the requirement for, and methods of, any further geoarchaeological and archaeological investigations.

1.2.3 To help frame geoarchaeological investigations of this nature, Wessex Archaeology has developed a five-stage approach, encompassing different levels of investigation appropriate to the results obtained, accompanied by formal reporting of the results at the level achieved. The stages are summarised below (**Table 1**). This report represents Stage 2 of this process.

1.2.4 In format and content this report conforms with current best practice and to the guidance outlined in *Management of Research Projects in the Historic Environment* (MoRPHE) (Historic England 2009), *Geoarchaeology. Using Earth Sciences to Understand the Archaeological Record* (Historic England 2015) and the Chartered Institute for Archaeologists' *Standards and Guidance for Archaeological Watching Brief* (CIfA 2014a).

Table 2 Staged approach to geoarchaeological investigations

Stage 1: WSI / Geoarchaeological Desk-based Assessment	Review of sub-surface data (e.g. mapping, existing GI/SI, BGS logs), and summary of local or regional context. Establish likely presence/ absence/ distribution of archaeologically relevant deposits. May include modelling of existing data, and for larger schemes a fuller landscape characterisation. Present recommendations for fieldwork including type, number, distribution, and depth of sampling methods.
Stage 2: Fieldwork, interpretation, and reporting (e.g. Borehole survey)	Fieldwork to investigate deposits and obtain samples, followed by reporting. Reporting will present results (usually including deposit modelling), interpretations and recommendations for further work. Should suitable deposits be present, detailed recommendations for palaeoenvironmental assessment and dating will be made (Stage 3).
Stage 3: Palaeoenvironmental assessment	Assessment of subsamples agreed in Stage 2 (for e.g. pollen, diatoms, plant macrofossils, molluscs, ostracods, and foraminifera), together with radiocarbon dating. Reporting would summarise results in the (geo)archaeological and palaeoenvironmental context of the local or wider area. Should deposits have the potential for analysis, recommendations will be made for Stage 4 work.
Stage 4: Analysis	Full analysis of samples specified in Stage 3, together with a detailed synthesis of the results, in their local, regional, or wider (geo)archaeological and palaeoenvironmental context as appropriate. Publication would usually follow from a Stage 4 report.
Publication	The scope and location of a publication report would be agreed in consultation with Norfolk Vanguard Ltd and Norfolk Boreas Ltd and the LPA(s) archaeological advisor (NCC HES). The publication report may comprise a note in a local journal or a larger publication article or monograph, dependant on the significance of the (geo)archaeological work.

2 GEOARCHAEOLOGICAL AND ARCHAEOLOGICAL BACKGROUND

2.1 Introduction

2.1.1 The geoarchaeological and archaeological background was assessed in a prior WSI (WA 2020a). This section provides relevant background to the geoarchaeology and archaeology along the cable routes. Additional information is referenced where appropriate.

2.1.2 Where age estimates are available these are expressed in millions of years (MA), thousands of years (Ka) and within the Holocene epoch as either years Before Present (BP), Before Christ (BC) and Anno Domini (AD).

2.2 Bedrock geology

2.2.1 The bedrock geology mapped by the British Geological Survey (BGS, BGS Geology of Britain Viewer) along the cable routes comprises sand and gravel of the Crag Group between Happisburgh and Cawston, dating to the <5 MA within the Neogene and early Quaternary periods (**Figure 2**). The remainder of the cable routes comprising Cretaceous deposits of the White Chalk sub-group (**Figures 3**–**4**), including Lewes Nodular Chalk Formation (72–94 MA), between Cawston and Dereham, and Lewes Nodular Chalk Formation, Seaford Chalk Formation, Newhaven Chalk Formation and Culver Chalk Formation (72–94 MA), between Dereham and Necton.

2.3 Superficial geology

2.3.1 The proposed cable routes cross a range of superficial geologies mapped by the BGS (**Figures 5**–**7**) that formed during the Quaternary period and dating to the Pleistocene and Holocene epochs (**Table 3**). These deposits are listed and discussed below.

Table 3 British Pleistocene chronostratigraphy

Geological Period	Chronostratigraphy		Age (Kya)	Marine Isotope Stage (MIS)
Holocene	Holocene		11.7 – present	1
Late Pleistocene	Devensian	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		115 – 130	5e
Middle Pleistocene		Unnamed cold stage	130-374	6
		Aveley interglacial		7
		Unnamed cold stage		8
		Purfleet interglacial		9
		Unnamed cold stage		10
	Hoxnian		374 – 424	11
	Anglian		424 – 478	12
	Cromerian		524 – 478	13

		790 – 524	14 – 19
Lower Pleistocene		790 – 866	20 – 21

Pleistocene deposits (600 – 11.7 kya)

2.3.2 Although not mapped by the BGS, Pleistocene deposits belonging to the Cromer Forest Bed Formation (CF-bF) are potentially present at the Happisburgh Landfall. The principal Pleistocene deposits mapped by the BGS across the cable routes are glaciogenic deposits, likely to primarily be Anglian in date (MIS 12; 478–424 Ka). The routes also cross Pleistocene terraces of River Wensum, and valley side locations where Pleistocene Head deposits are mapped.

Cromer Forest Bed Formation (CF-bF)

2.3.3 Deposits of the Cromer Forest Bed Formation (CF-bF) have been recorded 0.2 km north east of the Happisburgh Landfall, on the foreshore and in the near offshore zone (Lewis et al. 2019).

2.3.4 The CF-bF consists of Early and early Middle Pleistocene (2.00-0.50 MA) fluvial, flood plain and estuarine sediments, which are associated with internationally significant Lower Palaeolithic archaeology and palaeoenvironmental evidence (Parfitt et al. 2005, Lewis et al. 2019).

2.3.5 The CF-bF deposits at Happisburgh 1 consist of fluvial deposits within an active channel and flood plain lake sediments, which subsequently infilled this channel. The Happisburgh 1 stratigraphy (**Table 4**) consists of upper and lower grey sands, overlain by organic mud, and glaciogenic deposits. The organic mud has been defined as a separate Member within the CF-bF, termed the Low Lighthouse Member (Lewis et al. 2019). The upper grey sand and organic mud both preserve Lower Palaeolithic archaeology and a range of palaeoenvironmental evidence.

Table 4 Happisburgh 1 stratigraphy (Lewis et al. 2019)

Happisburgh 1 stratigraphy (Lewis et al. 2019)	**Member (after Lee et al. 2017 and Lewis et. al 2019)**	**Formation**		
		Glacial	**Freshwater**	**Marine**
	Lowestoft Diamicton	Lowestoft		
	Corton Sand			
	Corton Diamicton	Corton		
	Happisburgh Sand			
	Ostend Clay			
Happisburgh Diamicton	Happisburgh Diamicton	Happisburgh		
Organic mud	Low Lighthouse			

Grey sand (part)			Cromer Forest-bed	
Grey sand (part)				Wroxham Crag

2.3.6 The lower grey sands at Happisburgh 1 consist of grey, gravelly sand. Based on their high quartoze content, these sands are thought to predate the CF-bF and to be marine deposits belonging to the Wroxham Crag (2.4–>0.6 MA).

2.3.7 The stratigraphic division between the lower and upper grey sands at Happisburgh 1 is poorly defined. The upper grey sand consists of interbedded sands and gravels with horizons of mud dominated, possible laminated sediments, grading upwards into firm to very firm silty sands. There is change in colour from grey to black, and an increase in organic material in the uppermost part of the unit. The upper grey sands preserved freshwater molluscs and are interpreted as having been lain down fluvially within an active channel (Lewis et al. 2019).

2.3.8 The overlying organic mud (Low Lighthouse Member) ranges in thickness from 1.0 m to 2.4 m. In places it consists of a lower organic silt and clay, and an upper sandier organic deposit. They are interpreted as floodplain lake sediments which progressively infilled the channel (Lewis et al. 2019).

2.3.9 The CF-bF deposits at Happisburgh 1 are directly overlain by glaciogenic deposits. Following the nomenclature of Lee et al. (2017), these consist of Happisburgh Diamicton (sub-glacial Till), Ostend Clay (glacio-lacustrine) and Happisburgh Sand (deltaic glacio-fluvial outwash). These glaciogenic deposits most likely date to MIS 12 (478–424 Ka; Preece and Parfitt 2012, Lewis et al, 2019; but see also Lee et al. 2004).

2.3.10 Based on lithostratigraphic evidence (position of deposits beneath Happisburgh Diamicton thought to date to MIS 12 – see above), and associated biostratigraphic evidence (most notably the presence of the water vole *Arvicola*), the CF-bF deposits at Happisburgh 1 are dated to MIS 13 (524–478 Ka; Lewis et al. 2019).

2.3.11 The fluvial deposits associated with the upper grey sands and the Low Lighthouse Member are thought to belong to an unnamed north east flowing river system; the course of nearest known main river system, the River Bytham, has been located 30 km south of Happisburgh during MIS 13 (Lewis et al. 2019).

2.3.12 A previous borehole (BH12-1; see **Figure 8**), located on the top of the cliffs above Happisburgh 1 and adjacent to the Happisburgh Landfall, identified the initial landward continuation of the CF-bF deposits (Ashton et al. 2018). Additionally, ERT geophysical data (Ashton et al. 2018) suggests that the Happisburgh Landfall is located within an area where the landward continuation of the Happisburgh 1 CF-bF deposits may be present.

<u>Glaciogenic deposits</u>

2.3.13 The glaciogenic deposits present across much of the proposed cable routes represent sub-glacial, glacio-lacustrine, and deltaic glacio-fluvial outwash deposits. The deposits all likely reflect changing deposition through the Anglian (MIS 12; 478-424 Ka) glaciation (Preece and Parfitt 2012, Lewis et al, 2019; but see also Lee et al. 2004).

2.3.14 **Table 5** summarises the relative stratigraphy of glaciogenic deposits identified across north East Anglia (Lee et al. 2017).

Table 5 North East Anglian relative glacial stratigraphy (Lee et al. 2017)

Formation	Member	Other nomenclature	Depositional facies
Briton's Lane Formation	Briton's Lane Sand and Gravel Member		Deltaic
	Stody Diamicton Member		Sub-glacial
Lowestoft Formation	Lowestoft Diamicton Member	Boulder Clay, Lowestoft Boulder Clay, Lowestoft Till, Lowestoft Till Member	Sub-glacial
	Runton Sand and Gravel Member		
	Weybourne Diamicton Member	Marly Drift, Weybourne Town Member, Weybourne Town Till Member	Sub-glacial
	West Runton Melange Member	Contorted Drift, Cromer Diamicton, Cromer Member, Bacton Green Melange	Sub-glacial and marginal deltaic
Sherringham Cliffs Formation	Trimingham Sand Member		Deltaic
	Trimingham Clay Member		Glacio-lacustrine
	Bacton Green Diamicton Member	Stony Loam, Third Cromer Till, Norwich Brickearth, Walcott Diamicton, Mundesley–Trimingham Member, Bacton Green Till Member	Sub-glacial
Mundesley Formation	Ivy Farm Silt Member		Glacio-lacustrine
	Mundesley Sand Member		Deltaic
	Walcott Diamicton Member	Second Till, Second Cromer Till, Walcott Diamicton, Walcott Member, Walcott Till Member	Sub-glacial
Corton Formation	Corton Sand Member		Deltaic
	Coney Weston Sand & Gravel Member		Deltaic
	Leet Hill Sand & Gravel Member		Deltaic
	Starston Diamicton Member	Lower Boulder Clay, Starston Till	Sub-glacial
	Corton Diamicton Member	Loam with Boulders, Cromer Till, Norwich Brickearth, Eccles Diamicton,	Sub-glacial

		Corton Till, Corton Member, Corton Till Member	
Happisburgh Formation	Happisburgh Sand Member		Deltaic
	Ostend Clay Member		Glacio-lacustrine
	Happisburgh Diamicton Member	First Till, First Cromer Till, Happisburgh Diamicton, Happisburgh Member, Happisburgh Till Member	Sub-glacial

2.3.15 Glaciogenic deposits generally have limited archaeological and geoarchaeological potential. However, as at Happisburgh 1, they may seal and preserve underlying stratigraphy containing Palaeolithic archaeological sites, artefacts and/or associated palaeoenvironmental remains.

River terrace deposits

2.3.16 The proposed cable routes cross terraces of the River Wensum. Pleistocene river terrace deposits are key contexts for Palaeolithic archaeology and paleoenvironmental evidence. They represent fluvially deposited sediments (gravels, sands, clays, and silts) that have been subsequently incised through and preserved as evidence of former floodplains along the sides of current and former river valleys.

2.3.17 The terrace sands and gravels generally reflect deposition under cold climatic conditions in braided river environments, whereas silts and clays tend to be associated with meandering rivers in temperate climates. Within individual catchments evidence for several terrace deposits can usually be mapped representing successive phases of aggradation and incision covering multiple glacial-interglacial cycles.

Head

2.3.18 Deposits mapped as Head are recorded at locations along the proposed cable routes where they cross valleys incised into glaciogenic deposits (**Figures 5–7)**.

2.3.19 Deposits mapped as Head can be formed through different processes and can include aeolian, alluvial, colluvial and soliflucted material. Such sequences can encompass units deposited during more than one period of the Pleistocene and can include Holocene colluvium.

2.3.20 Head deposits can contain eroded and redeposited artefacts and seal underlying stratigraphy in the form of buried former land surfaces; these can be associated with minimally disturbed archaeology and palaeoenvironmental remains.

Holocene deposits (≤11.7kya)

2.3.21 Holocene alluvial deposits are recorded by the BGS at points where the proposed cable routes cross Holocene valleys incised to glaciogenic deposits. Mapped Holocene deposits consist of:

- Breydon Formation – comprising alluvium and peat;
- Undifferentiated alluvium – most likely of Holocene date with potential to contain peat deposits, and

- Peat.

2.3.22 Alluvium is a generalised term covering unconsolidated sediment transported by water in a non-marine environment (e.g. rivers). It has also been used as a banner term including other sediment such as peat, but that often occur as distinct bands or discrete features within alluvium. Alluvium will therefore be encountered within both active rivers and floodplains and the fills of former river channels (termed palaeochannels).

2.3.23 The geoarchaeological potential of the alluvium is generally low. 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. Floodplain alluvium has the potential to contain or partially mask archaeology, whilst both floodplain alluvium and palaeochannels are key contexts for the preservation of waterlogged archaeology.

2.3.24 Peat comprises partially decomposed organic matter preserved within waterlogged anaerobic (oxygen-free) conditions. 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.

2.4 Previous investigations

Happisburgh 1 (Ancient Occupation of Britain Project 2004; University of Leiden 2009–2010, Pathways to Ancient Britain Project 2011– 2012)

2.4.1 Archaeological excavations carried out between 2004 and 2010 by the Ancient Human Occupation of Britain Project (AHOB) and the University of Leiden identified internationally significant Lower Palaeolithic archaeology and paleoenvironmental evidence within fluvial and floodplain sediments of the Cromer Forest Bed Formation (CF-bF) at Happisburgh 1 (Lewis et al. 2019). The deposits and archaeology are dated to MIS 13 (524–478 Ka). The Happisburgh 1 deposits are located on the foreshore and in the near offshore zone 0.2 km north east of the Happisburgh Landfall. Further borehole and geophysical investigations were carried out between 2011–2012 by the Pathways to Ancient Britain Project (PAB), which identified the onshore continuation of these deposits (Ashton et al. 2018) and indicate that these deposits may continue onshore within the Happisburgh Landfall.

Norfolk Vanguard Offshore Wind Farm Onshore Archaeology and Cultural Heritage. Geoarchaeological Watching Brief: Onshore Engineering Ground Investigations (SI) works (Phase 1) (WA 2017)

2.4.2 In 2017 Phase 1 SI works were carried out across the proposed cable routes and were subject to geoarchaeological monitoring (WA 2018).

2.4.3 The investigation focused on possible landfall sites at Happisburgh (L1A and L1B; L1B being the current proposed Landfall), and at seven key crossing locations where the proposed cable routes intersect major transport routes or waterways where trenchless (e.g. HDD) methods will be required.

2.4.4 No deposits unequivocally belonging to the CF-bF were identified in the possible landfall areas. Minerogenic sands, clays, and gravels of glaciogenic origin, principally belonging to Happisburgh Formation, were recorded at both locations. Notably thick glaciogenic deposits identified at L1A correspond with a dip in the geometry of the glaciogenic deposits in nearby cliffs sections. This dip has been interpreted as due to glaciotectonic deformation by ice (Hart 1999, Hart and Boulton, 1991), the northern limb of a syncline (Lee 2003) or the result of solution in the underlying chalk resulting in the collapse of the overlying sediments (Lewis at al. 2019).

2.4.5 At L1B these glaciogenic deposits were underlain by sands which are likely to be marine and to belong to the Wroxham Crag (2.4->0.6 MYA).

2.4.6 At all seven crossing points the deposits encountered were largely glacial in origin. In one location (borehole BH17-C3-02, Crossing 3 – River Wensum) a Holocene pseudo-fibrous peat was recorded at 0.15 to 1.70 mbgl.

2.5 Geoarchaeological and archaeological context

Palaeolithic (0.6 MA – 11.7 kya)

2.5.1 Over recent decades there has been a tremendous amount of archaeological and geoarchaeological research undertaken in East Anglia focussed on the pre-Anglian (>MIS 12; 478–424 Ka) river systems of the Ancaster, Bytham (previously known as the Ingham) and Thames (e.g. Rose et al. 2001; 2002; Rose 2009; Parfitt et al. 2010, Lewis et al. 2019). This research has identified the earliest Palaeolithic archaeological sites in Britain and northern Europe at Pakefield, Suffolk and Happisburgh, Norfolk (Parfitt et al. 2005; 2010; Ashton et al. 2014, Lewis et al. 2019). East Anglia generally, and north Norfolk specifically, contains type sites for the Anglian Glaciation deposits (MIS 12; 478–424 Ka), and has been extensively studied (e.g. Reid 1882, Solomon 1932, Banham 1971, Lunkka 1994, Lee et al. 2004; 2017, Read et al. 2007; Pawley et al. 2008).

2.5.2 There is a rich archaeological record particularly for Lower Palaeolithic sites and artefacts in the region (Wymer 1999). Key sites such as Happisburgh 3 (Parfitt et al. 2010), Pakefield (Parfitt et al. 2005) and Happisburgh 1 (Lewis et al. 2019) in coastal positions have provided internationally significant artefactual and palaeoenvironmental records, reflecting rare evidence for human occupation predating the Anglian Glaciation. Investigations at Happisburgh have also revealed the oldest known hominin footprint surface outside Africa at between approximately 1 million and 0.78 million years ago (Ashton et al. 2014).

2.5.3 The Pakefield and Happisburgh sites are associated with Cromer Forest Bed Formation (CF-bF – see above). The CF-bF has long been known to contain fossil bones and other environmental remains key for understanding the Early and early Middle Pleistocene environmental history of the region. Significantly, however, studies carried out since 2000 by the Ancient Human Occupation of Britain (AHOB) and Pathways to Ancient Britain (PAB) Projects have identified several localities associated with internationally significant Lower and early Middle Pleistocene archaeology, reflecting the earliest human colonisation of northern Europe.

2.5.4 The deposits underlying the proposed Happisburgh cable landfall site may have significant geoarchaeological and archaeological potential. The Happisburgh Landfall is located 0.2 km south west of the Lower Palaeolithic site of Happisburgh 1. At Happisburgh 1 Lower Palaeolithic archaeology has been recovered from fluvial and floodplain sediments of the CF-bF (including the newly defined Low Lighthouse Member – see above). These deposits also contain a rich array of paleoenvironmental indicators.

2.5.5 The Lower Palaeolithic archaeology from Happisburgh 1 consists principally of hard hammer, simple core and flake working; notably, however, the assemblages include a handaxe. The archaeology is minimally disturbed and includes refitting lithic artefacts. The lithic assemblages are low density and reflect material transported into the area, with initial stages of manufacture having occurred elsewhere (Lewis et al. 2019). The site is dated to MIS 13 (524–478 Ka – see above).

2.5.6 The archaeology and associated palaeoenvironmental evidence from Happisburgh 1 are internationally significant as they reflect rare evidence of pre-Anglian (>500 kya) colonisation of northern Europe, and associated information on technological practices, landscape-use, and environmental tolerances. Happisburgh 1 is one of five MIS 13 sites in Britain.

2.5.7 The CF-bF deposits at Happisburgh 1 are known to extend inland from the modern foreshore. Although, their specific location and extent is currently unknown, they may be present beneath the Happisburgh Landfall (see above).

2.5.8 Mapped Pleistocene deposits along the rest of the proposed cable routes are dominated by glacial deposits (**Figures 5**–**7**) comprising sub-glacial diamicton (Till), glacio-lacustrine sediments and deltaic glacio-fluvial outwash gravels. All these deposits are likely Anglian in date (MIS 12; 478-424 Ka). Such deposits are recorded at most SI locations. The archaeological and geoarchaeological potential of these glacial deposit is generally low.

2.5.9 The proposed cable routes cross Pleistocene terrace deposits of the River Wensum. Terrace deposits of River Wensum are recorded by the BGS at one SI location, Elsing Lane (**Figure 6**).

2.5.10 The archaeological and geoarchaeological potential of the deposits at this specific location is poorly understood. However, broadly equivalent deposits in the wider area have produced Palaeolithic artefacts, including handaxes (Wymer 1999), and units preserving significant palaeoenvironmental datasets, including pollen, plant macro-fossils, non-marine molluscs and vertebrate remains (Coxon et al. 1980).

2.5.11 Pleistocene Head deposits are recorded at points along the cable routes located along margins of valleys incised into glaciogenic deposits (**Figures 5**–**7)**. They are recorded at two CPT SI locations (although they could be more extensive than mapped):

- Little London Road/Paston Way, and
- Marriotts Way North.

2.5.12 These Head deposits could include both Pleistocene and/or Holocene deposits. Their archaeological and geoarchaeological potential is poorly understood, but generally Head deposits can contain eroded and redeposited artefacts and seal underlying stratigraphy in the form of buried former land surfaces; these land surfaces can be associated with minimally disturbed archaeology and palaeoenvironmental remains.

Post Palaeolithic (≤11.7kya)

2.5.13 Most superficial deposits present along the proposed cable routes are Pleistocene in date, with Holocene alluvial deposits more sparsely present in association with watercourses (see **Figures 5**–**7**).

2.5.14 Alluvial deposits are recorded by the BGS at four SI locations:

- Lyngate Road;
- River Bure;
- Wendling Carr; and
- Stream Crossing, Necton.

2.5.15 Alluvial deposits mapped along the River Bure are classified as belonging to the Breydon Formation, widespread within both relict and extant fluvial systems across eastern Norfolk. The Breydon Formation includes both deposits of minerogenic alluvium in addition to lenses and bands of peat.

2.5.16 Alluvium represents mudflats and saltmarsh deposited during periods of sea-level rise with peats forming during periods of stable and/or falling sea levels when semi-terrestrial plant communities (e.g. tall herb swamp, fen woodland) encroached into the wetland. It is probable however that deposits within the upper reaches of the River Bure and at the other locations along the routes were freshwater rather than tidal estuarine. Alluvium has the potential to contain or partially mask archaeology.

2.5.17 Peat comprises partially decomposed organic matter preserved within waterlogged anaerobic (oxygen-free) conditions. In the context of the Breydon Formation, peat deposits would have developed under the background influence of sea-level rise/fall, forming within river floodplains during periods of reduced or stable ground water/sea-level rise.

2.5.18 Peat deposits are mapped specifically by the BGS at Lyngate Road, although their extent and context are poorly understood at present.

2.5.19 Where peat deposits are present, they may have high geoarchaeological potential.

2.6 Summary of the possible geoarchaeological and archaeological potential

2.6.1 The geoarchaeological and archaeological potential of Quaternary deposits potentially present at SI locations can be summarised as follows:

- late Middle Pleistocene deposits of the Cromer Forest-Bed Formation (CF-bF) may be present at depth beneath the Happisburgh Landfall. These deposits have high geoarchaeological and moderate-high archaeological potential; equivalent deposits to those at Happisburgh 1 (MIS 13; 524–478 Ka) may be present. Deposits at Happisburgh 1 have produced palaeoenvironmental datasets and internationally significant, relatively low-density Lower Palaeolithic archaeology.
- Pleistocene deposits in other areas of the proposed cable routes are likely to be dominated by Anglian (MIS 12; 478-424 Ka) glacial sediments, which have generally low geoarchaeological and archaeological potential.
- Pleistocene terrace deposits are present where the proposed cable routes cross the River Wensum. The specific geoarchaeological and archaeological potential of these deposits is unknown. However, consideration of evidence from equivalented deposits in the wider area indicates that they may have significant potential to preserve palaeoenvironmental evidence and contain Palaeolithic archaeology.

- Head deposits are likely to be present along valley margins along the proposed cable routes. The archaeological and geoarchaeological potential of these specific deposits is currently poorly understood. These deposits have general potential to contain reworked Palaeolithic and later archaeology (deposits mapped as Head can include Holocene colluvium). Head deposits also have the broad potential to bury land surfaces associated with minimally disturbed archaeology.

- Holocene alluvial deposits are recorded at four SI locations (Lyngate Road, River Bure, Wendling Carr and Stream Crossing, Necton). Such deposits could contain or mask archaeology. They could also contain peats, which can have significant geoarchaeological potential.

3 AIMS AND OBJECTIVES

3.1.1 The aims of the geoarchaeological monitoring and archaeological watching brief, as stated in the WSI (WA 2020a) and addendum (WA 2020b), were to:

- undertake archaeological watching brief and geoarchaeological monitoring of SI works;
- identify the presence of sequences of Pleistocene and Holocene sediments;
- record sequences and obtain representative samples from suitable deposits;
- assess the geoarchaeological and archaeological significance of the deposits; and
- report on results, including proportionate recommendations for further action.

3.1.2 Following consideration of the geoarchaeological and archaeological potential of the areas being monitored, the site-specific objectives of the SI monitoring were to:

- consider, within the limits of the monitoring works, the extent of Quaternary deposits within the proposed onshore project areas;
- monitor whether Quaternary deposits within significant geoarchaeological and archaeological potential are present in areas impacted on by SI interventions;
- allow any deposits with significant palaeoenvironmental and dating potential to be identified and sampled; and
- make recommendations for further geoarchaeological work, as appropriate.

4 METHODS

4.1 Introduction

4.1.1 All works were undertaken in accordance with the detailed methods set out within the WSI (WA 2020a) and addendum to the WSI (WA 2020b).

4.1.2 The geoarchaeological monitoring works and archaeological watching brief were carried out in general compliance with the relevant CIfA and Historic England guidance (CIfA 2014a, Historic England 2015). All works adhered to Norfolk County Council standards for

Development-led archaeological Projects in Norfolk (NCC 2018). The specific methods employed are summarised below.

4.2 Geoarchaeological monitoring of geotechnical boreholes

General

4.2.1 All cable percussion boreholes at the Happisburgh Landfall were carried out and recorded under geoarchaeological supervision (**Figure 1** and **8**).

4.2.2 For the remaining cable percussion borehole locations at Necton (**Table 1**) review of the BGS mapping (WA2020a) indicated that the Quaternary stratigraphy is dominated by Pleistocene glacial deposits, which have low geoarchaeological potential and so these locations were not subject to permanent geoarchaeological monitoring. Regular contact between the SI Contractor team and Wessex Archaeology's geoarchaeological team was maintained to establish whether significant strata were present. This included daily geoarchaeological review of SI logs. Had deposits with significant potential been present, geoarchaeological attendance would have been made to provide a more detailed record of sequences and to obtain suitable samples.

4.2.3 In line with the WSI and addendum (WA 2020a; 2020b) cone penetration tests (CPTs) were not subject to geoarchaeological monitoring.

4.2.4 All borehole logs will be made available to Wessex Archaeology as part of subsequent scheme-wide post-consent geoarchaeological and palaeoenvironmental works. Approaches to which will be further agreed in the post-consent stages with NCC HES, and HE, as required.

Methods

4.2.5 All monitored boreholes were carried out through cable percussion drilling (aka shell and auger).

4.2.6 Cable percussion drilling uses a 'clay cutter' for cohesive soils or a 'shell' (or bailer) for non-cohesive materials. The sides of the borehole are supported using steel casing which is lowered into the ground as the boring proceeds.

4.2.7 The material sampled using this method is generally sufficiently representative to determine the depth and description of the stratigraphy. Disturbed samples may be collected from both the clay cutter and the shell.

4.2.8 Undisturbed samples were recovered by driving a hollow 100mm tube (UT100s) into the ground and withdrawing the resultant core for subsequent examination.

4.2.9 Cable percussion rigs were operated by experienced engineers. All Quaternary deposits were recorded and their palaeoenvironmental and/or dating potential assessed by a suitably experienced member of the Wessex Archaeology geoarchaeological team.

4.2.10 Both disturbed and undisturbed geoarchaeological samples were taken from deposits with possible geoarchaeological potential.

Recording

4.2.11 Deposits encountered in each borehole were recorded using a pro forma recording system.

4.2.12 Descriptions of deposits present within each intervention include information such as:

- Depth
- Texture
- Composition
- Colour
- Inclusions
- Structure (bedding, ped characteristics etc.)
- Contacts between deposits

4.2.13 Interpretations were made regarding the probable depositional environments and formation processes of deposits.

4.2.14 This data was then tabulated by borehole (**Appendix 1**).

4.2.15 A record of the location of all boreholes, along with datum (either m above Ordnance Datum or m below ground level) levels of the geoarchaeological deposits was provided by the SI Contractor.

4.3 Archaeological and geoarchaeological monitoring of machine excavated trial pits

4.3.1 All machine excavated trial pits subject to archaeological and geoarchaeological monitoring (**Table 1** and **Figures 2**–**7**).

4.3.2 The trial pits were monitored by a suitably qualified (geo)archaeologist. They were excavated by the SI Contractor using an appropriate mechanical excavator. The SI contractor was responsible for identifying the presence of services and ensuring it was safe to excavate.

4.3.3 All trial pit locations were scanned with a metal detector prior to excavation. Any up cast (deposits and spoil) was metal detected, and any finds recovered, spatially recorded, labelled, and bagged.

4.3.4 Excavations of trial pits proceeded with a toothless ditching bucket under the direction of the SI engineering team or site supervisor in charge.

4.3.5 The SI Contractor provided a suitable and safe position for the monitoring archaeologist to view the excavation of the trial pits.

4.3.6 If the monitoring (geo)archaeologist required the excavation to be stopped to view the trial pit, this was communicated immediately to the site supervisor who stopped the excavation.

4.3.7 During monitoring, the attending (geo)archaeologist checked for the presence of archaeological features.

4.3.8 Arisings from each trial pit were visually scanned for artefacts and ecofacts.

4.3.9 Appropriate strategies for the recovery of palaeoenvironmental samples were in line with those detailed in the WSI and addendum (WA 2020a; 2020b)

Recording

4.3.10 All exposed geoarchaeological, archaeological deposits and features in each machine excavated trial pit were recorded using a pro forma recording system.

4.3.11 As above, descriptions of geoarchaeological deposits present within each intervention included information such as:

- Depth
- Texture
- Composition
- Colour
- Inclusions
- Structure (bedding, ped characteristics etc.)
- Contacts between deposits

4.3.12 Interpretations were made regarding the probable depositional environments and formation processes of geoarchaeological deposits.

4.3.13 This data was then tabulated by trial pit (**Appendix 2**).

4.3.14 A scaled drawn record of representative exposed sections was made for each machine excavated trial pit.

4.3.15 A full photographic record was made using digital cameras equipped with an image sensor of not less than 10 megapixels. Digital images have been subject to managed quality control and curation processes, which has embedded appropriate metadata within the image and will ensure long term accessibility of the image set.

4.3.16 A record of the location of all machine excavated trial pits along with datum (either m above Ordnance Datum or m below ground level) levels of the (geo)archaeological deposits was provided by the SI Contractor.

4.4 Deposit modelling

4.4.1 The results of the geoarchaeological monitoring and archaeological watching brief have demonstrated that deposit modelling is principally relevant to illustrate the distribution of deposits at the Happisburgh Landfall. The results of the borehole monitoring at the Landfall have been integrated with previous borehole data (WA 2018) and the results of investigations at Happisburgh 1 (Ashton et al. 2018, Lewis et al. 2019) to produce an integrated record of the deposits.

4.4.2 The different lithologies and stratigraphic interpretations have been entered into Rockworks™ v17.0. Selected SI monitoring locations have been used to produce representative transects through the deposits. Based on geoarchaeological interpretation of the lithological data (e.g., peat, clay, silt, sand etc.), a set of stratigraphic units (e.g. alluvium, peat, buried soils etc.) were created to group sets of deposits across the Landfall site.

4.4.3 The Rockworks data was used to create representative transects mapping the subsurface topography beneath the Happisburgh Landfall.

4.4.4 The Rockworks data was exported into ArcGIS $_{v.}$10.2 and used to create representative transects, mapping the subsurface topography and sediments beneath the site.

4.4.5 Key aims of the modelling were to interpret the data, identifying the probable environments represented, and determine areas of higher and/or lower geoarchaeological and archaeological potential where further work may be required (e.g. deposits with potential for the recovery of significant archaeological and environmental remains).

5 RESULTS

5.1 Introduction

5.1.1 The results of the geoarchaeological monitoring of cable percussion boreholes at the Happisburgh Landfall and Necton, and the (geo)archaeological monitoring of trial pits across the cable routes are outlined below. The stratigraphic and archaeological evidence is reviewed, and palaeoenvironmental and the dating potential of the deposits discussed.

5.2 Stratigraphic evidence

Happisburgh Landfall

5.2.1 The stratigraphy present in 9 cable percussion boreholes (BH116-LF – BH123LF, UNV-BH405) at the Happisburgh Landfall is listed and summarised below. The specific lithologies and stratigraphic succession encountered in each intervention are outlined in **Appendix 1**.

5.2.2 The generalised stratigraphic sequence encountered comprises:

- Modern Soil Profile (Recent)
- Beach sands and landslip deposits (Recent)
- Upper glacio-lacustrine clays (Middle Pleistocene)
- Upper glacio-fluvial sand and gravel (Middle Pleistocene)
- Upper Diamicton (Middle Pleistocene)
- Lower Glacio-fluvial sand and gravel (Middle Pleistocene)
- Lower Glacio-lacustrine clays (Middle Pleistocene)
- Lower Diamicton (Middle Pleistocene)
- Alluvial silt, sand, and gravelly sand (early Middle Pleistocene)
- Alluvial/estuarine clay, silt and sand (?Early to early Middle Pleistocene)

- Marine sand (Early to Middle Pleistocene)

Marine sand

5.2.3 Likely marine sand was encountered in 8 boreholes (BH116 – LF-B117-LF; BH119 – LF-B123-LF, UNV-BH405) generally below -2.00 m OD, represented by dark grey or greyish brown fine to coarse sand. In places this sand contains rare fine to coarse sub-angular and sub-round flint, quartzite, and mudstone clasts. Some units are also finely laminated. These sands likely belong to the Wroxham Crag (2.4->0.6 MA).

5.2.4 In six of these boreholes likely marine sands are directly overlain by diamicton. However, in two boreholes (BH120-LF and B121-LF) silt, sand and gravelly sand units were identified overlying likely marine sand and beneath diamicton, which are interpreted as alluvial.

Alluvial/estuarine clay, silt and sand

5.2.5 Potential alluvial or estuarine sediments were identified overlying marine sands and beneath glaciogenic deposits in UNV-BH405. These comprised dark brownish grey silty medium to coarse sand with occasional pockets of sandy clay and occasional shell fragments.; a large fragment of wood was recovered from these deposits. At the base a Grey silty sand and sandy clay unit was observed. These deposits were 1.50m thick and occurred between -7.29 and -8.79 mOD.

Alluvial silt, sand, and gravelly sand

5.2.6 In two boreholes (BH120-LF and B121-LF) silt, sand and gravelly sand units overlie likely marine sand; these may be stratigraphically distinct from the alluvia/estuarine clay, sit and sand in UNV-BH405. The lithological characteristics of these silt, sand and gravelly sand units in BH120-LF and B121-LF indicate that these may be alluvial.

5.2.7 The potential alluvial deposits in BH120-LF are found between 0.61 and -6.29 m OD. They consist of light grey slightly gravelly fine to coarse sand, which may be marine, overlain by dark grey slight gravely silty sand with thin beds of grey clay and silty clay, grey gravelly fine to coarse sand (gravel is primarily fine to medium sub-angular to sub-rounded flint, with common sub-rounded fine to medium quartzite and occasional chert clasts) with bands of dark grey clay containing organic fragments and laminated grey-brown, locally clayey, silty sand.

5.2.8 In BH121-LF the basal part of potential alluvial deposits consists of dark grey slightly gravelly fine silty sand, which becomes a dark grey fine sand with depth. This is found between -1.29 and -8.09 mOD, and the lithological changes may reflect a change from marine to alluvial deposition. This is overlain by laminated mid grey, slightly clayey sandy silt with organic material and thin fibrous organic laminations, and which becomes a gravelly mid grey fine to medium sand towards the base. The top of the potential alluvial deposits in BH121-LF is at 1.61 mOD.

5.2.9 It should be noted that the lithostratigraphic division between these potentially alluvial grey silts, sand, and gravelly sand, and the earlier – likely marine – grey or greyish brown sands is equivocal. Consequently, it is possible that the upper part of likely marine sands in other boreholes could include lateral equivalents of the potential alluvial units in BH120-LF and BH121-LF.

Lower Diamicton

5.2.10 The likely marine sands and potential alluvial deposits are overlain by diamict in 8 boreholes (BH116 – LF-B117-LF; BH119 – LF-B123-LF, UNV-BH405); potentially a second, distinct, upper diamict was recorded in UNV-405. The lower diamict consists of dark grey to grey-brown well consolidated sandy clay diamict with chalk and flint clasts, and rare shell fragments. Its depth generally varied from 2.91 to 1.61 mOD and -0.13 to -5.03 mOD. The deposits in UNV-405 are dipping to the south and the lower diamict occurred at between -7.09 and -7.29 mOD. Such deposits are characteristic of sub-glacial deposition.

5.2.11 This unit is equated to the Happisburgh Diamicton Member of the Happisburgh Formation, units of which are found immediately north east of the Landfall in cliff sections and at Happisburgh 1 (Lewis et al. 2019).

Lower glacio-lacustrine clays

5.2.12 Two boreholes (BH117-LF and BH122-LF) recorded laminated sandy clay above the Happisburgh Diamicton. These are glaciolacustrine sediments and likely correlate with the Ostend Clay Member of the Happisburgh Formation (Lee et al. 2017). They are found between 1.37 and -0.33 m OD in BH117-LF, and between 3.54 and 2.14 m OD in BH122-LF. Possible equivalent deposits are recorded in the same stratigraphic position in BH-121-LF.

Lower glacio-fluvial sand and gravel

5.2.13 Extensive sequences of sand and gravel are recorded overlying the Happisburgh Diamicton and Ostend Clays in six boreholes (BH116 – LF-B117-LF; BH119 – LF-B123-LF). The sands and gravels comprise light yellowish brown to light reddish-brown gravelly sands with occasional clay pockets. The gravel is generally fine to coarse, sub-angular and sub-rounded flint, with rare quartzite clasts. These sands and gravels are glacio-fluvial deposits laid down in deltaic fans beyond the margin on an ice sheet. They correlate to the Happisburgh Sand Member of the Happisburgh Formation.

Upper Diamicton

5.2.14 A potential second, upper, diamict was identified in UNV-BH405. This was found at between -2.69 and -5.29 mOD. This is similar lithologically to the diamict in other boreholes, comprising dark brownish grey medium sandy clay with occasional angular flint and siltstone clasts and occasional very fine shell fragments. Its stratigraphic position, however, suggests that it belongs to Corton Diamiction of the Corton Formation, rather than the Happisburgh Diamicton.

Upper glacio-fluvial sand and gravel

5.2.15 Mid greyish brown medium sand with occasional silty clay pockets and occasional angular flint clasts overlay the upper diamicton in UNV-BH405. These a glacio-fluvial sands and gravels; their stratigraphic position suggests they belong to the Corton Sand Member of the Corton Formation

5.2.16 Glacio-fluvial sands and gravels are recorded throughout the sequence in borehole BH118-LF from 10.45 to below -8.00 m OD. Their stratigraphic position suggests that these also belong to the Corton Sand Member.

Upper glacio-lacustrine clays

5.2.17 Laminated and sub-horizontally bedded mid reddish brown and brownish grey bedded silty clay were recorded at the top of the Pleistocene sequence, between -0.09 and -0.79 m OD, in UNV-BH405. These are interpreted as glacio-lacustrine deposits. Similar deposits exposed in cliff sections in the immediate area have been equated to the Ostend Clays (Lewis et. al. 2019). However, if they are located stratigraphically above the Corton Diamicton, this direct correlation with the Ostend Clay is questionable.

Beach sands and landslip deposits

5.2.18 The Pleistocene stratigraphy in UNV-BH405 is truncated and overlain by sands from a recent landslip and modern beach sands.

Modern Soil Profile

5.2.19 The upper most units in all 8 landfall boreholes consist of modern soil profiles. These comprise of greyish brown, slightly gravely clay sand.

Walcott Green

5.2.20 The stratigraphy in the single trial pit at Walcott Green (TP101-WG) is listed and summarised below. The specific lithologies and stratigraphic succession encountered in the trial pit are outlined in **Appendix 2**.

5.2.21 The generalised stratigraphic sequence encountered comprises:

- Modern soil profile (Recent)
- Glacio-fluvial sand and gravel (Middle Pleistocene)

Glacio-fluvial sand and gravel

5.2.22 The Walcott Green trial pit recorded yellow-brown sand with occasional fine to coarse sub-rounded flint clasts between 1.20 and beyond 2.00 mbgl. These are glacio-fluvial deposits and are correlated to the Happisburgh Sand Member of the Happisburgh Formation.

Modern soil profile

5.2.23 The glacio-fluvial deposits are overlain by a modern soil profile. This consists of dark brown sandy silty clay.

Happisburgh Road

5.2.24 The stratigraphy in the single trial pit at Happisburgh Road (TP102-HR) is listed and summarised below. The specific lithologies and stratigraphic succession encountered in the trial pit are outlined in **Appendix 2**.

5.2.25 The generalised stratigraphic sequence encountered comprises:

- Modern soil profile (Recent)
- Glacio-fluvial sand and gravel (Middle Pleistocene)

Glacio-fluvial sand and gravel

5.2.26 Yellow brown sandy clay and sand with occasional coarse sub-rounded flint clasts was recorded between 1.20 and +2.00 mbgl. These are glacio-fluvial deposits and belong to the Happisburgh Sand Member of the Happisburgh Formation.

Modern soil profile

5.2.27 The top of the sequence in the trial pit consisted of a modern soil profile. This uppermost units consist of dark brown sandy silty clay.

Witton Bridge

5.2.28 The stratigraphy in the single trial pit at Witton Bridge (TP103-WB) is listed and summarised below. The specific lithologies and stratigraphic succession encountered the trial pit are outlined in **Appendix 2**.

5.2.29 The generalised stratigraphic sequence encountered comprises:

- Modern Soil Profile (Recent)
- Glacio-fluvial sand and gravel (Middle Pleistocene)

Glacio-fluvial sand and gravel

5.2.30 Light reddish-brown coarse sand was identified between 0.50 to +2.00 mbgl. These are glacio-fluvial sands and correlate to the Happisburgh Sand Member of the Happisburgh Formation.

Modern soil profile

5.2.31 A modern soil profile was recorded overlying glacio-fluvial deposits. This uppermost units consists of brown to reddish brown sandy clay.

Witton Hill Plantation

5.2.32 The stratigraphy in the single trial pit at Witton Hill Plantation (TP104-WH) is listed and summarised below. The specific lithologies and stratigraphic succession encountered in the trial pit is outlined in **Appendix 2**.

5.2.33 The generalised stratigraphic sequence encountered comprises:

- Modern soil profile (Recent)
- Glacio-fluvial sand and gravel (Middle Pleistocene)

Glacio-fluvial sand and gravel

5.2.34 Light red fine sand was identified between 0.70 to +2.00 mbgl. These are glacio-fluvial deltaic sands, and likely belong to Briton’s Lane Sand and Gravel Member of the Briton’s Lane Formation.

Modern soil profile

5.2.35 A modern soil profile was recorded overlying glacio-fluvial deposits. This uppermost units consists of brown sandy clay.

Lyngate Road

5.2.36 The stratigraphy in the single trial pit at Lyngate Road (TP105-LR) is listed and summarised below. The specific lithologies and stratigraphic succession encountered in the trial pit are outlined in **Appendix 2**.

5.2.37 The generalised stratigraphic sequence encountered comprises:

- Modern soil profile (Recent)
- Peat (Holocene)
- Alluvium (Holocene)

Alluvium

5.2.38 The lowermost units of TP105-LR are alluvial. They consist of dark grey gravely silt and sub-angular to rounded flint and occasional quartzite gravel overlying light grey slight silt.

Peat

5.2.39 The alluvial deposits are overlain by 0.40 m of fibrous peat.

Modern soil profile

5.2.40 A modern soil profile comprising dark brown slightly sandy gravely silt overlay the peat. This uppermost unit consists of brown sandy clay.

North Walsham Railway

5.2.41 The stratigraphy in two trial pits at North Walsham Railway (TP106-NW and TP107-NW) is listed and summarised below. The specific lithologies and stratigraphic succession encountered in each intervention are outlined in **Appendix 2**.

5.2.42 The generalised stratigraphic sequence encountered comprises:

- Modern soil profile (Recent)
- Colluvial silt (Head) (Pleistocene and or Holocene)
- Glacio-fluvial sand and gravel (Middle Pleistocene)

Glacio-fluvial sand and gravel

5.2.43 Glacio-fluvial sands and gravels were identified in both trial pits. In TP106-NW these consist of yellowish grey to orange gravelly sands, which are tentatively correlated with the Happisburgh Sand Member of the Happisburgh Formation. In TP107-NW these sands and gravels are brown gravelly sands, which likely belong to the Briton's Lane Sand and Gravel Member of the Briton's Lane Formation.

Colluvial silt (Head)

5.2.44 Between 0.40-0.70 m of gravelly sandy silt overlie glacio-fluvial sand and gravel in both test pits. This likely reflects colluvial deposition.

Modern soil profile

5.2.45 A modern soil profile comprising grey brown slightly sandy slightly gravelly silt overlay colluvial silt in both interventions.

Suffield

5.2.46 The stratigraphy in the single trial pit at Suffield (TP108-SF) is listed and summarised below. The specific lithologies and stratigraphic succession encountered in the trial pit are outlined in **Appendix 2**.

5.2.47 The generalised stratigraphic sequence encountered comprises:

- Modern soil profile (Recent)
- Glacio-fluvial sand and gravel (Middle Pleistocene)

Glacio-fluvial sand and gravel

5.2.48 The basal units encountered consist of brown to yellow sandy clays. These are glacio-fluvial and are tentatively correlated with the Happisburgh Sand Member of the Happisburgh Formation.

Modern soil profile

5.2.49 The modern soil profile, which directly overlay glacio-fluvial deposits, comprised mid to dark brown silty sandy clay.

Cromer Road

5.2.50 The stratigraphy in the single trial pit at Cromer Road (TP109-CR) is listed and summarised below. The specific lithologies and stratigraphic succession encountered in the trial pit are outlined in **Appendix 2**.

5.2.51 The generalised stratigraphic sequence encountered comprises:

- Modern soil profile (Recent)
- Glacio-fluvial sand and gravel (Middle Pleistocene)

Glacio-fluvial sand and gravel

5.2.52 The lower-most units consist of yellow clays and angular and sub-angular gravel in reddish brown medium-coarse sand matrix. These are glacio-fluvial outwash deposits and are correlated with the Briton's Lane Sand and Gravel Member of the Briton's Lane Formation.

Modern soil profile

5.2.53 The modern soil profile overlying the glacio-fluvial deposits, comprises mid brown gravelly sandy silt.

Alysham Road

5.2.54 The stratigraphy in the single trial pit at Cromer Road (TP110-CR) is listed and summarised below. The specific lithologies and stratigraphic succession encountered in the trial pit are outlined in **Appendix 2**.

5.2.55 The generalised stratigraphic sequence encountered comprises:

- Modern soil profile (Recent)
- Glacio-fluvial sand and gravel (Middle Pleistocene)

Glacio-fluvial sand and gravel

5.2.56 Brown and yellow, generally gravelly, sands are found at the base of the sequence. These are glacio-fluvial outwash deposits and are correlated with the Briton's Lane Sand and Gravel Member of the Briton's Lane Formation.

Modern soil profile

5.2.57 The modern soil profile overlying the glacio-fluvial deposits comprise dark reddish grey brown slightly sandy slightly gravelly silt.

Hornsea

5.2.58 The stratigraphy in the three trial pits at Hornsea crossing (TP111-HS – TP113-HS) is listed and summarised below. The specific lithologies and stratigraphic succession encountered in each intervention are outlined in **Appendix 2**.

5.2.59 The generalised stratigraphic sequence encountered comprises:

- Modern soil profile (Recent)
- Diamicton (Middle Pleistocene)

Diamicton

5.2.60 Yellow brown, slightly gravelly, clayey silt, and silty clay diamict form the lower-most units in all three trial pits. This material is sub-glacially deposited and is part of the Sheringham Cliffs Formation.

Modern soil profile

5.2.61 Modern soil profiles overlie diamict in all three trial pits. This comprises dark grey brown slightly sandy slightly gravelly silt.

Kerdiston Road

5.2.62 The stratigraphy in the single trial pits at Kerdiston Road (TP114-KR) is listed and summarised below. The specific lithologies and stratigraphic succession encountered in the trial pit are outlined in **Appendix 2**.

5.2.63 The generalised stratigraphic sequence encountered comprises:

- Modern soil profile (Recent)
- Glacio-fluvial sand and gravel (Middle Pleistocene)

Glacio-fluvial sand and gravel

5.2.64 Yellow sands and slightly gravelly sands were recorded between 0.80 to +2.00 mbgl. These are glacio-fluvial sands are part of the Sherringham Cliffs Formation.

Modern soil profile

5.2.65 A modern soil profile comprising brown sandy clay overlay glacio-fluvial sand and gravel.

Jordan Lane

5.2.66 The stratigraphy in the single trial pits at Jordan Lane (TP116-JR) is listed and summarised below. The specific lithologies and stratigraphic succession encountered in the trial pit are outlined in **Appendix 2**.

5.2.67 The generalised stratigraphic sequence encountered comprises:

- Modern soil profile (Recent)

- Diamicton (Middle Pleistocene)

Diamicton

5.2.68 Orange brown, slightly gravelly clayey silt, and silty clay diamict was recorded between 0.80 to +2.00 mbgl. These sub-glacial deposits form part of the Sheringham Cliffs Formation.

Modern soil profile

5.2.69 A modern soil profile comprising brownish grey and yellowish orange slightly gravelly silt clay overlay diamict.

Elsing Lane

5.2.70 The stratigraphy in the single trial pits at Jordan Lane (TP116-EL) is listed and summarised below. The specific lithologies and stratigraphic succession encountered in the trial pit are outlined in **Appendix 2**.

5.2.71 The generalised stratigraphic sequence encountered comprises:

- Modern soil profile (Recent)
- Fluvial sand and gravel (Pleistocene)

Fluvial sand and gravel

5.2.72 Sands and gravels are present between 0.40 to +2.00 mbgl. The gravel consists of angular and sub-angular, fine to medium flint clasts, and the principal gravel unit encountered is moderately well sorted. These units are fluvial and belong to a Pleistocene terrace of the River Wensum.

Modern soil profile

5.2.73 A modern soil profile comprising mid brown sandy silt directly overlay fluvial gravelly sand.

B1147 Crossing

5.2.74 The stratigraphy in the single trial pits at the B1147 crossing (TP117-BR) is listed and summarised below. The specific lithologies and stratigraphic succession encountered in the trial pit are outlined in **Appendix 2**.

5.2.75 The generalised stratigraphic sequence encountered comprises:

- Modern soil profile (Recent)
- Glacio-fluvial sand and gravel (Middle Pleistocene)
- Diamicton (Middle Pleistocene)

Diamicton

5.2.76 The lower most units (0.70 to +2.10 mbgl) consists of grey clays and sandy silt diamict with frequent chalk clasts. This is sub-glacially deposited chalky diamict belonging to the Lowestoft Diamicton Member of the Lowestoft Formation.

Glaciofluvial sand and gravel

5.2.77 The chalky diamict is overlain by 0.40 m of yellowish orange slightly sandy slightly gravelly silt; the gravel is angular sub-rounded flint and quartzite. This gravelly silt is interpreted as glacio-fluvial, deltaic outwash.

Modern Soil Profile

5.2.78 A modern soil profile comprising dark brownish grey slightly sandy slightly gravelly silt forms the top of the sequence.

Mid Norfolk Railway

5.2.79 The stratigraphy in the two trial pits at the Mid Norfolk Railway (TP118-MN and TP119-MN) is listed and summarised below. The specific lithologies and stratigraphic succession encountered in each intervention are outlined in **Appendix 2**.

5.2.80 The generalised stratigraphic sequence encountered comprises:

- Modern soil profile (Recent)
- Diamicton (Middle Pleistocene)

Diamicton

5.2.81 In both trial pits the basal units (c .0.30 to +2.10 mbgl) consist of yellow brown and mottled grey orange sandy clay with frequent chalk clasts. This is sub-glacially deposited chalky diamict belonging to the Lowestoft Diamicton Member of the Lowestoft Formation.

Modern Soil Profile

5.2.82 Mid brown silty clay forming a modern soil profile directly overlies chalky diamict in both trial pits.

Bradenham Lane East

5.2.83 The stratigraphy in the single trial pit at Bradenham Lane East (TP120-BL) is listed and summarised below. The specific lithologies and stratigraphic succession encountered in the trial pit are outlined in **Appendix 2**.

5.2.84 The generalised stratigraphic sequence encountered comprises:

- Modern soil profile (Recent)
- Diamicton (Middle Pleistocene)

Diamicton

5.2.85 Light orange brown and mottled grey orange silty clay diamict with occasional chalk flecks and frequent angular chalk clasts was encountered between 0.70 to +2.00 mbgl. This sub-glacial deposit belongs to the Lowestoft Diamicton Member of the Lowestoft Formation.

Modern Soil Profile

5.2.86 A modern soil profile comprising brown and yellow brown silty clay directly overlies diamict.

Bradenham Lane West

5.2.87 The stratigraphy in the single trial pit at Bradenham Lane West (TP121-BL) is listed and summarised below. The specific lithologies and stratigraphic succession encountered in the trial pit are outlined in **Appendix 2**.

5.2.88 The generalised stratigraphic sequence encountered comprises:

- Modern soil profile (Recent)
- Glacio-fluvial sand and gravel (Middle Pleistocene)

Glacio-fluvial sand and gravel

5.2.89 Fine to coarse slightly gravelly yellow sand, overlain by yellowish brown sandy clay containing angular and sub-angular flint clasts is recorded between 0.90 to +2.00 mbgl. This is interpreted as glaciofluvial outwash gravel.

Modern Soil Profile

5.2.90 A modern soil profile comprising brown sandy clays is recorded at the top of the sequence.

Goggles Lane

5.2.91 The stratigraphy in the single trial pit at Goggles Lane (TP122-GL) is listed and summarised below. The specific lithologies and stratigraphic succession encountered in the trial pit are outlined in **Appendix 2**.

5.2.92 The generalised stratigraphic sequence encountered comprises:

- Modern soil profile (Recent)
- Diamicton (Middle Pleistocene)

Diamicton

5.2.93 Brown, light grey and light-yellow brown sandy and silty clay diamict with frequent chalk and flint clasts is present between 0.50 to +2.00 mbgl. This sub-glacial deposit belongs to the Lowestoft Diamicton Member of the Lowestoft Formation.

Modern Soil Profile

5.2.94 A modern soil profile comprising brown and orange silty clays directly overlay diamict.

Necton

5.2.95 The stratigraphy present in the eight (geo)archaeologically monitored trial pits (TP123-AR – TP130-AR), four (geo)archaeologically monitored soakaways (SA101-AR – SA104-AR) and 15 cable percussion SI logs (BH101-NT – BH115-NT) provided by the SI contractor is listed and summarised below.

5.2.96 The generalised stratigraphic sequence encountered comprises:

- Modern Soil Profile (Recent)
- Glacio-fluvial sand and gravel (Middle Pleistocene)
- Diamicton (Middle Pleistocene)

- Glacio-fluvial sand and gravel (Middle Pleistocene)

Glacio-fluvial sand and gravel

5.2.97 Below 41.84 mOD in BH105-NT light grey gravelly clayey sands is recorded beneath chalky diamict. The gravel component consists of sub-angular and sub-rounded fine to coarse chalk and flint clasts. This is interpreted as deltaic glacio-fluvial outwash.

Diamicton

5.2.98 Diamicton represented by slightly sandy gravelly clay clays is recorded in all trial pits, soakaways and boreholes, and is found between 71.28 to 41.58 mOD. The base of this deposit was only recorded in BH105-NT and is at 41.84 m OD. The upper, weathered units are brown, whilst the lower unweathered units are grey. The gravel content consists of fine to coarse sub-rounded blocky chalk clasts and fine to coarse angular to rounded flint clasts. The diamicton reflects sub-glacial deposition and represents the Lowestoft Diamicton Member of the Lowestoft Formation.

Glacial-fluvial sands

5.2.99 Glacio-fluvial sands and gravels overlie diamicton in 5 boreholes (BH105-NT, BH109-NT-BH112-NT), and is recorded between 69.89 to 67.95 mOD. The glacial-fluvial sand and gravel consists of orangish brown gravelly fine to coarse sand. The gravel component is angular and sub-angular fine to coarse of flint clasts. These sands and gravels were deposited in deltaic fans.

Modern soil profile

5.2.100 Modern soil profiles are found at the top of sequence in all interventions. These comprise greyish brown slightly sand gravelly clay.

5.3 Archaeological evidence

Introduction

5.3.1 Archaeological evidence was only identified in a single trial pit during the archaeological watching brief. This was located at North Walsham Railway (TP107-NW).

North Walsham Railway

5.3.2 A concave flat-bottomed feature with a maximum diameter of 1.00 m and a maximum depth of 0.30 m deep was identified in section in trial pit TR107-NW. It was cut into colluvial silt (Head). It had a uniform fill of dark brownish grey mottled brown and orange, slightly sandy, gravelly silt. Although the fill contained abundant burnt flint, no other artefactual evidence was recovered, and the feature is undated.

5.4 Paleoenvironmental potential

Introduction

5.4.1 Deposits with possible paleoenvironmental potential were identified and sampled at two location during SI monitoring, the Happisburgh Landfall and Lyngate Road.

Happisburgh Landfall

5.4.2 A series of intact UT100 and disturbed bulk samples were taken through deposits at the Happisburgh Landfall (**Table 6**). Sampling was focussed on early Middle Pleistocene alluvial deposits located immediately beneath Happisburgh Diamicton Member (BH120-LF, BH121-LF and UNV-BH405). These are considered to have significant paleoenvironmental potential and may relate to Cromer Forest-Bed Formation (CF-bF) deposits associated with Lower Palaeolithic archaeology and palaeoenvironmental datasets at Happisburgh 1.

5.4.3 The samples taken have the potential to provide palaeoenvironmental evidence indicative of depositional environment, chronology, environment, and landscape conditions. Such paleoenvironmental datasets are key to assessing the lateral extent and geoarchaeological potential of any deposits of the CF-bF which may be present beneath the Happisburgh Landfall.

Table 6 Palaeoenvironmental samples from Happisburgh Landfall

GI Ref.	Sample number	Sample depth	Sample type	Sample size (litres)	Context number	Context	Potential for assessment
BH122-LF	1	14.50	Bulk	7.50	91125	?Marine sand	Medium
BH122-LF	2	15.50	Bulk	5.00	91125	?Marine sand	Medium
BH116-LF	3	18.00-18.45	UT	-	91165	?Marine sand	Medium
BH116-LF	4	19.50-20.00	Bulk	6.00	91165	?Marine sand	Medium
BH123-LF	5	12.50-12.95	UT	-	91238	Happisburgh Diamicton	Low
BH123-LF	6	15.50-15.95	UT	-	91238	?Happisburgh Diamicton	Low
BH123-LF	7	17.00-17.45	UT	-	91239	?Marine sand	Medium
BH123-LF	8	17.80	Bulk	10.00	91239	?Marine sand	Medium
BH123-LF	9	18.80	Bulk	10.00	91239	?Marine sand	Medium
BH123-LF	10	19.00-19.45	UT	-	91239	?Marine sand	Medium
BH117-LF	11	12.25-12.75	UT	-	91178	?Marine sand	Medium
BH117-LF	12	13.50	Bulk	8.00	91178	?Marine sand	Medium
BH117-LF	13	14.50	Bulk	6.00	91178	?Marine sand	Medium
BH117-LF	14	15.00-15.45	UT		91179	?Marine sand	Medium
BH117-LF	15	16.50	Bulk	10.00	91179	?Marine sand	Medium
BH120-LF	16	10.75-11.20	UT		91206	?Alluvial sand	Medium
BH120-LF	17	13.50-13.95	UT		92107	?Alluvial sand	Medium
BH120-LF	18	15.50-15.95	UT	-	91208	?Alluvial sand	Medium
BH120-LF	19	17.50-17.95	UT	-	912010	?Marine sand	Medium
BH121-LF	20	10.50-10.95	UT	-	91217	?Alluvial sand	Medium
BH121-LF	21	11.40	Bulk	4.00	91218	?Alluvial silt and sand	High

BH121-LF	22	12.50-12.95	UT	-	91218	?Alluvial silt and sand	High
BH121-LF	23	13.00	Bulk	0.10	91218	?Alluvial silt and sand	Low
BH121-LF	24	13,50-13.95	UT	-	91219	?Alluvial/marine silt and sand	Medium
BH121-LF	25	14.50-14.95	UT	-	91219	?Alluvial/marine silt and sand	Medium
UNV-BH405	1		Bulk		40505	Corton Diamicton	Low
UNV-BH405	2		Bulk		40506	?Happisburgh Sand	Low
UNV-BH405	3		Bulk		40506	?Happisburgh Sand	Low
UNV-BH405	4		Bulk		40507	?Happisburgh Diamicton	Low
UNV-BH405	5		Bulk		40508	Alluvial/estuarine clay, silt and sand	High
UNV-BH405	6		Bulk		40509	?Marine sand	Medium
UNV-BH405	7		Bulk		40509	?Marine sand	Medium
UNV-BH405	8		Bulk		40510	Marine Sand	Medium
UNV-BH405	9		Bulk		40510	Marine Sand	Medium
UNV-BH405	10		Bulk		405087	Alluvial/estuarine clay, silt and sand	High

5.4.4 Intact UT100 and disturbed bulk samples were also taken through deposits located immediately beneath Happisburgh diamicton which, based on lithostratigraphy, have been interpreted as marine sands of the Wroxham Crag (BH116-LF, BH117-LF, BH121-LF and BH125-LF, UNV-BH405). Given the equivocal lithostratigraphic separation between these deposits and the possible stratigraphically later alluvial units, these samples have significant potential for assessment (particularly micro-paleontological) aimed at distinguishing between marine deposits of the Wroxham Crag and potential alluvial deposits. This is key to delimiting the lateral extent of CF-bF deposits beneath the Happisburgh Landfall.

Lyngate Road

5.4.5 Three bulk samples were taken through peat deposits in TP105-LR at Lyngate Road (**Table 7**). One (sample 26) was recovered from the base of the modern soil profile and has low palaeoenvironmental potential. The remaining two samples were taken from the top and base of the peat. Bulk samples taken through peat lack suitable stratigraphic integrity and are not ideal for palaeoenvironmental assessment. However, assessment of a small number of targeted sub-samples can provide a crude indicator of the preservation of key botanical remains (e.g. pollen and plant macrofossils) and a guide to the potential of the deposits for future work, where appropriate.

Table 7 Palaeoenvironmental samples from Lyngate Road

GI Ref.	Sample number	Sample depth	Sample type	Sample size (litres)	Context number	Context	Potential for assessment
TP105-LR	26	0.60	Bulk	2.00	1052	Modern soil profile	Low
TP105-LR	27	0.80	Bulk	2.00	1053	Top of peat	Medium
TP105-LR	28	1.05	Bulk	2.00	1053	Based of peat	Medium

5.5 Dating potential

Introduction

5.5.1 Quaternary deposits with dating potential were identified at three locations – the Happisburgh Landfall, Elsing Lane and Lyngate Road.

Happisburgh Landfall

5.5.2 The deposits identified at the Happisburgh Landfall site do not have direct dating potential. However, should the potential alluvial deposits contain palaeoenvironmental evidence, this may include material that date the deposits through biostratigraphy, particularly through comparison to datasets from Happisburgh 1.

Elsing Lane

5.5.3 Sand units present within fluvial sand and gravel in TP116-EL are likely to be suitable for Optically Stimulated Luminescence (OSL) dating. No samples were taken during monitoring as the deposits were not directly accessible.

Lyngate Road

5.5.4 Bulk samples taken through the peat at Lyngate Road may contain short-lived terrestrial plant material suitable for AMS radiocarbon dating.

5.6 Discussion

5.6.1 Monitoring of SI works across the proposed cable routes has identified deposits divisible into three groups: Pleistocene marine, alluvial and glaciogenic deposits at the Happisburgh Landfall; glaciogenic deposits present across the routes; Pleistocene terrace deposits of the River Wensum at Elsing Lane, and Holocene peat and alluvial deposits at Lyngate Road. Additionally, although not investigated during monitored SI works, Holocene alluvial deposits are recorded by the BGS at three other locations along the proposed cable routes – River Wensum Crossing, River Bure Crossing, Wendling Carr, and Stream Crossing, Necton (see **Figures 5–7**).

5.6.2 These deposits and their geoarchaeological potential are discussed below.

5.7 Happisburgh Landfall site

Introduction

5.7.1 Monitoring of SI works has revealed a sequence of Quaternary deposits at the Happisburgh Landfall. These deposits comprise early Pleistocene marine deposits, potentially overlain in places by early Middle Pleistocene alluvial deposits and thick sequences of Middle Pleistocene glaciogenic deposits.

Deposit modelling

5.7.2 In order to consider the distribution of Pleistocene deposits across the Landfall, the stratigraphic data obtained from the SI monitoring, along with data from previous SI works (WA 2018) and the results of the extensive investigations at Happisburgh 1 (Lewis et al. 2019) was entered into Rockworks™ 17 to create projected cross sections through the deposits. Data coverage is generally good, although given the complexity of the deposits present beneath the glaciogenic deposits (possible alluvial deposits and marine sand), coverage is not sufficient to accurately map the lateral extent of the potential alluvial deposits of the CF-bF. Five cross-sections (see **Figure 8** for locations) have been produced.

5.7.3 Cross-Section 1 (**Figure 9**) reproduces data from Lewis et al. (2019) to illustrate the deposits identified at Happisburgh 1 in relation to those in UNV-BH405. At Happisburgh 1, freshwater, early Middle Pleistocene deposits (upper grey sands and Low Lighthouse Member) of the Cromer Forest Bed Formation (CF-bF) are within a channel and are directly and consistently overlain by diamict of the Happisburgh Diamicton Member of the Happisburgh Formation. Glacio-lacustrine deposits of the Ostend Clay Member and glacio-fluvial deltaic deposits of the Happisburgh Sand Member. It should be noted that division between the upper, freshwater grey sands and lower, marine sands is not defined by Lewis et al. (2019) as the specific lithostratigraphic boundary between these units is not clear. Potential alluvial/estuarine deposits were identified in UNV-BH405. These may also broadly relate to the Cromer Forest Bed Formation (CF-bF) but may not be directly equivalent to those at Happisburgh 1.

5.7.4 Cross-Sections 2 and 3 (**Figures 10–11**) illustrate the stratigraphic relations between the Happisburgh 1 deposits (Lewis et al. 2019) and the possible alluvial deposits identified in BH120-LF, BH121-LF and UNV-BH405 during SI monitoring. These demonstrate that the possible alluvial deposits in BH120-LF and BH121-LF are in the same stratigraphic position and broadly at the same elevation as the freshwater deposits (upper grey sands and Low Lighthouse Member) at Happisburgh 1. This would support stratigraphic correlation and indicates that these possible alluvial deposits may belong to the CF-bF. The data also suggests that laminated silts/silty sands in BH120-LF and BH121-LF may be equivalent. Conversely, although the deposits as a whole in the area of UNV-BH405, the esturine/alluvial deposits identified in UNV-BH405 may not be directly equivalent with the Happisburgh 1 sequence.

5.7.5 Cross-Sections 4 and 5 (**Figures 12–13**) show the relationship between deposits across the Landfall site recorded in SI investigations. They suggest that south east of BH120-LF the possible alluvial deposits may be absent, with grey and brown sands interpreted as marine sands of the Wroxham Crag directly underlying glaciogenic deposits. However, given the equivocal lithostratigraphic relationship between grey marine and grey alluvial sands at Happisburgh 1, it cannot be excluded that upper parts of the dark grey to brown sands identified as marine in boreholes south-east of BH120-LF contain depositional and stratigraphic equivalents of the possible alluvial deposits.

5.7.6 Cross-Sections 4 and 5 additionally demonstrate that in the south east of the Landfall site (BH17-L1B-04 and BH118-LF) glacio-genic deposits thicken and drop to more than -8.0 mOD. This likely corresponds to a marked dip in the glaciogenic deposits identified in cliff sections, which has been interpreted as due to glaciotectonic deformation (Hart 1999, Hart and Boulton, 1991), a syncline (Lee 2003) or the result of solution in the underlying chalk resulting in the collapse of the overlying sediments (Lewis at al. 2019). The data from the Happisburgh Landfall and previous SI investigations further south at Happisburgh L1-A (WA 2018) suggests an extensive sequence of glaciogenic deposits are infilling this feature.

Wroxham Crag

5.7.7 Dark grey and brown sand interpreted as marine was identified in boreholes across the Landfall site. This likely belongs to the Wroxham Crag (2.4->0.6 MA). However, as the lithostratigraphic separation between these marine sands and freshwater sands identified at Happisburgh 1 is unclear, in the absence of other evidence (particularly micro-fossils and potentially detailed minerology), it cannot be excluded that the upper parts of these sands may include later alluvial deposits. Marine sands of the Wroxham Crag have low geoarchaeological and archaeological potential.

Possible alluvial/esturine deposits

5.7.8 Possible alluvial deposits containing organic material were identified in BH120-LF and BH121-LF in the north east part of the site. They consist of laminated clayey silty sand over coarser gravelly sands. This lithological change may reflect a transition from more active fluvial deposition to an alluvial floodplain environment. These may be the stratigraphic equivalent to the upper grey sand and organic mud of the Low Lighthouse Member of the Cromer Forest Bed Formation (CF-bF) at Happisburgh 1. They may represent the continuation of the channel identified at Happisburgh 1. The data suggests that these alluvial deposits may have been largely cut out by glaciogenic deposits further south east of BH120-LF and BH121-LF. The possible alluvial deposits are overlain by diamict of the Happisburgh Diamicton Member of the Happisburgh Formation, and therefore predate MIS 12 (>478-424 Ka).

5.7.9 Potential alluvial clays, silts and sand containing organic material were identified beneath glaciogenic deposits in UNV-BH405. As a whole, the deposits in this area are dipping to the south and their specific relationship to the Happisburgh 1 sequence is currently difficult to determine with certainty. However, their stratigraphic position and depth suggests that they may belong to a separate set of deposits from those at Happisburgh 1 and BH120-LF and BH121-LF.

5.7.10 The possible alluvial/estuarine deposits in BH120-LF, BH121-LF and UNV-BH405 have high geoarchaeological potential and may contain a range of palaeoenvironmental remains (e.g. microfossils, pollen, and plant macrofossils) informing on past physical vegetation and environmental change. The material they contain may also enable the relationships between these deposits and with those at Happisburgh 1 to be determined. If they include deposits that are stratigraphically equivalent to those at Happisburgh 1, they also have the potential to be associated with significant Lower Palaeolithic archaeology; such archaeology is likely to be low density but internationally significant.

Glaciogenic deposits

5.7.11 Glaciogenic deposits have been identified across the Landfall site. These equate to Happisburgh Formation and Corton Formations. Units identified include sub-glacial deposits of the Happisburgh Diamicton and Corton Diamicton Members, glacio-lacustrine deposits of the Ostend Clay Member and deltaic glacio-fluvial deposits of Happisburgh Sand and Corton Sand Members. Glaciofluvial outwash deposits are more extensive in interventions in the south east of the site, where they appear to be dipping into and infilling a depression, which may be due to glaciotectonic deformation (Hart 1999, Hart and Boulton, 1991), a syncline (Lee 2003) or the result of solution in the underlying chalk resulting in the collapse of the overlying sediments (Lewis at al. 2019). The Happisburgh and Corton Formations are thought to reflect changes in glaciogenic deposition during the Anglian glaciation (MIS 12; 478-424 Ka). These glaciogenic deposits have generally low geoarchaeological and archaeological potential.

5.8 Glaciogenic deposits

5.8.1 Glaciogenic deposits, generally directly overlain by a modern soil profile, were identified across the proposed cable routes, at the proposed substation locations at Necton. **Table 8** summarises this data. These glaciogenic deposits reflect varying modes of glaciogenic deposition. They include sub-glacial deposits laid down beneath an ice sheet, glaciolacustrine deposits and glacio-fluvial outwash gravels deposited in deltaic fans beyond the ice margin. The units encountered can be related to three formations of the East Anglian glacial stratigraphy. Following the nomenclature of Lee et al. (2017) these are the Happisburgh Formation, Sheringham Cliffs Formation, Lowestoft Formation and Briton's Lane Formation. All these deposits are likely to principally date to the Anglian glaciation (MIS 12; 478-424 Ka) and have generally low geoarchaeological and archaeological potential.

Table 8 Summary of glaciogenic deposits in SI interventions

GI Ref.	Formation	Depth range (mbgl)	Overlain by
BH116-LF	Happisburgh	0.90-16.60	Modern soil profile
BH117-LF	Happisburgh	1.20-12.20	Modern soil profile
BH118-LF	Happisburgh	1.20-19.65+	Modern soil profile
BH119-LF	Happisburgh	0.90-12.50	Modern soil profile
BH120-LF	Happisburgh	1.10-10.60	Modern soil profile
BH121-LF	Happisburgh	1.30-10.30	Modern soil profile
BH122-LF	Happisburgh	0.90-13.70	Modern soil profile
BH123-LF	Happisburgh	0.70-16.60	Modern soil profile
TP101-WG	Happisburgh	1.20-2.00+	Modern soil profile
TP102-HR	Happisburgh	1.20-2.00+	Modern soil profile
TP103-WB	Happisburgh	0.50-2.00+	Modern soil profile
TP104-WH	Briton's Lane	0.70-2.00+	Modern soil profile
TP106-NW	?Happisburgh	1.10-2.20+	?Colluvial silt (Head)
TP107-NW	Briton's Lane	1.30-2.20+	?Colluvial silt (Head)
TP108-SF	?Happisburgh	0.30-2.00+	Modern soil profile
TP109-CR	Briton's Lane	0.40-2.00+	Modern soil profile
TP110-AH	Briton's Lane	0.50-2.10+	Modern soil profile
TP111-HS	Sheringham Cliffs	0.85-2.05+	Modern soil profile
TP112-HS	Sheringham Cliffs	0.40-2.10+	Modern soil profile
TP113-HS	Sheringham Cliffs	0.45-2.00+	Modern soil profile
TP114-KR	Sheringham Cliffs	0.80-2.00+	Modern soil profile
TP115-JR	Sheringham Cliffs	0.25-2.10+	Modern soil profile
TP117-BR	Lowestoft	0.70-2.10+	Glacio-fluvial sand and gravel
TP118-MN	Lowestoft	0.30-2.00+	Modern soil profile
TP119-MN	Lowestoft	1.00-2.00+	Modern soil profile
TP120-BL	Lowestoft	0.70-2.00+	Modern soil profile
TP121-BL	Lowestoft	0.90-2.00+	Modern soil profile
TP122-GL	Lowestoft	0.50-2.00+	Modern soil profile
BH101-NT	Lowestoft	0.80-30.00+	Modern soil profile
BH102-NT	Lowestoft	0.30-30.00+	Modern soil profile

BH103-NT	Lowestoft	0.80-30.00+	Modern soil profile
BH104-NT	Lowestoft	0.80-30.00+	Modern soil profile
BH105-NT	Lowestoft	1.40-28.40	Glacio-fluvial sand and gravel
BH106-NT	Lowestoft	0.40-10.00+	Modern soil profile
BH107-NT	Lowestoft	0.30-10.00+	Modern soil profile
BH108-NT	Lowestoft	0.60-10.00+	Modern soil profile
BH109-NT	Lowestoft	1.20-10.00+	Glacio-fluvial sand and gravel
BH110-NT	Lowestoft	1.50-10.00+	Glacio-fluvial sand and gravel
BH111-NT	Lowestoft	1.00-10.00+	Glacio-fluvial sand and gravel
BH112-NT	Lowestoft	0.65-10.00+	Glacio-fluvial sand and gravel
BH113-NT	Lowestoft	0.40-10.00+	Modern soil profile
BH114-NT	Lowestoft	1.00-10.00+	Glacio-fluvial sand and gravel
BH115-NT	Lowestoft	0.70-10.05+	Modern soil profile
TP123-AR	Lowestoft	0.65-2.00+	Modern soil profile
TP124-AR	Lowestoft	0.30-2.00+	Modern soil profile
TP125-AR	Lowestoft	0.60-2.00+	Modern soil profile
TP126-AR	Lowestoft	0.35-2.10+	Modern soil profile
TP127-AR	Lowestoft	0.30-2.00+	Modern soil profile
TP128-AR	Lowestoft	0.50-2.00+	Modern soil profile
TP129-AR	Lowestoft	0.60-2.00+	Modern soil profile
TP130-AR	Lowestoft	0.60-2.00+	Modern soil profile
SA101-AR	Lowestoft	0.35-3.00+	Modern soil profile
SA102-AR	Lowestoft	0.50-3.00+	Modern soil profile
SA103-AR	Lowestoft	0.70-3.00+	Modern soil profile
SA104-AR	Lowestoft	0.50-3.00+	Modern soil profile

5.9 Pleistocene terraces of the River Wensum – Elsing Lane

5.9.1 A trial pit at Elsing Lane (TR116-EL) identified +1.40 mbgl of fluvial sands and gravels overlain by a modern soil profile. These sands and gravels are Pleistocene and belong to a terrace of the River Wensum.

5.9.2 These deposits are mapped by the BGS (online viewer) as Terrace 1 of the Wensum. These terrace deposits likely accumulated at some point within the Ipswichian (MIS 5e; 123-111 kya) and Devensian (MIS 5d-2; 111-11.7 Kya).

5.9.3 Elsing Lane is located approximately 3 km south west of gravel pits at Swanton Morley, where deposits mapped as Terrace 1 of the River Wensum produced rich pollen, plant macro-fossils, non-marine molluscs and vertebrate remains of Ipswichian age (MIS 5e; 123-109 kya) from alluvial muds, silts sands and brecciated clays at the base of the sequence. These basal deposits were overlain by fluvial sands and gravels that themselves produced cold stage Devensian vertebrate remains (Coxon et al. 1980).

5.9.4 Only the top of a fluvial sequence was encountered in TR116-EL, and the sands and gravels encountered had generally low geoarchaeological potential. However, the evidence from Swanton Morley indicates that the fluvial sequence at Elsing Lane may have significant potential. These fluvial deposits also have broad potential to preserve Palaeolithic archaeology. Known Palaeolithic findspots (Wymer 1999) associated with these deposits include two handaxes from a gravel pit 366m north of St. Margret's Church, Lyng (606700, 318200), 1.1 km east of Elsing Lane, and a further handaxe from Inne and Co's Pit at Lenwade Mill, Great Witchingham (607600, 317900) located 2km east of Elsing Lane. No artefacts were recovered from terrace deposits in TR116-EL.

5.10 Holocene alluvium – Lyngate Road, River Wensum, River Bure, Wendling Carr, and Stream Crossing, Necton

5.10.1 SI monitoring identified fibrous peat deposits 0.40 m thick directly beneath a modern soil profile in TR105-LR at Lyngate Road. This overlies alluvial silts, sands, and gravels. The sequence reflects a transition from active fluvial deposition to a more stable wetland environment.

5.10.2 The peat and alluvial deposits at Lyngate Road are located along the margins of a now canalised stream draining into an abandoned section of North Walsham and Dilham Canal. The canal was constructed in 1825 to canalise and make navigable the River Ant upstream of Dilham. Prior to being canalised the tributary stream associated with the peat and alluvial deposits would have been a natural tributary draining into the upper reaches of the River Ant.

5.10.3 Previous SI monitoring (WA 2018) along the proposed cable routes at the River Wensum crossing (BH17-C3-02, Crossing 3 – River Wensum) also identified a Holocene pseudo-fibrous peat at 0.15 to 1.70 mbgl.

5.10.4 Peat deposits are geoarchaeologically significant as a source of information on past vegetation, landscape change and land-use. Isolated peat deposits preserved within minor river valleys have tended to be overlooked in favour of more expansive bed, for example such as those preserved in the Fenlands and long palaeoenvironmental sequences preserved in meres (e.g. Bennett 1983, Peglar 1993). However, river valleys contain important palaeoenvironmental archives and evidence of the dynamic nature of past riverine wetland environments.

5.10.5 No peats associated with alluvial deposits are currently known from areas along the along the proposed cable routes at the River Bure, Wendling Carr, and Stream Crossing, Necton. However, the limited data coverage from these areas means that the presence of peat cannot be excluded.

5.10.6 Alluvium is present at five locations along the routes, Lyngate Road, River Wensum, River Bure, Wendling Carr, and Stream Crossing, Necton. Minerogenic alluvial deposits have a low geoarchaeological potential. Palaeoenvironmental remains are likely to be preserved in the alluvium, but these will invariably be fluvially transported from within the catchment and therefore representative of a potentially large and uncertain source area. Alluvium also lacks material suitable for radiocarbon dating. Such alluvial deposits do, however, have general potential to contain or bury archaeology.

6 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

6.1.1 Geoarchaeological monitoring of cable percussion boreholes and trial pits has established the nature of the geoarchaeological resource present in SI locations across the proposed cable routes. This comprises sequences of Pleistocene and Holocene sediments summarised below, with a statement on their geoarchaeological and archaeological significance outlined in **Tables 9–11**.

Happisburgh Landfall

6.1.2 The following deposits were identified at the Happisburgh Landfall:

- **Marine sands (Wroxham Crag)**: deposited in shallow marine environment during the early Pleistocene (2.4–>0.6 MYA). Stratigraphic separation between the upper part of these sands and overlying possible alluvial deposits is tentative.
- **Possible alluvial/estuarine deposits (?Cromer Forest Bed Formation)**: these clays, silts, sands and gravels contain organic material and were identified in BH120-LF, BH121-LF and UNV-BH405. Based on lithology, these deposits are interpreted as reflecting alluvial and/or estuarine deposition. The deposits in BH120-LF and BH121-LF are potentially stratigraphically equivalent with early Middle Pleistocene (MIS 13; 524–478 Ka) upper grey sands and organic muds of the Low Lighthouse Member (Lewis et al. 2019) of the Cromer Forest Bed Formation (CF-bF). The sediments in UNV-BH405 may potentially relate to a separate Pleistocene sequence associated with the CF-bF.
- **Glaciogenic deposits (Happisburgh Formation):** glaciogenic deposits consisting of sub-glacial diamicton (Happisburgh Diamicton Member), glacio-lacustrine sediments (Ostend Clay Member) and deltaic glacio-fluvial sands and gravels (Happisburgh Sand Member). These reflect changing deposition during the earlier part of the Anglian glaciation (MIS 12; 478–424 Ka).

6.1.3 The geoarchaeological and archaeological potential of these deposits are summarised in **Table 9.**

Table 9 Geoarchaeological and archaeological potential of deposits at Happisburgh Landfall

Deposit	Formation / age	Geoarchaeological potential	Archaeological potential
Marine sands (Wroxham Crag)	Shallow marine environment. Early Pleistocene (2.4->0.6 MA)	Low; however, have significant potential to preserve microfossils. Micro-fossils and, possibly minerology, may allow the upper units of Wroxham Crag to be distinguished from alluvial freshwater deposits of CF-bF	Low
Possible alluvial/estuarine deposits (?Cromer Forest Bed Formation)	Alluvial freshwater or brackish water estuarine environment ?Early Middle Pleistocene (MIS 13; 524–478 Ka)	High (evidence for past environment, climate, and local and regional landscapes)	?Medium-High (possible potential for low density but highly significant Lower Palaeolithic archaeology
Glaciogenic deposits	Sub-glacial, glacio-lacustrine, and deltaic.	Low	Low

	Middle Pleistocene (MIS 12; 478-424 Ka)		

Glaciogenic deposits

6.1.4 Glaciogenic deposits are present across the proposed cable routes, extending from the Happisburgh Landfall to the proposed Necton substations. These reflect different glaciogenic depositional environments, including sub-glacial, glacio-lacustrine, and deltaic outwash fans. They can be related to four formations of the northern East Anglian glacial stratigraphy (Happisburgh Formation, Sheringham Cliffs Formation, Lowestoft Formation and Briton's Lane) and date to the Anglian glaciation (MIS 12; 478–424 Ka).

6.1.5 The geoarchaeological and archaeological potential of these deposits are summarised in **Table 10**.

Table 10 Geoarchaeological and archaeological potential of glaciogenic deposits in SI interventions

Deposit	Formation / age	SI interventions	Geoarchaeological potential	Archaeological potential
Briton's Lane Formation	Deltaic and sub-glacial. Middle Pleistocene (MIS 12; 478–424 Ka)	TP104-WH; TP107-NW; TP109-CR; TP110-AH	Low	Low
Lowestoft Formation	Sub-glacial and marginal deltaic. Middle Pleistocene (MIS 12; 478–424 Ka)	BH101-NT – BH123-NT; TP117-BR; TP118-MN – TP119-MN; TP120-BL – TP121-BL; TP122-GL; TP123-AR – TP130-AR; SA101-AR – SA104-AR	Low	Low
Sheringham Cliffs Formation	Deltaic, glacio-lacustrine and sub-glacial. Middle Pleistocene (MIS 12; 478–424 Ka)	TP111-HS – TP113-HS; TP114-KR; TP115-JR	Low	Low
Happisburgh Formation	Deltaic, glacio-lacustrine and sub-glacial. Middle Pleistocene (MIS 12; 478–424 Ka)	BH116-LF – BH123 LF; TP101-WG; TP102-HR; TP103-WB;? TP106-NW; ?TP108-SF	Low	Low

Pleistocene terraces of the River Wensum – Elsing Lane

6.1.6 The following deposits were identified in TP116-EL at Elsing Lane:

- **Fluvial sands and gravels (Terrace 1, River Wensum)**: Pleistocene fluvial deposits of the River Wensum. Biostratigraphic evidence from upstream at Swanton Morley indicates that these fluvial deposits may include deposits of Ipswichian (MIS 5e; 123-109 kya) and Devensian (MIS 5d-2; 111–11.7 kya) date.

6.1.7 The geoarchaeological and archaeological potential of these deposits are summarised in **Table 11**.

Table 11 Geoarchaeological and archaeological potential of deposits at Elsing Lane

Deposit	Formation / age	Geoarchaeological potential	Archaeological potential
Fluvial sands and gravel (Terrace 1, River Wensum)	Active river channel and alluvial floodplain. Upper Pleistocene (MIS 5e-2; 123-11.7 kya)	Unknown. Broadly equivalent deposits at Swanton Morley which are demonstrated to have high potential (evidence for past environment, climate, and local and regional landscapes)	Unknown. Broadly equivalent deposits demonstrated to contain Palaeolithic archaeology. Palaeolithic archaeology could be reworked and/or minimally disturbed

Holocene alluvium – Lyngate Road, River Wensum, River Bure, Wendling Carr, and Stream Crossing, Necton

6.1.8 The following deposits were identified in TP105-LR at Lyngate Road:

- **Alluvium:** minerogenic alluvium underlies the peat, reflecting an active Holocene floodplain environment within a tributary of the River Ant.
- **Peat:** forming in a stable riparian wetland environment likely to include a range of herb-swamp and wet woodland habitats.

6.1.9 Previous SI monitoring (WA 2018) has identified similar peat deposits at the River Wensum crossing. Alluvium is also likely to present at the River Wensum and River Bure crossings, Wendling Carr and Stream Crossing, Necton.

6.1.10 The geoarchaeological and archaeological potential of these deposits are summarised in **Table 12**.

Table 12 Geoarchaeological and archaeological potential of deposits at Elsing Lane

Deposit	Formation / age	Geoarchaeological potential	Archaeological potential
Alluvium: Lyngate Road (tributary of River Ant); River Wensum Crossing; River Bure Crossing; Wendling Carr; Stream Crossing, Necton	Active alluvial floodplain. Holocene (<11.7 kya).	Low	Unknown. Potential to seal archaeology
Peat: Lyngate Road (tributary of River Ant); River Wensum	Stable riparian wetland. Holocene (<11.7 kya).	High (evidence for past environment, climate, and human land-use)	Unknown. Possibly highly dependent on age of peat (may preserve waterlogged archaeology)

6.2 Recommendations

6.2.1 Geoarchaeological and archaeological monitoring of SI works has enabled the geoarchaeological and archaeological potential of deposits encountered to be assessed. Based on the results of this assessment recommendations regarding potential requirements for, and methods of, any further geoarchaeological and archaeological investigations.

Happisburgh Landfall

6.2.2 Stage 3 (see **Table 2**) palaeoenvironmental assessment of samples taken during SI monitoring is recommended. This will enable the presence/absence of Cromer Forest Bed Formation (CF-bF) deposits to be established and their palaeoenvironmental potential to be assessed.

6.2.3 Assessment should include samples taken from postulated marine sands of the Wroxham Crag to clearly define the stratigraphic separation between marine sands of the Wroxham Crag, and potential alluvial freshwater deposits of the CF-bF. This may also enable areas of the Landfall site to be delimited where CF-bF deposits are present and absent.

6.2.4 Recommendations for sample assessment are outlined in **Table 13**.

Table 13 Recommendations for sample assessment, Happisburgh Landfall

GI Ref.	Sample number	Sample type	Context	Potential for assessment	Selected for assessment?	Assess for
BH122-LF	1	Bulk	?Marine sand	Medium		Micropal.; Sedimentology
BH122-LF	2	Bulk	?Marine sand	Medium		Micropal.; Sedimentology
BH116-LF	3	UT	?Marine sand	Medium		Micropal.; Sedimentology
BH116-LF	4	Bulk	?Marine sand	Medium		Micropal.; Sedimentology
BH123-LF	5	UT	Happisburgh Diamicton	Low	No	-
BH123-LF	6	UT	?Happisburgh Diamicton	Low	No	-
BH123-LF	7	UT	?Marine sand	Medium		Micropal.; Sedimentology
BH123-LF	8	Bulk	?Marine sand	Medium		Micropal.; Sedimentology
BH123-LF	9	Bulk	?Marine sand	Medium		Micropal.; Sedimentology
BH123-LF	10	UT	?Marine sand	Medium		Micropal.; Sedimentology
BH117-LF	11	UT	?Marine sand	Medium		Micropal.; Sedimentology
BH117-LF	12	Bulk	?Marine sand	Medium		Micropal.; Sedimentology
BH117-LF	13	Bulk	?Marine sand	Medium		Micropal.; Sedimentology

BH117-LF	14	UT	?Marine sand	Medium		Micropal.; Sedimentology
BH117-LF	15	Bulk	?Marine sand	Medium		Micropal.; Sedimentology
BH120-LF	16	UT	?Alluvial sand	Medium		Micropal.; Sedimentology
BH120-LF	17	UT	?Alluvial sand	Medium		Micropal.; Sedimentology
BH120-LF	18	UT	?Alluvial sand	Medium		Micropal.; Sedimentology
BH120-LF	19	UT	?Marine sand	Medium		Micropal; Sedimentology
BH121-LF	20	UT	?Alluvial sand	Medium		Micropal. Pollen; Plant macros Molluscs; Vertebrates;
BH121-LF	21	Bulk	?Alluvial silt and sand	**High**		Micropal. Pollen; Plant macros Molluscs; Vertebrates
BH121-LF	22	UT	?Alluvial silt and sand	**High**		Micropal. Pollen; Plant macros Molluscs; Vertebrates
BH121-LF	23	Bulk	?Alluvial silt and sand	Low	No	-
BH121-LF	24	UT	?Alluvial/marine silt and sand	Medium		Micropal. ?Pollen; ?Plant macros ?Molluscs; ?Vertebrates
BH121-LF	25	UT	?Alluvial/marine silt and sand	Medium		Micropal. ?Pollen; ?Plant macros ?Molluscs; ?Vertebrates

6.2.5 Based on the results of the Stage 3 assessment, further targeted geoarchaeological boreholes may be required to delimit deposits of the Cromer Forest Bed Formation (CF-bF), to establish the extent of specific units and to take further palaeoenvironmental samples.

6.2.6 Given the depth of these deposits (10.00-10.60 mbgl) no direct archaeological evaluation is possible.

Glaciogenic deposits

6.2.7 Anglian glaciogenic deposits are present across the cable routes. These have generally low geoarchaeological and archaeological potential. No further geoarchaeological or archaeological investigations of these deposits are likely to be required.

Pleistocene terraces of River Wensum

6.2.8 Upper Pleistocene terrace deposits of the River Wensum were identified at Elsing Lane. The potential of these specific deposits is currently unknown but comparison to broadly equivalent deposits in area suggests that they may have some Pleistocene geoarchaeological and Palaeolithic archaeological potential. Sand units within these deposits are also suitable for luminescence dating, which may allow any significant archaeological or geoarchaeological evidence to be dated.

6.2.9 It is also recommended that full and further specialist review of the results of and reports from the previous phases of engineering-led SI for the Projects be undertaken to better understand and establish the level of this potential. This should be supplemented by consideration of results of archaeological evaluation trial trenching undertaken by Headland Archaeology in 2020/21; although restricted in their depth, c. 20-25 archaeological trial trenches were undertaken in the wider vicinity of the River Wensum. It is anticipated that construction related HDD pits either side of the Wensum may also form a later focus and provide a potential opportunity to assess Pleistocene deposits at this location.

Holocene alluvium – Lyngate Road, River Wensum, River Bure, Wendling Carr, and Stream Crossing, Necton

6.2.10 Holocene alluvium is present at several locations along the proposed cable routes. These alluvial deposits may have the potential to seal Holocene archaeological evidence, potentially covering multiple periods.

Table 14 Recommendations for sample assessment, Lyngate Road

GI Ref.	Sample number	Sample type	Context	Potential for assessment	Selected for assessment?	Assess for
TP105-LR	26	Bulk	Modern soil profile	Low	No	-
TP105-LR	27	Bulk	Top of peat	Medium	Yes	Pollen; Plant macros AMS radiocarbon dating.
TP105-LR	28	Bulk	Based of peat	Medium	Yes	Pollen; Plant macros AMS radiocarbon dating.

6.2.11 Again full and further review of the results of and reports from the previous phases of engineering-led SI for the Projects is recommended to better understand and establish the level of this potential. The results of archaeological evaluation trial trenching undertaken by Headland Archaeology in 2020/21 should also be considered as part of this review. The data from the following trial trenches could be considered as part of this review:

- 3 archaeological trial trenches undertaken in the wider vicinity of Lyngate Road;
- 25 archaeological trial trenches undertaken in the wider vicinity of the River Wensum;

- 15 archaeological trial trenches undertaken in the wider vicinity of the River Bure;
- 8 archaeological trial trenches undertaken in the wider vicinity of Wendling Carr; and
- 7 archaeological trial trenches undertaken either side of Stream Crossing, Necton.

6.2.12 It is also anticipated that construction related HDD pits either side of the River Wensum, River Bure and Wendling Carr may also form a later focus and provide a potential opportunity for assessing the Holocene deposits present at these locations.

Peats within alluvium

6.2.13 Peats preserved within these alluvial sequences have significant potential to provide paleoenvironmental evidence for changing Holocene environment, climate, and human land-use practices. Monitoring of SI works has established peats are present at Lyngate Road, within a tributary of the River Ant, and at the River Wensum crossing (WA 2018). Bulk samples were obtained from the top and bottom of the peat at Lyngate Road. These bulk samples may contain short-lived terrestrial plant material suitable for AMS radiocarbon dating. Stage 3 (see **Table 2**) palaeoenvironmental assessment (e.g. pollen and plant macrofossils) of these samples is recommended (**Table 14**) to assess potential, attempt to establish their age and direct the need for and scope of further geoarchaeological investigations.

6.2.14 Peats may also be present at other locations along the cable routes where alluvial deposits occur. To investigate this possibility, and to establish the potential of any peat, in the first instance it is recommend that full and further review of the results of and reports from the previous phases of engineering-led SI for the Projects be undertaken, augmented with consideration of the results of archaeological evaluation trial trenching carried out by Headland Archaeology in 2020/21.

Summary of recommendations

6.2.15 Stage 3 (see **Table 2**) palaeoenvironmental assessment of samples taken during SI monitoring at the Happisburgh Landfall and Lyngate Road is recommended. Additionally, it is suggested that full and further specialist review of the results of and reports from the previous phases of engineering-led SI for the Projects be undertaken to better understand and establish the archaeological and geoarchaeological potential of Quaternary deposits at Lyngate Road, River Wensum, River Bure, Wendling Carr, and Stream Crossing, Necton

6.2.16 Any further requirements / subsequent recommendations for justified and proportionate targeted geoarchaeological-specific site interventions, such as additional targeted test pits and/or boreholes, outside of the engineering-led works, will be determined following the completion and reporting of the initial exercises as described above. This is in line with the Outline Written Schemes of Investigation for both Projects where by there is a commitment to implementing a ‘scheme-wide approach to geoarchaeology and the palaeoenvironment’ in the post-consent stages. The Projects preferences remain to implement joined up and coordinated approaches to any further survey and investigation works, e.g. associated with any additional engineering-led SI and also subsequently facilitating opportunities, where possible and practical, to gain a better understanding of identified deeper deposits of interest, where relevant, in association with construction-related ground works, specifically targeted on e.g. HDD crossing locations.

7 ARCHIVE STORAGE AND CURATION

7.1 Museum

7.1.1 The archive, which includes paper records, graphics and digital data, will be prepared following the standard conditions for the acceptance of excavated archaeological material, and in general following nationally recommended guidelines (SMA 1995; CIfA 2014b; Brown 2011; ADS 2013).

7.2 Preparation of the archive

7.2.1 The archive, which includes paper records, graphics and digital data, will be prepared following the standard conditions for the acceptance of excavated archaeological material, and in general following nationally recommended guidelines (SMA 1995; CIfA 2014b; Brown 2011; ADS 2013).

7.2.2 All archive elements are marked with the site code **ENF148610**, and a full index will be prepared. The physical archive currently comprises the following:

- 01 files/document cases of paper records and A3/A4 graphics.

7.3 Selection policy

7.3.1 Wessex Archaeology follows national guidelines on selection and retention (SMA 1993; Brown 2011, section 4). In accordance with these, and any specific guidance prepared by the museum, a process of selection and retention will be followed so that only those artefacts or ecofacts that are considered to have potential for future study will be retained. The selection policy will be agreed with the museum and is fully documented in the project archive.

7.4 Security copy

7.4.1 In line with current best practice (e.g., Brown 2011), on completion of the project a security copy of the written records will be prepared, in the form of a digital PDF/A file. PDF/A is an ISO-standardised version of the Portable Document Format (PDF) designed for the digital preservation of electronic documents through omission of features ill-suited to long-term archiving.

7.5 OASIS

7.5.1 An OASIS online record (http://oasis.ac.uk/pages/wiki/Main) has been initiated, with key fields and a .pdf version of the final report submitted. Subject to any contractual requirements on confidentiality, copies of the OASIS record will be integrated into the relevant local and national records and published through the Archaeology Data Service ArchSearch catalogue.

8 COPYRIGHT

8.1 Archive and report copyright

8.1.1 The full copyright of the written/illustrative/digital archive relating to the project will be retained by Wessex Archaeology under the *Copyright, Designs and Patents Act* 1988 with all rights reserved. Norfolk Vanguard Ltd and Norfolk Boreas Ltd will be licenced to use each report for the purposes that it was produced in relation to the project(s) as described in the specification. The museum, however, will be granted an exclusive licence for the use of the archive for educational purposes, including academic research, providing that such use conforms to the *Copyright and Related Rights Regulations* 2003. In some instances, certain regional museums may require absolute transfer of copyright, rather than a licence; this should be dealt with on a case-by-case basis.

8.1.2 Information relating to the project will be deposited with the Historic Environment Record (HER) where it can be freely copied without reference to Wessex Archaeology for the purposes of archaeological research or development control within the planning process.

8.2 Third party data copyright

8.2.1 This document and the project archive may contain material that is non-Wessex Archaeology copyright (e.g., Ordnance Survey, British Geological Survey, Crown Copyright), or the intellectual property of third parties, which Wessex Archaeology are able to provide for limited reproduction under the terms of our own copyright licences, but for which copyright itself is non-transferable by Wessex Archaeology. Users remain bound by the conditions of the *Copyright, Designs and Patents Act* 1988 with regard to multiple copying and electronic dissemination of such material.

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APPENDICES

Appendix 1 Borehole records

Site Code: ENF148610		**Site Name:** Norfolk Vanguard and Norfolk Boreas Offshore Wind Farms	**Borehole ID:** BH116-LF		
Coordinates (NGR) X: 638892.23		**Coordinates (NGR) Y:** 330420.50	**Level (top):** 11.57 m OD		
Length: **-**		**Width:** **-**	**Depth:** 20 m		
Context Number	**Description**	**Interpretation**	**Depth m BGL**	**Depth m OD**	**Samples**
91161	Dark greyish brown clayey medium sand. <1% fine to coarse (5-100mm) angular and sub-angular flint clasts. Poorly sorted. Structureless. Poorly consolidated. Diffuse contact.	Modern soil profile	0.00-0.40	11.57-11.17	-
91162	Mid yellowish brown gravelly medium sand. <5% fine to coarse (5-60mm) angular and sub-angular flint clasts. <1% sub-rounded chalk fragments. Gravel is poorly sorted. Structureless. Poorly consolidated. Sharp contact.	Modern soil profile	0.40-0.90	11.17-10.67	-
91163	Light brownish yellow medium-coarse sand with occasional pockets of clay. <1% fine to coarse (5-60mm) angular and sub angular flint clasts. <1% sub-rounded chalk fragments. poorly sorted. Structureless. Poorly consolidated. 2.90-3.10m: large pocket of clay with more rounded (pebble) flint clasts. More well consolidated.	Glacio-fluvial. Happisburgh Sand	0.90-11.70	10.67--0.13	-
91164	Dark grey fine sandy clay diamict. Matrix supported. <1% sub-rounded and rounded fine (<30mm) chalk and flint clasts. Well consolidated	Diamicton Happisburgh Diamicton	11.70-16.60	-0.13--5.03	-
91165	Mid greyish brown medium-coarse sand. No visible inclusions. Poorly consolidated. Structureless.	?Marine sand. ?Wroxham Crag	16.60-20.00+	-5.03--8.43+	3, 4

Site Code: ENF148610	**Site Name:** Norfolk Vanguard and Norfolk Boreas Offshore Wind Farms	**Borehole ID:** BH117-LF
Coordinates (NGR) X: 638898.31	**Coordinates (NGR) Y:** 330326.44	**Level (top):** 11.47 m OD
Length:	**Width:**	**Depth:** 20 m

Context Number	**Description**	**Interpretation**	**Depth m BGL**	**Depth m OD**	**Samples**
91171	Firm dark grey brown slightly gravelly sandy silt. Sand is fine to coarse. Gravel is sparse angular to sub-angular fine to medium flint <40 mm. Diffuse contact.	Modern soil profile	0.00-0.40	11.47-11.07	-
91172	Soft dark yellowish brown slightly gravelly silty sand. Sand is fine to medium. Gravel is rare sub-angular to sub-rounded fine to medium flint <40 mm. Diffuse contact.	Modern soil profile	0.40-0.90	11.07-10.57	-
91173	Dark orangish brown slightly gravelly silty sand. Sand is fine to medium. Gravel is rare sub-angular to sub-rounded fine to medium flint <30 mm. 0.05 m thick band of light greyish white gravelly clay where the gravel is abundant sub-rounded to rounded fine chalk <10 mm. This chalk may be the base of the deposit above. Diffuse contact.	Modern soil profile. Possibly colluvially reworked/ cryoturbated top of Happisburgh sand	0.90-1.20	10.57-10.27	
91174	Mid orangish brown clayey sand. Sand is fine to coarse. Rare fine to medium sub-angular to sub-rounded flint <4 mm. Distinct contact.	Glacio-fluvial sand. Happisburgh sand	1.20-2.60	10.27-9.27	-
91175	Mid yellowish brown and mid orange brown slightly gravelly fine to coarse sand. Very dense. Gravel is rare sub-angular to sub-rounded fine to medium flint (<50mm). From 7.00 mbgl rare pockets (60 mm x 60 mm) of mid grey slightly sandy clay. Sand is fine.	Glacio-fluvial sand. Happisburgh sand	2.60-9.00	9.27-2.87	-
91176	Mid grey slightly sandy clay. Sand is fine to medium. Rare bands of thinly laminated orangish brown fine sand.	Glacio-lacustrine clay Ostend clay	9.00-10.50	2.87-1.37	-

91177	Dark grey sandy silt diamict. Sand is fine. Rare sub-angular to sub-rounded fine flint <5 mm. Rare sub-angular to rounded fine chalk <5 mm. Very rare shell fragments.	Diamicton. Happisburgh Till.	10.50-12.20	1.37--0.33	-
91178	Light brownish grey fine sand. Becomes gravelly towards base of UT11 (12.70 mbgl). Gravel is sub-angular to sub-rounded fine flint <10 mm. Within shoe of UT, the sand appeared to be thickly laminated or thinly bedded. Rare pockets of laminated clay (60 mm x 60mm). Distinct change at base. From 13.50 mbgl becomes fine to coarse sand.	?Marine sand. ?Wroxham Crag	12.20-14.90	0.33--2.03	11, 12, 13
91179	Very dark grey fine to coarse sand. Locally fine silty sand. Locally clayey fine sand. Very rare sub-angular to sub-rounded fine to coarse flint <60 mm, predominantly <5 mm. Fairly dense. Rare sub-angular to rounded fine to coarse quartzite <60 mm. Rare fragments of brown and grey weak sub-rounded mudstone <30 mm. Around 17.45 mbgl was dark greenish grey locally clayey fine to medium sand with occasional fragments of grey weak mudstone <20 mm. Returned to above description by 18.00 mbgl.	?Marine sand. ?Wroxham Crag	14.90-20.00+	-2.03--7.13+	14, 15

Site Code: ENF148610		**Site Name:** Norfolk Vanguard and Norfolk Boreas Offshore Wind		**Borehole ID:** BH118-LF	
Coordinates (NGR) X: 639037.84		**Coordinates (NGR) Y:** 330305.32		**Level (top):** 11.27 m OD	
Length: -		**Width:** -		**Depth:** 19.65 m	
Context Number	**Description**	**Interpretation**	**Depth m BGL**	**Depth m OD**	**Samples**
91181	Dark brown slightly clayey fine sand with very occasional medium coarse sub-angular flint clasts; ≤<60mm.	Modern soil profile.	0.00-0.40	11.65-11.25	-
91182	Mid reddish brown slightly clayey fine to medium sand. Occasional medium to very coarse angular, sub-angular and sub-rounded flint clasts; <200mm.	Modern soil profile.	0.40-1.20	11.25-10.45	-
91183	Light reddish brown to light brownish yellow fine to medium sand. Extremely occasional fine to medium sub-angular flint clasts; <40mm. Occasional slightly clayey sand pockets.	Glacio-fluvial sand. Corton Sand	1.20-3.00	10.45-8.65	-
91184	Light reddish brown to light brownish yellow medium to coarse sand. Occasional to very occasional fine to medium sub-angular flint clasts; ≤40mm. Occasional fine (≤5mm) sub-angular and angular flint gravelly units c 200mm thick; flint clasts in gravelly units generally fine to medium (≤20mm). Occasional mid to dark brown clayey sand pockets.	Glacio-fluvial sand. Corton Sand	3.00-5.20	8.65-6.45	-
91185	Light reddish brown to light brownish yellow fine to medium sand. Occasional clay pockets. Very mid to dark brown occasional fine to medium angular and sub-angular flint clasts (≤30mm). Occasional mid to dark brown clayey sand pockets.	Glacio-fluvial sand. Corton Sand	5.20-7.20	6.45-4.45	-
91186	Light reddish brown to light brownish yellow fine to medium sand. Occasional mid to dark brown clay lenses (≤20mm). Generally, clast free; extremely occasional fine to medium sub-angular flint and iron stone clasts.	Glacio-fluvial sand. Corton Sand	7.20-15.00	4.45--3.35	-

91187	Light reddish-brown medium to coarse sand. Occasional to moderately frequent fine to medium angular and sub-angular flint clasts (≤<400 mm).	Glacio-fluvial sand. Corton Sand	15.00-16.00	-3.35- -4.35	-
91188	Light reddish brown to light brownish yellow coarse to very coarse gravelly sand. Gravel is fine to coarse (<≤600mm) angular to sub-angular flint.	Glacio-fluvial sand. Corton Sand	16.00-16.20	-4.35- -4.55	-
91189	Light reddish brown to light brownish yellow medium sand. Moderately frequent fine to medium angular and sub-angular flint clasts (≤<35mm).	Glacio-fluvial sand. Corton Sand	16.20-19.65+	-4.55- -8.00+	-

Site Code: ENF148610	**Site Name:** Norfolk Vanguard and Norfolk Boreas Offshore Wind Farms	**Borehole ID:** BH119-LF
Coordinates (NGR) X: 638888.54	**Coordinates (NGR) Y:** 330233.90	**Level (top):** 9.47 m OD
Length: -	**Width:** -	**Depth:** 20.00 m

Context Number	**Description**	**Interpretation**	**Depth m BGL**	**Depth m OD**	**Samples**
91191	Dark grey brown slightly clayey slightly gravelly slightly sandy silt. Sand is fine to coarse. Gravel is sparse sub-angular to angular fine to coarse flint; <80 mm. Diffuse contact.	Modern soil profile.	0.00-0.45	9.47-9.02	-
91192	Dark orangish brown silty fine to coarse sand. Very rare sub-angular to sub-rounded fine to medium flint; <40 mm. Diffuse contact.	Modern soil profile	0.45-0.90	9.02-8.57	-
91193	Mid orangish brown locally yellowish-brown fine to medium sand. Very rare sub-angular to sub-rounded fine to medium flint; <30 mm. Very rare fine shell fragments.	Glacio-fluvial sand. Happisburgh sand	0.90-9.50	8.57--0.03	-
91194	Very dense mid to dark orange brown fine to coarse sand. Very rare sub-angular to rounded fine to medium flint; <30 mm. Very rare fine shell fragments. Very rare fine black carbonaceous fragments. Diffuse contact.	Diamicton. Happisburgh Diamicton	9.50-12.50	-0.03--3.03	-
91195	Light brownish grey to mid grey fine to medium sand. Very rare fine shell fragments. Rare sub-angular fine to medium flint gravel <30 mm. At 15.00 mbgl rare very fine black carbonaceous stems <3 mm.	?Marine sand. ?Wroxham Crag	12.50-20.00+	-3.03--10.53+	-

Site Code: ENF148610	**Site Name:** Norfolk Vanguard and Norfolk Boreas Offshore Wind Farms	**Borehole ID:** BH120-LF
Coordinates (NGR) X: 638783.25	**Coordinates (NGR) Y:** 330491.08	**Level (top):** 11.21 m OD
Length: **-**	**Width:** **-**	**Depth:** 20.00 m

Context Number	**Description**	**Interpretation**	**Depth m BGL**	**Depth m OD**	**Samples**
91201	Soft dark grey brown slightly clayey slightly gravelly slightly sandy silt. Sand is fine to coarse. Gravel is sparse angular to sub-angular fine to coarse flint; <60 mm. Diffuse contact.	Modern soil profile	0.00-0.35	11.21-10.86	-
91202	Soft dark orange brown slightly gravelly slightly sandy silt. Sand is fine to coarse. Gravel is rare fine to coarse sub-angular to sub-rounded flint; <50 mm. Abrupt contact.	Modern soil profile. Subsoil	0.35-1.10	10.86-10.11	-
91203	Mid yellowish brown slightly gravelly fine to medium sand. Gravel is rare sub-angular to sub-rounded fine to medium flint; <40 mm. Very rare sub-rounded to rounded fine to medium quartzite <30 mm	Glacio-fluvial sands. Happisburgh sand	1.10-8.50	10.11-2.71	-
91204	Light brown with a greyish hue slightly gravelly fine to medium sand. Gravel is rare fine to medium sub-angular to sub-rounded flint; <30 mm. Rare pockets of light brown silt (30mm x 30 mm). Very rare black fine stems of carbonaceous material (3 mm).	?Glacio-fluvial sand. ?Happisburgh sand	8.50-9.30	2.71-1.91	-
91205	Mid to dark bluish grey locally mid brown grey very slightly gravelly sandy silty clay diamict. Sand is fine to medium. Gravel is very rare sub-angular to sub-rounded fine to medium flint; <30 mm. Very rare sub-rounded to rounded fine to medium quartzite; <20 mm. Very rare fine shell fragments.	Diamicton. Happisburgh Diamicton	9.30-10.60	1.91-0.61	

91206	Mid to dark grey brown locally clayey fine to medium silty sand. Sand appears to be thinly laminated. Small rare pockets of mid brown clayey sand and slightly sandy silty clay <100 mm x 40 mm. Distinct change at base.	?Alluvial sand. ?CF-bF	10.60-12.15	0.61--0.94	16
91207	Mid grey gravelly fine to coarse sand. Gravel is very common sub-angular to sub-rounded fine to medium flint; <30 mm, predominantly <5 mm. Common sub-rounded to rounded fine to medium quartzite; <30 m, predominantly <5 mm. Rare sub-angular to sub-rounded fine to medium chert; <10 mm. From 14.0 mbgl bands of dark grey clay. Rare black carbonaceous organic fragments <3 mm. Very rare sub-angular fine mudstone <5 mm.	?Alluvial sand. ?CF-bF	12.15-15.00	-0.94--3.79	17
91208	Dark grey slightly gravelly fine to medium silty sand. Gravel is very rare sub-angular to sub-rounded fine to medium flint (<30 mm) and rare sub-rounded to rounded fine to medium quartzite (<30 mm). Thin beds of dark grey sandy clay and silty clay.	?Alluvial sand. ?CF-bF	15.00-16.60	-3.79--5.39	18
91209	Light grey slightly gravelly fine to coarse sand. Gravel is sparse sub-angular to sub-rounded fine to medium flint <30 mm and rare sub-rounded to rounded fine to medium quartzite <30 mm. Diffuse transition at base.	?Alluvial or marine sand. ?CF-bF or Wroxham Crag	16.60-17.50	-5.39--6.29	
912010	Mid grey silty fine sand. Appears to be thinly laminated. Very rare fine sub-angular to sub-rounded flint gravel <10 mm.	?Marine sand. ?Wroxham Crag	17.50-20.00+	-6.29--8.69+	19

<table>
<tr><td colspan="2">Site Code:
ENF148610</td><td colspan="2">Site Name:
Norfolk Vanguard and Norfolk Boreas Offshore Wind Farms</td><td colspan="2">Borehole ID:
BH121-LF</td></tr>
<tr><td colspan="2">Coordinates (NGR) X:
638669.59</td><td colspan="2">Coordinates (NGR) Y:
330431.57</td><td colspan="2">Level (top):
11.91 m OD</td></tr>
<tr><td colspan="2">Length:
-</td><td colspan="2">Width:
-</td><td colspan="2">Depth:
20.00 m</td></tr>
<tr><td>Context Number</td><td>Description</td><td>Interpretation</td><td>Depth m BGL</td><td>Depth m OD</td><td>Samples</td></tr>
<tr><td>91211</td><td>Mid brownish grey slightly sandy slightly gravelly silty clay. Sand is fine to coarse. Gravel is rare sub-angular to sub-rounded fine to coarse flint <50 mm. Friable.

Abrupt contact.</td><td>Modern soil profile</td><td>0.00-0.50</td><td>11.91-11.41</td><td>-</td></tr>
<tr><td>91212</td><td>Dark orangish brown slightly gravelly slightly sandy silt. Sand is fine to medium. Gravel is rare sub-angular to sub-rounded fine to coarse flint <60 mm.

Diffuse contact.</td><td>Modern soil profile. Transitioning into Happisburgh sand</td><td>0.50-1.30</td><td>11.41-10.61</td><td>-</td></tr>
<tr><td>91213</td><td>Mid yellowish brown mottled orangish brown fine silty sand. Thinly laminated. Lenses of orangish brown fine sandy silt and mid orangish brown clay.
.</td><td>Glacio-fluvial sand Happisburgh sand</td><td>1.30-6.50</td><td>10.61-5.41</td><td>-</td></tr>
<tr><td>91214</td><td>Mid yellowish brown mottled orangish brown gravelly fine to medium sand. Rare pockets <40 mm x 40 mm of silty clay. Gravel is common sub-angular to rounded fine to medium flint (<40 mm) and rare sub-rounded to rounded fine quartzite (<30 mm).</td><td>Glacio-fluvial sand. Happisburgh Sand</td><td>6.50-7.60</td><td>5.41-4.31</td><td>-</td></tr>
<tr><td>91215</td><td>Stiff mid to dark orangish brown slightly sandy slightly gravelly silt. Sand is fine to medium. Gravel is very rare fine to medium sub-angular to sub-rounded flint; <20 mm.</td><td>?Glacio-lacustrine. ?Ostend Clay</td><td>7.60-9.00</td><td>4.31-2.91</td><td>-</td></tr>
<tr><td>91216</td><td>Stiff dark grey, locally dark bluish grey sandy silty clay diamict. Very rare fine shell fragments; <2 mm. Very rare sub-rounded to rounded fine chalk fragments; <3 mm. Rare sub-angular to sub-rounded fine to medium flint gravel; <20 mm. Very rare sub-rounded to rounded fine to medium quartzite gravel; <20 mm.</td><td>Diamicton. Happisburgh Diamicton</td><td>9.00-10.30</td><td>2.91-1.61</td><td>-</td></tr>
</table>

91217	Mid grey very fine to medium sand. Possibly some bands of mid grey sandy clay.	?Alluvial sand. ?CF-bF	10.30-11.10	1.61-0.81	20
91218	Mid grey fine slightly clayey sandy silt. Sand is fine to medium. Thinly and thickly laminated. Fragments of fibrous organic matter. Bands of mid grey sandy clay. Fibrous organic matter found as thin laminations <3 mm thick. Principally observed between 11.20 and 11.40 mbgl (Sample 21). Thick laminations of mid grey fine to medium sand. 13.00 mbgl: slightly gravelly sand, sub-rounded to rounded fine to medium flint clasts (<30 mm). Some fine fibrous fragments noted.	?Alluvial silt and sand. ?CF-bF	11.10-13.20	0.81--1.29	21, 22, 23,
91219	Dark grey slightly gravelly silty fine sand. Very rare fine black fibrous material <1 mm. Gravel is rare fine sub-angular to rounded flint <10 mm. 14.00-20.00 mbgl: silt content disappears, becomes dark grey slightly gravelly fine sand.	?Alluvial silty sand overlying marine sand ?CF-bF overlying Wroxham Crag	13.20-20.00+	-1.29--8.09+	24, 25

Site Code: ENF148610	**Site Name:** Norfolk Vanguard and Norfolk Boreas Offshore Wind Farms	**Borehole ID:** BH122-LF
Coordinates (NGR) X: 638759.45	**Coordinates (NGR) Y:** 330355.62	**Level (top):** 13.14 m OD
Length: -	**Width:** -	**Depth:** 20.00 m

Context Number	Description	Interpretation	Depth m BGL	Depth m OD	Samples
91221	Dark greyish brown fine sandy clay. <1% fine to coarse angular to sub angular flint clasts. Poorly sorted. Structureless. Poorly consolidated. Sharp contact.	Modern soil profile	0.00-0.90	13.14-12.24	
91222	Light reddish yellow very fine sand. No apparent clasts. Structureless. Poorly consolidated. Sand becoming coarser from 2m. Still no apparent inclusions. 7.90m: occasional clay pockets. Fine sand.	Glacio-fluvial sand. Happisburgh Sand	0.90-9.60	12.24-3.54	-
91223	Mid yellowish-brown clay and brownish yellow medium sand. <1% fine <20mm rounded and sub-rounded flint clasts. Well consolidated. Laminated.	Glacio-lacustrine clay. Ostend Clay	9.60-11.00	3.54-2.14	-
91224	Dark grey fine sandy clay diamict. Matrix supported. <1% sub-rounded and rounded fine (<30mm) chalk and flint clasts. Poorly sorted. Well consolidated.	Diamicton. Happisburgh Diamicton	11.00-13.70	2.14--0.56	
91225	Mid-light greyish brown to brownish red medium to coarse sand. No visible inclusions. Structureless. Poorly consolidated.	?Marine sand. ?Wroxham Crag	13.70-17.00	-0.56--3.86	1, 2
91226	Mid greyish brown silty fine sand. No apparent inclusions. Possibly laminated. Poorly consolidated. 18.50m: becomes coarser and sandier. Contains <5% sub-angular flint, quartz and quartzite clasts.	Marine sand. ?Wroxham Crag	17.00-20.00	-3.86--6.86	-

Site Code: ENF148610		Site Name: Norfolk Vanguard and Norfolk Boreas Offshore Wind Farms		Borehole ID: BH123-LF	
Coordinates (NGR) X: 638726.50		**Coordinates (NGR) Y:** 330272.74		**Level (top):** 12.23 m OD	
Length: -		**Width:** -		**Depth:** 20.20 m	
Context Number	**Description**	**Interpretation**	**Depth m BGL**	**Depth m OD**	**Samples**
91231	Dark grey brown mottled orange slightly gravelly slightly fine to coarse sandy silt. Gravel is very rare sub-angular to sub-rounded fine to coarse flint; <60mm. Diffuse contact.	Modern soil profile	0.00-0.40	12.23-11.83	-
91232	Mid brown slightly gravelly silty fine to coarse sand. Gravel is very rare fine to medium sub-angular to sub-rounded flint; <40mm. Sharp contact.	Modern soil profile	0.40-0.70	11.83-11.53	-
91233	Mid brownish orange slightly gravelly fine to coarse sand. Gravel is rare sub-angular to sub-rounded fine to medium flint <40 mm. Becomes gravelly at 1.10 mbgl. Common sub-angular to sub-rounded fine to coarse flint; <60mm. At around 2.50 mbgl gravel inclusions of quartzite start to appear, fine to medium, sub-rounded; <30 mm.	Glacio-fluvial. Happisburgh Sand	0.70-3.50	11.53-8.73	-
91234	Light to mid yellowish brown slightly gravelly fine to medium sand. Rare sub-angular to sub-rounded fine gravel of flint <8 mm. From approx. 8.50 mbgl rare pockets of yellowish-brown clay.	Glacio-fluvial sand. Happisburgh sand	3.50-10.20	8.73-2.03	-
91235	Mid yellowish brown mottled reddish brown slightly gravelly fine to medium sand. Gravel is sparse angular to sub-angular fine to medium flint <30mm. Distinct transition at base.	Glacio-fluvial sand. Happisburgh sand	10.20-10.90	2.03-1.33	-
91326	Mid brownish grey fine to medium sand. Distinct transition at base.	?Glacio-fluvial sand. ?Happisburgh sand	10.90-11.40	1.33-0.83	-

91237	Dark brownish grey sandy silt. Sand is fine. Very rare sub-angular to sub-rounded fine flint; <10 mm. Rare sub-rounded to rounded fine chalk; <10 mm. Mottled orangish brown towards top. Very rare shell fragments.	?Diamicton. ?Happisburgh Diamicton	11.40-12.00	0.83-0.23	-
91238	Dark brownish grey sandy silt diamict. Sand is fine. Very rare sub-angular to sub-rounded fine flint <10 mm. Rare sub-rounded to rounded fine chalk; <10 mm. Very rare shell fragments. Distinct transition at base. At around 15.20 very thin laminations of fine light grey sand are visible.	Diamicton. Happisburgh Diamicton	12.00-16.10	0.23--3.87	5, 6
91239	Light brownish grey fine sand. Very fine rounded black (?organic) inclusions <1 mm. Very fine rounded flint gravel; <3 mm.	?Marine sand. ?Wroxham Crag	16.10-20.20+	-3.87--7.97	7, 8, 9, 10

Site Code: **ENF148610**	**Site Name:** **Norfolk Vanguard and Norfolk Boreas Offshore Wind Farms**	**Borehole ID:** UNV-BH405
Coordinates (NGR) X: **639024.57**	**Coordinates (NGR) Y:** **330421.98**	**Level (top):** **2.71** mOD
Length: **-**	**Width:** **-**	**Depth:** **16.50 m**

Context Number	**Description**	**Interpretation**	**Depth m BGL**	**Depth m aOD**	**Samples**
40501	Light greyish brown medium sand. No apparent clasts. Poorly consolidated.	Marine sands. Modern beach sand	0.00-1.00	2.71-1.71	-
40502	Mid greyish brown medium sand. <1% fine to coarse (5-40mm) angular chalk clasts. <1% fine to medium (5-20mm) rounded and sub-rounded flint clasts. Poorly sorted. Poorly consolidated.	Redeposited sand. Modern landslip deposits	1.00-2.80	1.71-0.09	-
40503	Mid reddish brown and brownish grey bedded silty clay. No apparent clasts. Well consolidated. Laminated and sub-horizontally bedded. Becoming coarser and sandier with depth	Glacio-lacustrine clays.	2.80-3.50	0.09--0.79	-
40504	Mid greyish brown medium sand with occasional silty clay pockets. <1% fine (3mm) angular flint clasts. Poorly consolidated.	Glacio-fluvial sands. Corton Sands	3.50-5.40	-0.79--1.69	-
40505	Dark brownish grey medium sandy clay. <1% fine (5mm) angular flint and siltstone clasts. Poorly sorted. Possible laminations? Occasional very fine shell fragments. Well consolidated.	Diamicton. Corton Diamicton	5.40-8.00	-1.69--4.09	1
40506	Mid brownish grey silty medium sand with rare pockets of sandy clay. No visible clasts. Poorly consolidated.	Glacio-fluvial sands. ?Happisburgh Sands	8.00-9.80	-4.09--5.89	2, 3
40507	Dark brownish grey medium sandy clay. <1% fine (5mm) angular flint and siltstone clasts. Poorly sorted. Possible laminations? Occasional very fine shell fragments. well consolidated.	Diamicton. ?Happisburgh Diamicton	9.80-10.00	-5.89--6.09	4

40508	Dark brownish grey silty medium to coarse sand with occasional pockets of sandy clay. No visible clasts. Occasional shell fragments (fossil?). Poorly consolidated. 11.00-11.50 m: Grey silty sand and sandy clay.	?Alluvial/ estuarine sands, silts and clays ?CF-bF Piece of wood recovered at 10.5mbgl and retained.	10.00-11.50	-6.09- -7.59	5, 10
40509	Mid reddish brown silty medium to coarse sand. No visible clasts. Occasional fine shell fragments. Poorly consolidated 13.00 m: Sand becoming coarser with depth.	?Marine Sands. ?Wroxham Crag	11.50-14.50	-7.59- -10.59	6, 7
40510	Mid-dark brownish grey medium to coarse sand. No visible clasts. Possible rare very fine shell fragments. Poorly consolidated. Structureless. 16.00 m: becoming coarser, <1% fine to coarse (3-30mm) rounded, sub-rounded, sub-angular and angular flint, quartz, quartzite and sandstone clasts. Poorly sorted.	Marine Sands. Wroxham Crag	14.50-16.50+	-10.59- -12.59+	8, 9

Appendix 2 Trial Pit records

Trial Pit No TP101-WG	Length 2.30 m	Width 0.60 m	Depth 2.00 m	
Easting 637085.00	Northing 330677.00	m OD 7.30		
Context Number	**Fill Of/Filled With**	**Interpretative Category**	**Description**	**Depth BGL**
1011		Modern soil profile	Mid to dark brown silty sandy clay. Soft. Occasional rounded stone clasts (average size 80 mm). Occasional rounded flints clasts (average size 10 mm).	0.00-0.40
1012		Modern soil profile	Mid to dark yellow brown silty sandy clay. Soft. Very occasional sub-rounded flint clasts (average size 80 mm),	0.40-1.20
1013		Glacio-fluvial sand and gravel Happisburgh Formation	Mid yellow grey sandy clay. Firm. Rare sub-rounded flint clasts (average size 10 mm).	1.20-1.40
1014		Glacio-fluvial sand and gravel Happisburgh Formation	Bright yellow coarse sand. Occasional sub-rounded flint clasts (average size 60 mm).	1.40-2.00+

Trial Pit No TP102-HR	Length 2.20 m	Width 0.60 m	Depth 2.00 m	
Easting 635166.61	Northing 331191.80	m OD 7.88		
Context Number	**Fill Of/Filled With**	**Interpretative Category**	**Description**	**Depth BGL**
1021		Modern soil profile	Dark brown silty sandy clay. Soft. Very frequent angular flint clast (average size 100 mm). Frequent rounded stones (average size 80mm).	0.00-0.40
1022		Modern soil profile	Mid to dark brown sandy clay. Soft. Occasional angular flint clasts (average size 100 mm).	0.40-1.20
1023		Glacio-fluvial sand and gravel. Happisburgh Formation	Mid to light yellow brown sandy clay. Moderately firm. Very occasional sub- rounded flint clasts (average size 80 mm).	1.20-1.50

1024		Glacio-fluvial sand and gravel. Happisburgh Formation	Bright yellow coarse sand. Occasional sub- rounded flint clasts (average size 60 mm).	1.50-2.00+

Trial Pit No TP103-WB	**Length 2.20 m**	**Width 0.60 m**	**Depth 2.00 m**	
Easting 633640.00		**Northing 330619.20**	**m OD 7.30**	
Context Number	**Fill Of/Filled With**	**Interpretative Category**	**Description**	**Depth BGL**
1031		Modern soil profile	Mid to dark brown sandy clay. Soft. Frequent angular flint clasts (average size 100 mm.	0.00-0.30
1032		Modern soil profile	Mid to light red brown sandy clay. Soft. Occasional rounded flint clasts (average size 80 mm).	0.30-0.50
1033		Glacio-fluvial sand and gravel. Happisburgh Formation	Light reddish yellow coarse sand. Becomes finer with depth.	0.50-2.00+

Trial Pit No TP104-WH	**Length 2.20 m**	**Width 0.60 m**	**Depth 2.00 m**	
Easting 631791.00		**Northing 331393.00**	**m OD 36.74**	
Context Number	**Fill Of/Filled With**	**Interpretative Category**	**Description**	**Depth BGL**
1041		Modern soil profile	Mid to dark brown sandy clay soft. Frequent angular and sub-angular flint clasts (average size 100mm).	0.00-0.30
1042		Modern soil profile	Reddish brown sandy clay. Soft. Occasional angular and sub-angular flint clast (average size 80 mm).	0.30-0.70
1043		Glacio-fluvial sand and gravel. Briton’s Lane Formation	Light red fine to coarse sand.	0.70-2.00+

Trial Pit No TP105-LR	**Length 2.60 m**	**Width 0.60 m**	**Depth 2.10 m**	
Easting 627747.00	**Northing 331763.00**	**m OD 17.98**		
Context Number	**Fill Of/Filled With**	**Interpretative Category**	**Description**	**Depth BGL**
1051		Modern soil profile	Soft dark grey brown slightly sandy slightly gravelly silt. Sand is fine to coarse. Gravel is sparse angular to sub-rounded fine to coarse flint (<50 mm). Abrupt contact.	0.00-0.50
1052		Modern soil profile	Very dark grey brown to black slightly sandy slightly gravelly silt. Sparse pockets of fibrous organic matter (peat). Sand is fine to coarse. Gravel is sparse sub-angular to sub-rounded fine to coarse flint <60 mm. Abrupt contact.	0.50-0.70
1053		Peat	Very dark grey brown to black slightly gravelly fibrous organic matter. Near complete fibrous organic matter (peat). Very rare gravel of sub-angular to sub-rounded fine to medium flint (<40 mm). Sharp contact.	0.70-1.10
1054		Alluvium	Dark grey sandy gravelly silt. Sand is fine to coarse. Gravel is abundant sub-angular to rounded fine to coarse flint (<60mm) and rare sub-rounded to rounded fine to medium quartzite (<30 mm). Top of this deposit was an approximately 50 mm thick band of light yellowish grey silt. Abrupt contact.	1.10-1.40
1055		Alluvium	Dark grey slightly clayey sandy gravel. Sand is fine to coarse. Gravel is very common sub-angular to sub-rounded fine to medium flint (<40 mm). Abrupt contact.	1.40-1.90
1056		Alluvium	Light grey cohesive slightly sandy silt.	1.90-2.10+

Trial Pit No TP106-NW	Length 2.40 m	Width 0.60 m	Depth 2.20 m	
Easting 626853.83		**Northing 331635.03**	**m OD 25.11**	
Context Number	**Fill Of/Filled With**	**Interpretative Category**	**Description**	**Depth BGL**
1061		Modern soil profile	Soft very dark grey brown slightly sandy slightly gravelly silt. Sand is fine to medium. Gravel is rare sub-angular to rounded fine to medium flint (<60 mm). Abrupt contact.	0.00-0.60
1062		?Colluvial silt (Head)	Light brownish yellow mottled orangish brown mottled grey brown and orangish brown slightly sandy slightly gravelly silt. Sand is fine to medium. Gravel is rare sub-angular to rounded fine to coarse flint (<60 mm). Friable. Diffuse contact.	0.60-1.00
1063		Glacio-fluvial sand and gravel. ?Happisburgh Formation	Light yellowish grey slightly gravelly fine to medium sand. Gravel is rare medium to coarse sub-angular to sub-rounded flint (<60 mm). Abrupt contact.	1.00-1.40
1064		Glacio-fluvial sand and gravel. ?Happisburgh Formation	Light yellowish grey mottled orange slightly sandy slightly gravelly silt. Fine to medium sand. Gravel is rare sub-angular to sub-rounded fine to coarse flint (<50mm). Frequent pockets of mid orangish brown sand <200 x 150 mm. Abrupt contact.	1.40-1.95
1065		Glacio-fluvial sand and gravel. ?Happisburgh Formation	Light to mid yellowish orange slightly gravelly fine to coarse sand. Gravel is rare sub-angular to sub-rounded fine to coarse flint (<80mm). Rare pockets and lenses of orangish brown silt.	1.95-2.20+

Trial Pit No TP107-NW	Length 2.90 m	Width 0.60 m	Depth 2.20 m	
Easting 626703.98	Northing 331552.62	m OD 30.75		
Context Number	**Fill Of/Filled With**	**Interpretative Category**	**Description**	**Depth BGL**
1071		Modern soil profile	Dark grey brown slightly sandy slightly gravelly silt. Sand is fine to medium. Gravel is rare sub-angular to sub-rounded fine to coarse flint (<60 mm). Abrupt contact.	0.00-0.50
1072	1073	Uncategorised feature	Incomplete uncategorised feature with shallow, concave sides and a flat base. Length: >1.00 m. Width: >0.60 m. Depth: 0.30 m.	0.50-0.80
1073	1072	Fill	Dark grey brown mottled mid brown and mid orange slightly sandy slightly gravelly silt with sand is fine to coarse. rare pockets of mid to dark red brown silt <50 mm x 50 mm inclusions	0.50-0.80
1074		?Colluvial silt (Head).	Soft light brown slightly sandy slightly gravelly silt. Sand is fine to medium. Gravel is rare sub-angular to sub-rounded fine to coarse flint (<50 mm). Abrupt contact.	0.50-1.30
1075		Glacio-fluvial sand and gravel. Briton's Lane Formation	Mid to dark orangish brown gravelly sand. Sand is fine to coarse. Gravel is very common angular to sub-rounded fine to coarse flint (<60 mm). Diffuse contact.	1.30-1.50
1076		Glacio-fluvial sand and gravel. Briton's Lane Formation	Light yellowish brown mottled whitish brown slightly gravelly fine to medium sand. Gravel is rare sub-angular to sub-rounded fine to medium flint (<40 mm). At 2.00 mbgl becomes light grey in colour.	1.50-2.20+

Trial Pit No TP108-SF	**Length 2.20 m**	**Width 0.60 m**	**Depth 2.00 m**	
Easting 623557.11		**Northing 330510.51**	**m OD 22.42**	
Context Number	**Fill Of/Filled With**	**Interpretative Category**	**Description**	**Depth BGL**
1081		Modern soil profile	Mid to dark brown silty sandy clay, friable. Occasional angular flint clasts (average size 80mm). Frequent rounded stones (average size 10 mm).	0.00-0.30
1082		Glacio-fluvial sand and gravel ?Happisburgh Formation	Dark red brown sandy clay. Moderately firm. Occasional angular flint clasts (average size 90 mm).	0.30-0.80
1083		Glacio-fluvial sand and gravel ?Happisburgh Formation	Yellow sandy clay. Moderately firm. Very occasional angular flint clasts (average size 80 mm).	0.80-1.70
1084		Glacio-fluvial sand and gravel ?Happisburgh Formation	Mottled yellow brown sandy clay. Firm. Occasional rounded stones (average size 100mm) and occasional angular flint clasts average size (100 mm).	1.70-2.00+

Trial Pit No TP109-CR	**Length 2.30 m**	**Width 0.60 m**	**Depth 2.00 m**	
Easting 619209.73		**Northing 328205.48**	**m OD 14.96**	
Context Number	**Fill Of/Filled With**	**Interpretative Category**	**Description**	**Depth BGL**
1091		Modern soil profile	Mid brown sandy silt. Friable. Frequent angular flint clasts (average size 100 mm).	0.00-0.40
1092		Glacio-fluvial sand and gravel. Briton’s Lane Formation	Dark red brown sandy silty clay. Friable. Frequent angular flint clasts (average size 80 mm).	0.40-0.90
1093		Glacio-fluvial sand and gravel. Briton’s Lane Formation	Mottled grey yellow sandy clay. Moderately firm. Less sandy towards base.	0.90-1.30

1094		Glacio-fluvial sand and gravel Briton's Lane Formation	Angular and sub-angular gravel in reddish brown medium-coarse sand. Average clast size 100 mm.	1.30-1.70
1095		Glacio-fluvial sand and gravel Briton's Lane Formation	Orange yellow sandy clay. Firm. Occasional angular to sub-angular flint clasts (average size 100 mm).	1.70-2.00+

Trial Pit No TP110-AH	**Length 2.50 m**	**Width 0.60 m**	**Depth 2.10 m**	
Easting 616800.13		**Northing 327572.36**	**m OD 36.64**	
Context Number	**Fill Of/Filled With**	**Interpretative Category**	**Description**	**Depth BGL**
1101		Modern soil profile	Dark reddish grey brown slightly sandy slightly gravelly silt. Sand is fine to coarse. Gravel is sparse sub-angular to sub-rounded fine to coarse flint (<60 mm). Diffuse contact.	0.00-0.50
1102		Glacio-fluvial sand and gravel Briton's Lane Formation	Mid to dark reddish brown slightly sandy slightly gravelly silt. Sand is fine to coarse. Gravel is rare sub-angular to rounded fine to coarse flint (<50 mm). Diffuse contact.	0.50-1.10
1103		Glacio-fluvial sand and gravel Briton's Lane Formation	Mid yellowish grey mottled orangish brown and yellowish brown slightly gravelly sandy silt. Sand is fine to coarse. Rare sub-angular to sub-rounded fine flint and quartzite gravel (<5 mm). Diffuse contact.	1.10-1.90
1104		Glacio-fluvial sand and gravel Briton's Lane Formation	Light to mid brownish yellow gravelly fine to coarse sand. Gravel is common sub-angular to sub-rounded medium to coarse flint (<60 mm). Rare sub-angular to sub-rounded fine to medium quartzite (<30 mm).	1.90-2.10+

Trial Pit No TP111-HS		Length 2.40 m		Width 0.60 m	Depth 2.05 m
Easting 611358.10			Northing 323849.91	m OD 39.48	
Context Number	**Fill Of/Filled With**	**Interpretative Category**	**Description**		**Depth BGL**
1111		Modern soil profile	Soft very dark grey brown slightly sandy slightly gravelly silt. Sand is fine to coarse. Gravel is sparse sub-angular to sub-rounded fine to coarse flint (<60 mm). Abrupt contact.		0.00-0.55
1112		Modern soil profile	Soft dark orangish brown slightly gravelly silty sand. Sand is fine to medium. Common pockets (<100 ×80 mm) of orangish brown silt. Gravel is sparse sub-angular to sub-rounded fine to coarse flint (<60 mm). Abrupt contact.		0.55-0.85
1113		Diamicton. Sheringham Cliffs Formation	Stiff mid yellowish brown slightly sandy slightly gravelly clayey silt diamict. Sand is fine to coarse. Gravel is sparse angular to sub-angular fine to coarse of flint (<64 mm). Rare sub-angular cobbles of flint (<200 mm). Diffuse contact.		0.85-1.90
1114		Diamicton. Sheringham Cliffs Formation	Stiff mid yellowish grey mottled orange slightly sandy, gravelly, silty clay diamict. Sand is fine to coarse. Gravel is sparse angular to sub-rounded fine to coarse flint <60 mm, very common sub-angular to sub-rounded fine to coarse chalk (<60 mm), rare cobbles of sub-angular to sub-rounded flint (<200 mm), rare cobbles of sub-angular to sub-rounded chalk (<160 mm).		1.30-2.05+

Trial Pit No TP112-HS	Length 2.50 m	Width 0.60 m	Depth 2.10 m	
Easting 611269.61		**Northing 323852.08**	**m OD 40.89**	
Context Number	**Fill Of/Filled With**	**Interpretative Category**	**Description**	**Depth BGL**
1121		Modern soil profile	Soft very dark grey brown slightly sandy slightly gravelly silt. Sand is fine to coarse. Gravel is sparse sub-angular to sub-rounded fine to coarse flint <60 mm. Abrupt contact.	0.00-0.40
1122		Glacio-fluvial sand and gravel Sheringham Cliffs Formation	Mid to dark orangish brown slightly gravelly silty sand. Sand is fine to medium. Gravel is sparse sub-angular to sub-rounded fine to coarse flint (<60 mm). Diffuse contact.	0.40-0.80
1123		Diamicton. Sheringham Cliffs Formation	Mid yellowish brown slightly sandy slightly gravelly silty clay diamict. Sand is fine to coarse. Gravel is common sub-angular to rounded fine to very coarse flint (<220 mm), predominantly medium to coarse (<160 mm). Common pockets <200 × 150 mm of mid orangish brown fine to coarse silty sand.	0.80-2.10+

<table>
<tr><th colspan="2">Trial Pit No
TP113-HS</th><th>Length
2.00 m</th><th>Width
0.60 m</th><th>Depth
2.00 m</th></tr>
<tr><th colspan="2">Easting 611184.99</th><th colspan="2">Northing 323868.88</th><th>m OD 41.05</th></tr>
<tr><th>Context Number</th><th>Fill Of/Filled With</th><th>Interpretative Category</th><th>Description</th><th>Depth BGL</th></tr>
<tr><td>1131</td><td></td><td>Modern soil profile</td><td>Soft dark brown slightly gravelly sandy silt. Sand is fine to coarse. Gravel is sparse sub-angular fine to coarse of flint <60 mm.

Abrupt contact.</td><td>0-0.45</td></tr>
<tr><td>1132</td><td></td><td>Diamicton. Sheringham Cliffs Formation</td><td>Dark orangish brown mottled brown slightly sandy slightly gravelly silt diamict. Sand is fine to coarse. Gravel is sparse angular to sub-rounded fine to coarse flint <60 mm with very rare sub-angular flint cobbles <130 mm. From 1.20 mbgl rare pockets <200 mm x 100 mm of orangish brown silty fine to coarse sand.

Abrupt contact.</td><td>0.45-1.40</td></tr>
<tr><td>1133</td><td></td><td>Diamicton. Sheringham Cliffs Formation</td><td>Dark greyish brown mottled orange slightly sandy gravelly clayey silt diamict. Sand is fine to coarse. Gravel is very common sub-angular to sub-rounded fine to coarse chalk <60 mm, with moderate sub-rounded to sub-angular fine to coarse flint <60 mm. From 1.70 mbgl rare sub-angular to sub-rounded chalk cobbles <80 mm.</td><td>1.40-2.00+</td></tr>
</table>

Trial Pit No TP114-KR		**Length 2.20 m**		**Width 0.60 m**	**Depth 2.00 m**
Easting 609608.39			**Northing 323856.05**	**m OD 40.78**	
Context Number	**Fill Of/Filled With**	**Interpretative Category**	**Description**		**Depth BGL**
1141		Modern soil profile	Mid to dark brown silty clay. Frequent angular and sub-angular flint clasts (average size 160 mm).		0.00-0.45
1142		Modern soil profile	Mid red brown sandy clay. Firm. Occasional angular and sub-angular flint clasts (average size 100 mm). Occasional chalk flecks.		0.45-0.80
1143		Glacio-fluvial sand and gravel. Sheringham Cliffs Formation	Mid yellow gravelly sandy silty clay. Firm. Frequent angular and flint clasts (<350 mm). Occasional sub-angular chalk clasts (average size 160mm).		0.80-1.70
1144		Glacio-fluvial sand and gravel. Sheringham Cliffs Formation	Mid to light yellow brown sand. Friable. Occasional fine angular flint clasts (average size 80 mm). Occasional sub-angular chalk clasts (average size 50 mm).		1.70-1.90
1145		Glacio-fluvial sand and gravel. Sheringham Cliffs Formation	Bright yellow coarse sand.		1.90-2.00+

Trench No TP115-JR	Length 2.50 m	Width 0.60 m	Depth 2.10 m	
Easting 607510.72		Northing 321530.57		m OD 42.98
Context Number	**Fill Of/Filled With**	**Interpretative Category**	**Description**	**Depth BGL**
1151		Modern soil profile	Very soft to soft dark brownish grey slightly sandy slightly gravelly silt. Sand is fine to coarse. Gravel is moderate angular to sub-rounded fine to coarse flint <64 mm, and rare sub-angular to sub-rounded fine to medium quartzite (<30 mm). Abrupt contact.	0.00-0.25
1152		Diamicton. Sheringham Cliffs Formation	Firm to locally stiff, light yellowish orange slightly sandy slightly gravelly silt diamict. Sand is fine to coarse. Gravel is sparse sub-angular to sub-rounded fine to coarse flint (<60 mm) and very rare sub-angular to rounded fine to coarse quartzite (<30 mm). Diffuse contact.	0.25-1.00
1153		Diamicton. Sheringham Cliffs Formation	Firm to locally stiff light orange mottled grey and brown slightly sandy gravelly clayey silt diamict. Sand is fine to coarse. Gravel is very common sub-angular to sub-rounded fine to coarse chalk <60 mm and sparse sub-angular to sub-rounded fine to coarse flint (<60 mm). Diffuse contact.	0.50-1.10

1154		Diamicton. Sheringham Cliffs Formation	Stiff mid orangish brown mottled grey brown slightly sandy gravelly silty clay diamict. Sand is fine to coarse. Gravel is abundant sub-angular to rounded fine to coarse chalk (<60 mm) with rare sub-angular to sub-rounded chalk cobbles (<150 mm). Sparse sub-angular to sub-rounded medium to coarse flint, sparse sub-angular to sub-rounded flint cobbles (<200 mm) and rare flint boulders (<450 mm). Rare pockets (150 × 100 mm) of orangish brown fine to coarse sand.	1.10-2.10+

Trial Pit No TR116-EL	**Length 2.20 m**	**Width 0.60 m**	**Depth 1.95 m**	
Easting 605002.78	**Northing 318013.59**	**m OD 60.23**		
Context Number	**Fill Of/Filled With**	**Interpretative Category**	**Description**	**Depth BGL**
1161		Modern soil profile	Mid brown sandy silt. Friable. Moderately frequent angular and sub-angular angular flint clasts (average size 100mm).	0-0.40
1162		Fluvial sand and gravel. River terrace	Mid brown orange gravelly silty sand. Firm. Moderately frequent angular and sub-angular flint clasts (average size 160mm).	0.40-1.10
1163		Fluvial sand and gravel. River terrace	Angular and sub-angular fine to medium flint gravel (20mm-200mm) in dark orange fine to coarse sand matrix.	1.10-1.60
1164		Fluvial sand and gravel. River terrace	Coarse grey gravelly sand. Moderately frequent fine to coarse angular and sub-angular flint clasts.	1.60-1.95+

Trial Pit No TP117-BR	Length 2.50 m	Width 0.60 m	Depth 2.10 m	
Easting 601489.37		Northing 315503.40	m OD 68.68	
Context Number	**Fill Of/Filled With**	**Interpretative Category**	**Description**	**Depth BGL**
1171		Modern soil profile	Very soft to soft dark brownish grey slightly sandy slightly gravelly silt. Sand is fine to coarse. Gravel is moderate angular to sub-rounded fine to coarse flint (<64 mm), and rare sub-angular to sub-rounded fine to coarse quartzite (<50 mm). Abrupt contact.	0.00-0.30
1172		Glacio-fluvial sand and gravel	Firm to stiff, locally stiff, light yellowish orange slightly sandy slightly gravelly silt. Sand is fine to coarse. Gravel is sparse sub-angular to sub-rounded fine to coarse flint (<60 mm) and very rare sub-angular to rounded fine to coarse quartzite (<30 mm). Diffuse contact.	0.30-0.70
1173		Diamicton. Lowestoft Formation	Firm light greyish yellow mottled orange slightly sandy gravelly clayey silt diamict. Sand is fine to coarse. Gravel is common sub-angular to sub-rounded fine to coarse chalk (<50 mm). Frequent pockets (<200 ×150 mm) and lenses (<300 × 50 mm) of light orange silty fine to coarse sand. Abrupt contact.	0.70-1.15

1174		Diamicton. Lowestoft Formation	Firm to stiff locally stiff light grey mottled orange and brown slightly sandy gravelly silt diamict. Sand is fine to coarse. Gravel is abundant sub-angular to sub-rounded fine to coarse chalk (<60 mm) and rare sub-angular to sub-rounded fine to coarse flint (<60 mm). From 1.60 mbgl sparse sub-angular to sub-rounded cobbles of chalk <150 mm and rare sub-angular to sub-rounded cobbles of flint <170 mm.	1.15-2.10+

Trial Pit No TP118-MN	**Length 2.20 m**		**Width 0.60 m**	**Depth 2.00 m**
Easting 599618.56		**Northing 315240.59**		**m OD 60.23**
Context Number	**Fill Of/Filled With**	**Interpretative Category**	**Description**	**Depth BGL**
1181		Modern soil profile	Mid brown silty clay. Frequent angular and sub-angular flint clasts (average size 150mm).	0.00-0.30
1182		Modern soil profile	Mid yellow brown sandy clay. Flecks of chalk, Frequent angular and sub-angular flint clasts (average size 100 mm).	0.30-0.65
1183		Diamicton. Lowestoft Formation	Till. Light yellow brown sandy clay. Firm. Frequent sub-angular chalk clasts (average size 160 mm). Occasional angular flint clasts. Occasional bright orange sandy patches toward the base.	0.65-1.50
1184		Diamicton. Lowestoft Formation	Till. Mottled grey orange sandy clay. Firm. Frequent sub-angular chalk clasts (average size 80mm). Frequent angular flint clasts (average size 200 mm).	1.50-2.00+

Trial Pit No TP119-MN	**Length 2.20 m**		**Width 0.60 m**	**Depth 2.00 m**
Easting 599442.20		**Northing 315262.64**		**m OD 59.35**
Context Number	**Fill Of/Filled With**	**Interpretative Category**	**Description**	**Depth BGL**
1191		Modern soil profile	Mid brown sandy silt. Friable. Frequent angular and sub-angular flint clasts (average size 160 mm).	0.00-0.35
1192		Modern soil profile	Mid brown orange sandy silt. Moderately firm. Frequent angular flint clasts (average size 160 mm).	0.35-1.00

1193		Diamicton. Lowestoft Formation	Light yellow brown sandy clay. Firm. Frequent chalk clasts (average size 160mm). Frequent angular and sub-angular flint clasts (average size 250mm).	1.00-1.80
1194		Diamicton. Lowestoft Formation	Mottled grey orange coarse sand. Occasional sub-angular flint clasts average size 100 mm).	1.80-2.00+

Trial Pit No TP120-BL	**Length 2.30 m**	**Width 0.60 m**	**Depth 2.00 m**	
Easting 593948.76		**Northing 311538.98**	**m OD 40.83**	
Context Number	**Fill Of/Filled With**	**Interpretative Category**	**Description**	**Depth BGL**
1201		Modern soil profile	Mid brown sandy clay. Friable. Frequent angular and sub-angular flint clasts (average size 100 mm).	0.00-0.40
1202		Modern soil profile	Mid yellow brown silty clay. Firm. Occasional chalk flecks and frequent coarse angular flint clasts (average size 200 mm).	0.40-0.70
1203		Diamicton. Lowestoft Formation	Till. Light yellow brown firm silty clay. Occasional chalk flecks. Frequent angular flint clasts (average size 160 mm).	0.70-1.30
1204		Diamicton. Lowestoft Formation	Till. Mottled grey orange silty sandy clay. Occasional chalk flecks. Frequent angular flint clasts (average size 160mm).	1.30-2.00+

Trial Pit No TP121-BL	**Length 2.20 m**	**Width 0.60 m**	**Depth 2.00 m**	
Easting 593571.88		**Northing 311304.79**	**m OD 61.84**	
Context Number	**Fill Of/Filled With**	**Interpretative Category**	**Description**	**Depth BGL**
1211		Modern soil profile	Mid to dark brown soft silty sandy clay. Occasional angular and sub-angular flint clasts (average size 100 mm).	0.00-0.30
1212		Modern soil profile	Dark red brown sandy clay. Soft. Moderately frequent angular and sub-angular flint clasts (average size 800 mm).	0.30-0.90

1213		Diamicton. Lowestoft Formation	Mid yellowish-brown sandy clay. Firm angular and sub-angular flint clasts (average size 200 mm).	0.90-1.40
1214		Diamicton. Lowestoft Formation	Fine yellow fine to coarse sand. Occasional patches of coarse orange sand. Moderate sub-angular flint clasts (average size 160 mm).	1.40-2.00+

Trial Pit No TP122-GL	**Length 2.40 m**	**Width 0.60 m**	**Depth 2.00 m**	
Easting 591257.45		**Northing 310784.21**	**m OD 41.01**	
Context Number	**Fill Of/Filled With**	**Interpretative Category**	**Description**	**Depth BGL**
1221		Modern soil profile	Mid to dark brown silty clay with frequent angular and sub-angular flint clasts (average size 100 mm).	0.00-0.30
1222		Modern soil profile	Firm orange sandy silty clay. Frequent sub-angular chalk clasts (average size 100 mm). Frequent angular flint clasts (average size 150 mm).	0.30-0.50
1223		Diamicton. Lowestoft Formation	Till. Light yellow brown sandy clay. Firm. Frequent sub-angular chalk clasts (average size 150 mm). Frequent angular flint clasts (average size 200 mm. Occasional patches of fine red brown sand; soft.	0.50-1.10
1224		Diamicton. Lowestoft Formation	Till. Light grey silty clay. Firm. Frequent angular flint clasts (average size 100 ,m. Frequent sub-angular chalk clasts (average size 180mm, ranges from 500 mm-300 mm).	1.10-1.50
1225		Diamicton. Lowestoft Formation	Till. Off white brown silty clay. Firm. Frequent sub-angular chalk clasts (average size 100mm, ranges in size from 500 mm to 250 mm). Frequent angular flint clasts (average size 100 mm, ranges from 60 mm-350 mm).	1.50-2.00+

<table>
<tr><td colspan="2">Trial Pit No
TP123-AR</td><td>Length
3.00 m</td><td>Width
1.00 m</td><td>Depth
2.00 m</td></tr>
<tr><td colspan="2">Easting 589246.39</td><td colspan="2">Northing 311349.77</td><td>m OD 56.55</td></tr>
<tr><td>Context Number</td><td>Fill Of/Filled With</td><td>Interpretative Category</td><td>Description</td><td>Depth BGL</td></tr>
<tr><td>1231</td><td></td><td>Modern soil profile</td><td>Dark brown to dark greyish brown soft slightly sandy slightly gravelly clay. Sand is fine to coarse. Gravels are sparse fine to coarse sub-rounded to sub-angular flint (<100mm), mostly comprising fragmented nodular pieces.

Sharp contact.</td><td>0.00-0.30</td></tr>
<tr><td>1232</td><td></td><td>Modern soil profile</td><td>Strong yellowish brown slightly sandy slightly gravelly clay. Sand is fine to coarse. Gravels are sparse to occasional fine to coarse sub-rounded to sub-angular flint (<160mm); rare to sparse sub-rounded blocky chalk (<10mm). A CBM land-drain was encountered at 0.60 mbgl.

Abrupt contact.</td><td>0.30-0.65</td></tr>
</table>

1233		Diamicton. Lowestoft Formation	Till. Firm yellowish brown and pale grey slightly sandy gravelly clay. Sand is fine to coarse. Gravels are moderate fine to coarse sub-rounded to angular flint (<145mm, including fragmented nodular pieces). Chalk is moderate fine to coarse sub-rounded to sub-angular blocky (<110mm). Sharp contact.	0.65-1.20
1234		Diamicton. Lowestoft Formation	Till. Firm to stiff dark grey to dark greyish brown slightly sandy gravelly clay browning off rapidly on exposure. Slightly darker with depth. Sand is fine to coarse chalk. Gravels are flint and chalk; moderate fine to coarse sub-rounded to angular flints with angular elements (<160mm), moderate to common fine to coarse sub-rounded blocky chalk (<95mm).	1.20-2.00+

Trial Pit No TP124-AR	**Length 2.20 m**	**Width 0.60 m**	**Depth 2.00 m**	
Easting 589389.22		**Northing 311360.37**	**m OD 74.43**	
Context Number	**Fill Of/Filled With**	**Interpretative Category**	**Description**	**Depth BGL**
1241		Modern soil profile	Dark grey brown silty clay. Moderately firm. Frequent angular and sub-angular flint clasts (average size 100mm).	0.00-0.30
1242		Diamicton. Lowestoft Formation	Till. Mid orange firm sandy clay. Very frequent angular flint and chalk clasts (average size 200mm).	0.30-0.80
1243		Diamicton. Lowestoft Formation	Till. Blue to yellow clay. Stiff. Frequent sub-angular chalk clasts (average size 150, max size 250mm). Frequent angular flint clasts (average size 100mm, maximum size 300mm).	0.80-2.00+

Trial Pit No TP125-AR	**Length 2.20 m**	**Width 0.60 m**	**Depth 2.00 m**	
Easting 589601.47		**Northing 311270.89**	**m OD 72.91**	
Context Number	**Fill Of/Filled With**	**Interpretative Category**	**Description**	**Depth BGL**

1251		Modern soil profile	Mid to dark brown silty clay. Moderately firm. Moderately frequent angular flint clasts (average size 200mm).	0.00-0.30
1252		Modern soil profile	Orange sandy clay. Stiff. Frequent angular flint clasts (average size 100m, maximum size 300mm).	0.30-0.60
1253		Diamicton. Lowestoft Formation	Dark orange brown sandy clay. Firm. Very frequent angular flint clasts (average size 200mm).	0.60-1.20
1254		Diamicton. Lowestoft Formation	Light grey chalky silty clay. Very firm. Angular flints clasts (0.10-0.40mm).	1.20-2.00+

Trial Pit No TP126-AR	**Length 2.40 m**	**Width 0.60 m**	**Depth 2.10 m**	
Easting 589787.84		**Northing 311175.54**	**m OD 72.81**	
Context Number	**Fill Of/Filled With**	**Interpretative Category**	**Description**	**Depth BGL**
1261		Modern soil profile	Soft dark grey brown slightly sandy slightly gravelly silty clay. Sand is fine to coarse. Gravel is sparse fine to coarse sub-angular to sub-rounded flint (<60 mm). Abrupt contact.	0.00-0.35
1262		Diamicton. Lowestoft Formation	Stiff dark orange gravelly silty clay diamict. Sparse bands of light grey fine to coarse sand. Gravel is very common sub-angular to sub-rounded fine to coarse flint (<60 mm), predominantly medium to coarse flint. Rare pockets (<200 ×150 mm) of mid orangish brown fine to coarse sand. Abrupt contact.	0.35-1.10

1263		Diamicton. Lowestoft Formation	Till. Stiff mid grey mottled orangish brown slightly sandy gravelly clayey silt diamict. Sand is fine to coarse. Gravel is frequent fine to coarse sub-angular to rounded chalk (<60 mm), sparse sub-angular to sub-rounded fine to coarse flint (<60 mm). Very rare sub-rounded to rounded fine to medium quartzite (<30 mm). Very occasional chalk cobbles (<140 mm). From 1.20 0m includes moderate sub-angular to sub-rounded flint cobbles (<160mm). From 1.70 mbgl common sub-angular to sub-rounded flint cobbles (<180mm) and rare sub-angular to rounded flint boulders (<300mm). Chalk content remains the same throughout.	1.10-2.10+

Trial Pit No TP127-AR	**Length 2.20 m**	**Width 0.60 m**	**Depth 2.00 m**	
Easting 589847.97	**Northing 311104.52**	**m OD 80.96**		
Context Number	**Fill Of/Filled With**	**Interpretative Category**	**Description**	**Depth BGL**
1271		Modern soil profile	Mid to dark brown silty clay. Frequent angular flint clasts (average size 150mm).	0.00-0.30
1272		Diamicton. Lowestoft Formation	Orange sandy clay. Firm. Frequent angular flint and chalk clasts (average size 200mm)	0.30-01.10
1273		Diamicton. Lowestoft Formation	Light brown yellow silty clay. Firm. Frequent angular flint and sub-angular chalk clasts (average size 160mm)	1.10-2.00+

Trial Pit No TP128-AR	**Length 2.20 m**	**Width 0.60 m**	**Depth 2.00 m**	
Easting 589813.20	**Northing 310961.15**	**m OD 68.73**		
Context Number	**Fill Of/Filled With**	**Interpretative Category**	**Description**	**Depth BGL**

1281		Modern soil profile	Mid to dark brown silty clay. Soft. Frequent angular flint clasts (average size 160mm).	0.00-0.30
1282		Modern soil profile	Mid yellow brown silty clay. Firm. Frequent angular flint clasts (average size 100mm).	0.30-0.50
1283		Diamicton. Lowestoft Formation	Light yellow brown silty gravelly clay. Firm. Very frequent chalk clasts (average size 500mm. Frequent angular flint clasts (average size 250mm).	0.50-1.60
1284		Diamicton. Lowestoft Formation	Mid to dark grey brown silty clay. Firm. Coarse angular flint clasts (average size 200mm. Coarse chalk clast (average size 160mm).	1.60-2.00+

Trial Pit No TP129-AR	**Length 8.00 m**	**Width 1.50 m**	**Depth 2.00 m**	
Easting 589804.68		**Northing 310767.63**	**m OD 60.51**	
Context Number	**Fill Of/Filled With**	**Interpretative Category**	**Description**	**Depth BGL**
1291		Modern soil profile	Stiff dark brown slightly sandy slightly gravelly clay. Sand is fine to coarse. Gravel is sparse angular to sub-rounded fine to medium flint and rare sub-angular to rounded fine to medium chalk. Abrupt contact.	0.00-0.40
1292		Modern soil profile	Firm mid orangish brown slightly sandy slightly gravelly clay. Sand is fine to coarse. Gravel is rare sub-angular to sub-rounded fine to medium flint and very rare sub-rounded to rounded fine to medium chalk. Abrupt contact.	0.40-0.60

1293		Diamicton. Lowestoft Formation	Till. Firm light grey brown mottled yellowish brown slightly sandy gravelly clay. Sand is fine. Gravel is sparse sub-angular to rounded fine to very coarse flint, up to nodules. Frequent sub-angular to rounded fine to medium chalk clasts.	0.40-2.00+

Trial Pit No TP130-AR	**Length 4.20 m**		**Width 1.70 m**	**Depth 2.00 m**
Easting 589975.38		**Northing 310639.32**		**m OD 61.65**
Context Number	**Fill Of/Filled With**	**Interpretative Category**	**Description**	**Depth BGL**
1301		Modern soil profile	Dark brown very soft slightly sandy slightly gravelly clay. Sand is fine to coarse. Gravel is very rare sub-angular to sub-rounded fine chalk (<10mm) and sparse angular to sub-rounded fine to medium flint (<40mm). Abrupt contact.	0.00-0.35
1302		Modern soil profile	Firm mid orangish brown slightly sandy slightly gravelly clay. Sand is fine to medium. Gravel is very rare sub-angular to sub-rounded fine to medium flint (<40mm). Abrupt contact. Found as large pockets at top of 1303.	0.35-0.60

1303		Diamicton. Lowestoft Formation	Till. Firm light yellowish brown mottled orangish brown slightly sandy gravelly clay. Sand is fine. Gravel is abundant angular to sub-rounded fine to coarse chalk (<60mm), predominantly fine to medium, with rare angular to sub-rounded fine to coarse flint (<60mm). From 1.00 mbgl flint cobbles (<200mm). From 1.30 mbgl very rare sub-angular to sub-rounded flint boulders (<300mm). From 1.40 mbgl chalk size increases to cobbles (<150mm).	0.35-2.00+

Trial Pit No SA101-AR		**Length 3.00 m**	**Width 1.80 m**	**Depth 3.00 m**
Easting 589405.00		**Northing 311351.00**		**m OD 72.67**
Context Number	**Fill Of/Filled With**	**Interpretative Category**	**Description**	**Depth BGL**
81011		Modern soil profile	Mid to dark greyish brown soft slightly sandy slightly gravelly clay silt. Sand is fine to medium. Gravel is occasional fine to coarse angular, sub-angular and sub-rounded flint (<115 mm). Sparse sub-rounded blocky chalk inclusions (<16 mm). Abrupt contact.	0.00-0.27

81012		Modern soil profile	Yellowish brown soft slightly sandy slightly gravelly clay silt. Sand is fine to medium. Gravel is sparse to occasional fine to coarse angular, sub-angular and sub-rounded flint (<95 mm). Sparse sub-rounded blocky chalk inclusions (<22 mm). Abrupt contact.	0.27-0.35
81013		Diamicton. Lowestoft Formation	Mid to pale yellowish brown slightly sandy slightly gravelly clay. Sand is fine to medium. Gravel is moderate small sub-rounded blocky chalk (<30 mm) with sparse sub-rounded to sub-angular fine to coarse flint (<125 mm). Diffuse contact.	0.35-0.60
81014		Diamicton. Lowestoft Formation	Pale grey slightly sandy slightly gravelly silty clay with mid to pale yellowish brown slightly sandy slightly gravelly silty clay. Sand is mostly chalk derived, fine to coarse. Gravel is mostly fine to coarse sub-rounded to rounded chalk (<88 mm), rare sub-angular clasts. Sparse to occasional sub-rounded to angular flint clasts (fine to coarse), cobbles and boulders (<350mm). Silt percentage increases slightly with depth. Sharp contact.	0.60-1.10
81015		Diamicton. Lowestoft Formation	Stiff grey to dark grey slightly sandy gravelly clay. Sand is medium to coarse. Chalk is hard, common, fine to coarse rounded, sub-rounded and sub-angular (<115mm), some boulder sized. Flint is moderate to common fine to very coarse (<400mm). Chalk tends to increase slightly in frequency with depth.	1.10-3.00+

Trial Pit No SA102-AR	Length 2.00 m	Width 1.80 m	Depth 3.00 m
Easting 589695.00	**Northing 311222.00**	**m OD 70.47**	

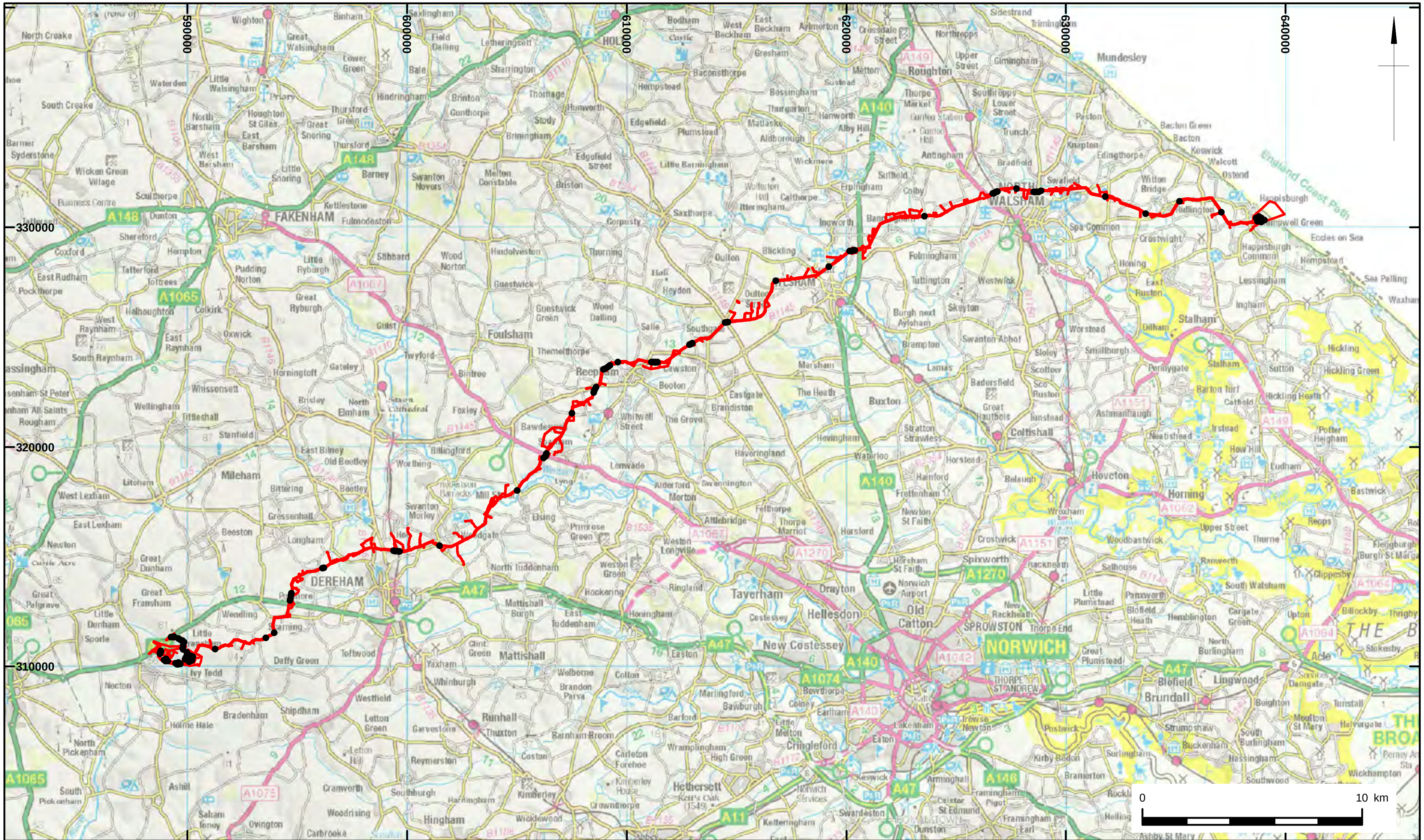
Context Number	Fill Of/Filled With	Interpretative Category	Description	Depth BGL
81021		Modern soil profile	Mid to dark greyish brown soft slightly sandy slightly gravelly clay silt. Sand is fine to medium. Gravel is sparse to occasional fine to coarse angular, sub-angular and sub-rounded flint gravels (<115 mm). Sparse sub-rounded blocky chalk inclusions (<15 mm). Abrupt contact.	0.00-0.30

81022		Modern soil profile	Yellowish brown to strong yellowish-brown soft clay. Rare sand, rare flint gravel (sub-rounded <45 mm). Blocky structure in upper bioturbated zone becoming less obvious towards base	0.30-0.50
81023		Diamicton. Lowestoft Formation	Greyish brown slightly sandy gravelly clay with mid to pale yellowish brown slightly sandy gravelly clay mottling. Sand is fine to coarse. Gravel is mostly fine to coarse sub-rounded to rounded chalk (<80 mm), rarely sub-angular. Sparse to occasional sub-rounded to angular flint gravels (fine to coarse), cobbles and boulders (<270mm). Angular elements derive from fractured nodules. Sharp contact.	0.50-1.10
81024		Diamicton. Lowestoft Formation	Till. Stiff dark greyish brown slightly sandy gravelly clay, smearing to a yellowish-brown colour. Sand is medium to coarse. Gravels are chalk and flint. Chalk is common, fine to coarse rounded, sub-rounded and sub-angular (<200mm). Flint is moderate fine to coarse clasts(<300mm). Chalk tends to increase slightly in frequency with depth.	1.10-3.00+

Trial Pit No SA103-AR	**Length 2.20 m**		**Width 0.60 m**	**Depth 3.00 m**
Easting 589792.72		**Northing 310831.81**		**m OD 63.84**
Context Number	**Fill Of/Filled With**	**Interpretative Category**	**Description**	**Depth BGL**
81031		Modern soil profile	Mid to dark brown silty clay. Occasional fine sub-angular flint clasts (average size 100mm).	0.00-0.70
81032		Diamicton. Lowestoft Formation	Mid brown sandy clay. Stiff. Occasional fine angular chalk clast (50mm average size). Occasional angular flint clasts (100mm average size).	0.70-1.70

81033		Diamicton. Lowestoft Formation	Mid grey firm clay. Frequent rounded chalk clasts (average size 150mm). Frequent flint angular and sub-angular flint clasts (average size 200mm).	1.70-3.00+

Trial Pit No SA104-AR	**Length 3.00 m**	**Width 1.00 m**	**Depth 3.00 m**	
Easting 590078.73		**Northing 310211.45**	**m OD 71.23**	
Context Number	**Fill Of/Filled With**	**Interpretative Category**	**Description**	**Depth BGL**
81041		Modern soil profile	Soft dark greyish brown slightly sandy slightly gravelly clay. Sparse to occasional fine to coarse sub-rounded to angular flint clasts (<115mm). Sharp contact.	0.00-0.50
81042		Diamicton. Lowestoft Formation	Firm light grey slightly sandy gravelly clay with orange brown mottling. Occasional to moderate fine to very coarse sub-rounded to angular flint clasts (<280mm). Occasional to moderate fine to very coarse sub-rounded to sub-angular blocky chalk (<150mm).	0.50-3.00+



● SI intervention ▭ Onshore Project Areas

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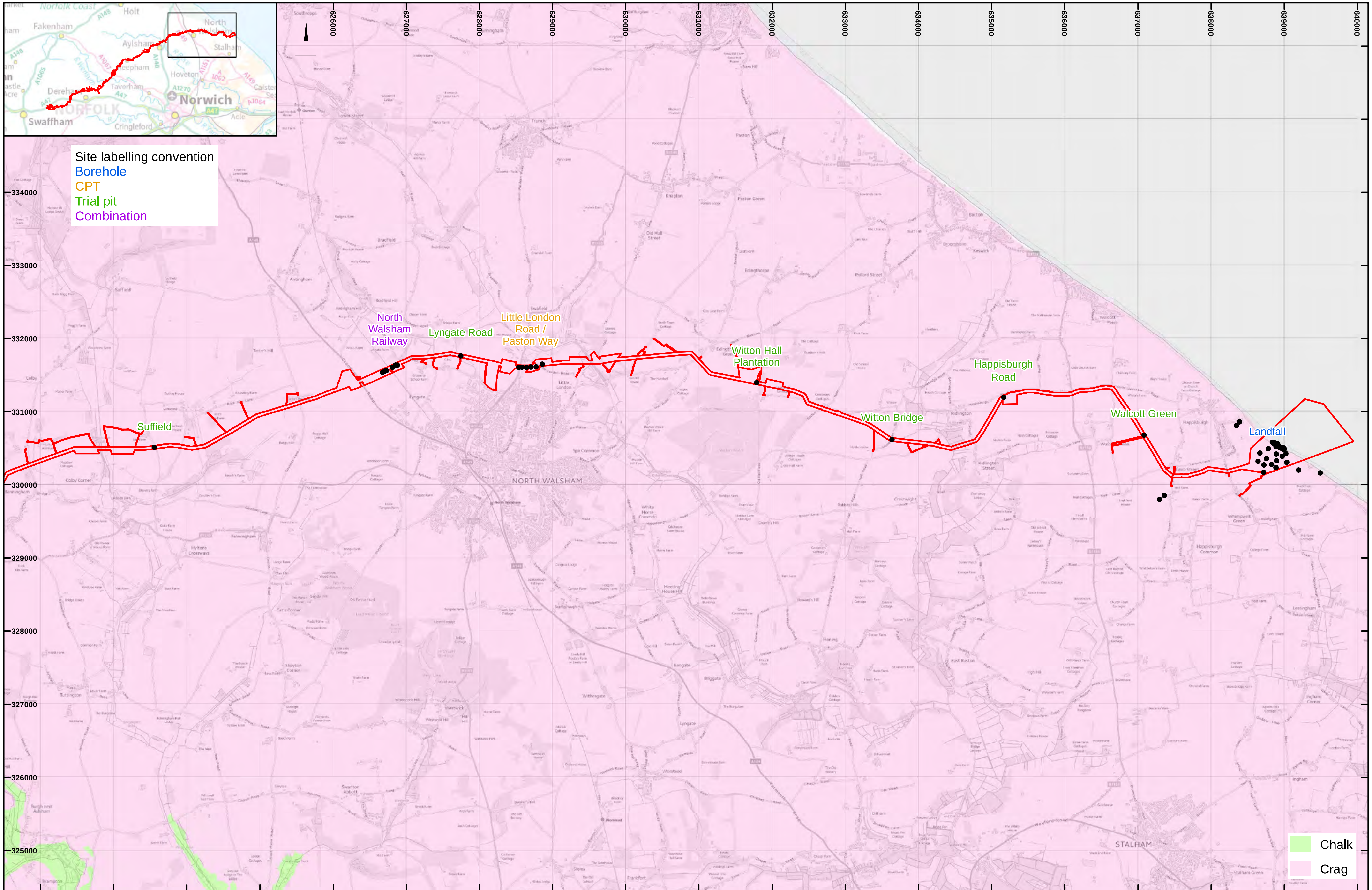
Proposed cable routes (onshore project areas)

Figure 1



Onshore Project Areas

SI intervention

0 2.5 km

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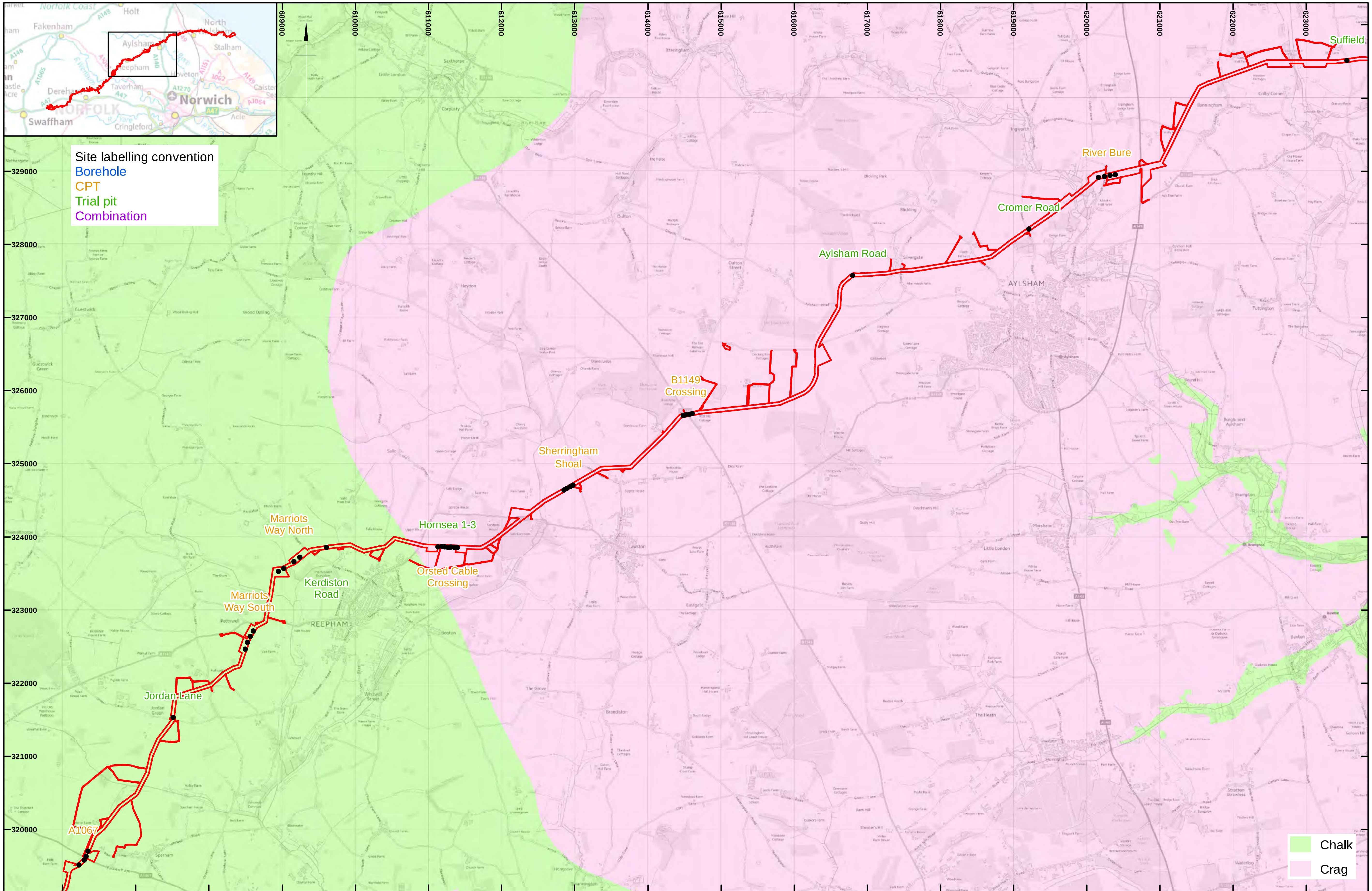
Solid geology: eastern section

Figure 2



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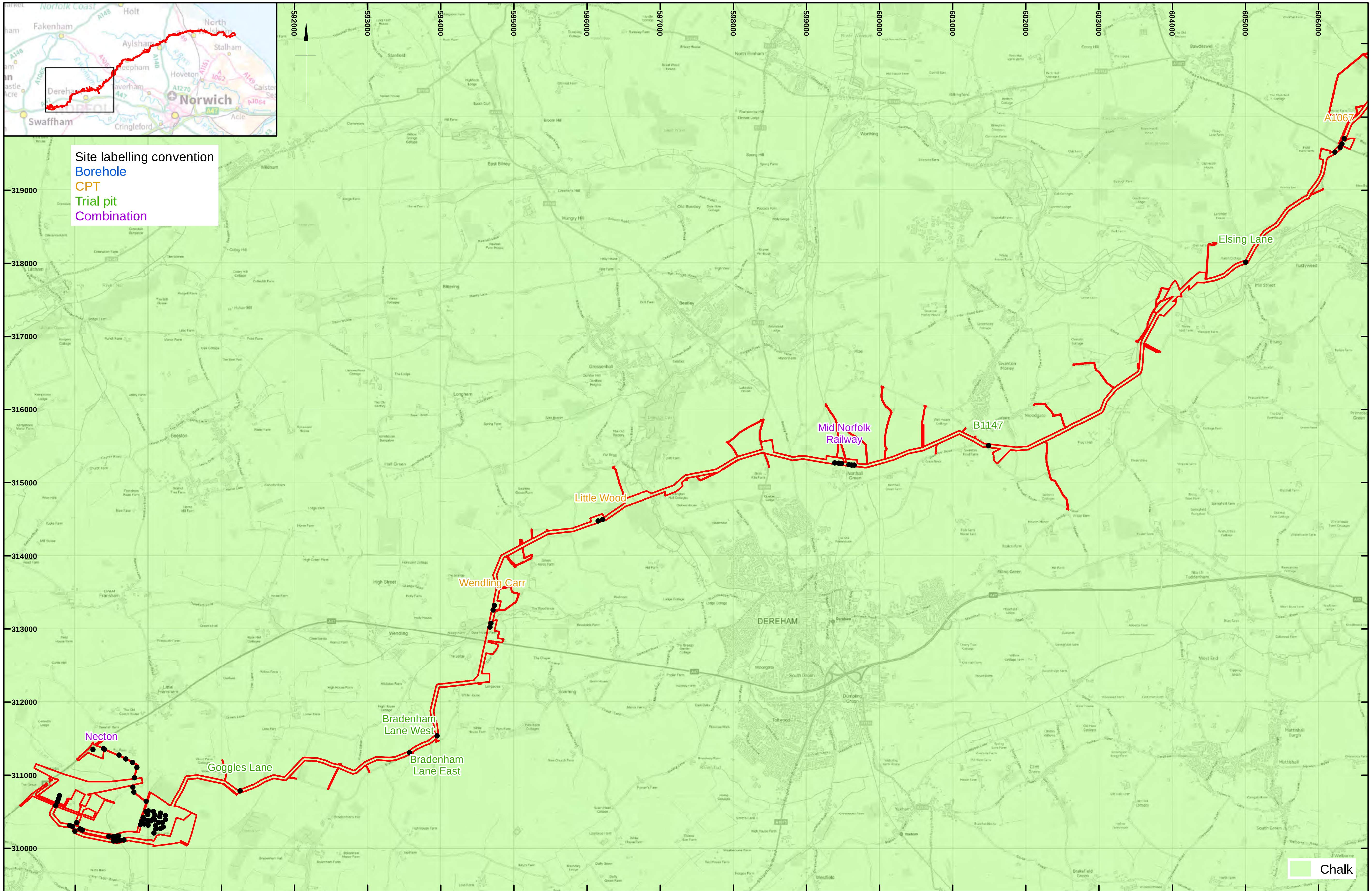
Solid geology: central section

Figure 3



Onshore Project Areas

SI intervention

0 2.5 km

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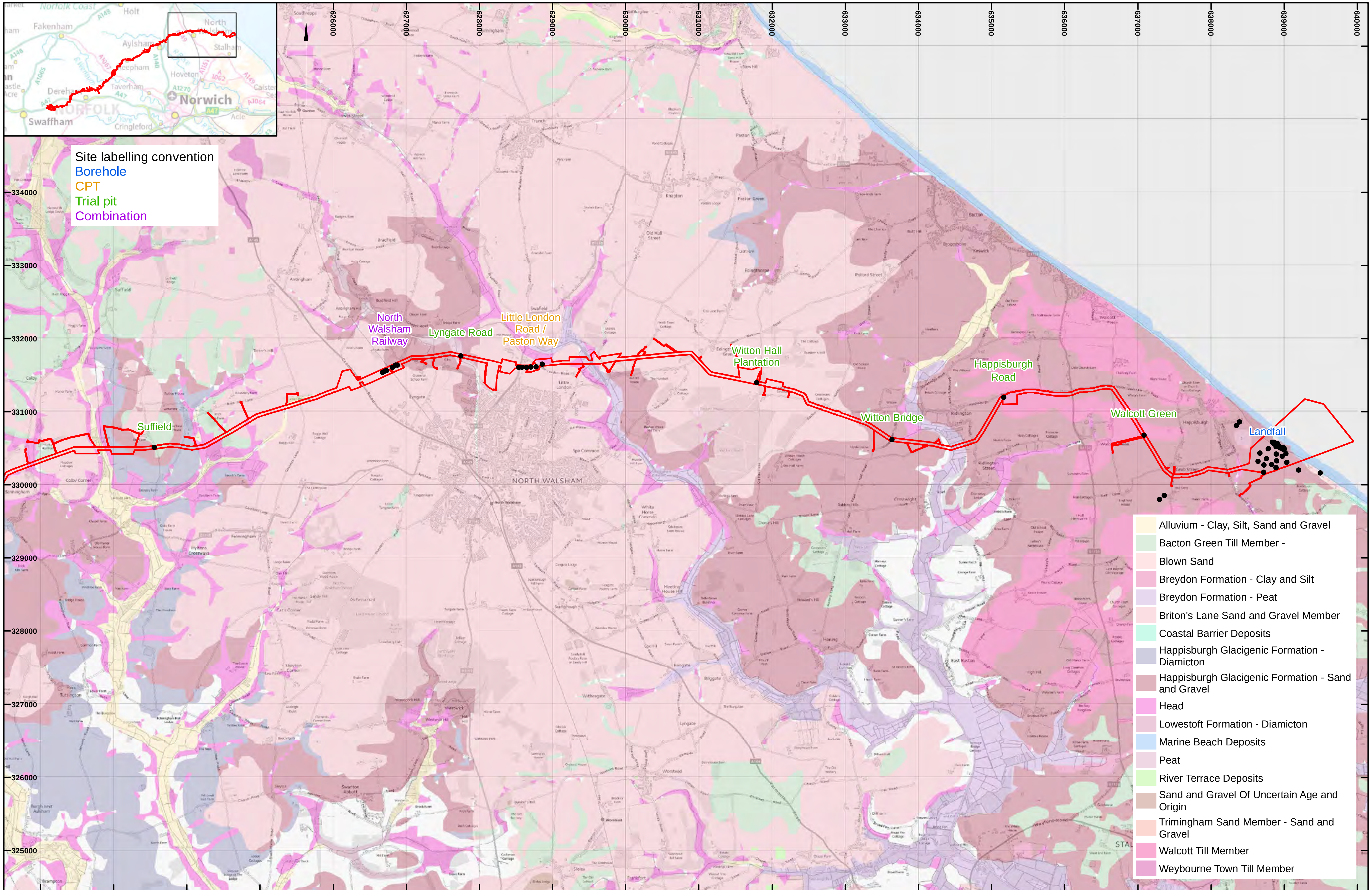
Solid geology: western section

Figure 4



Onshore Project Areas

• SI intervention

0 2.5 km

Date:	15/11/2021	Revision Number:	1
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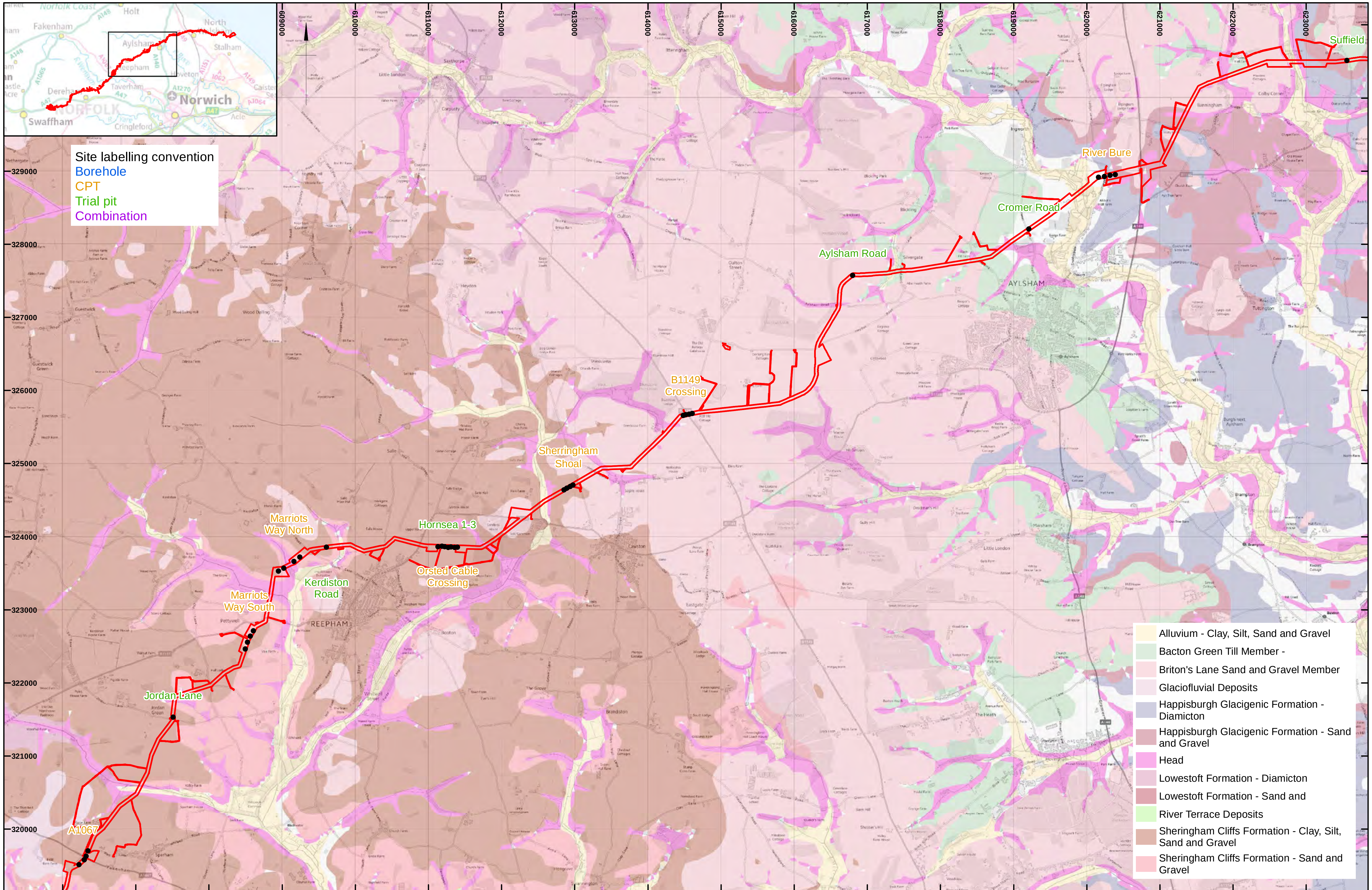
Superficial geology: eastern section



Onshore Project Areas

• SI intervention

0 2.5 km

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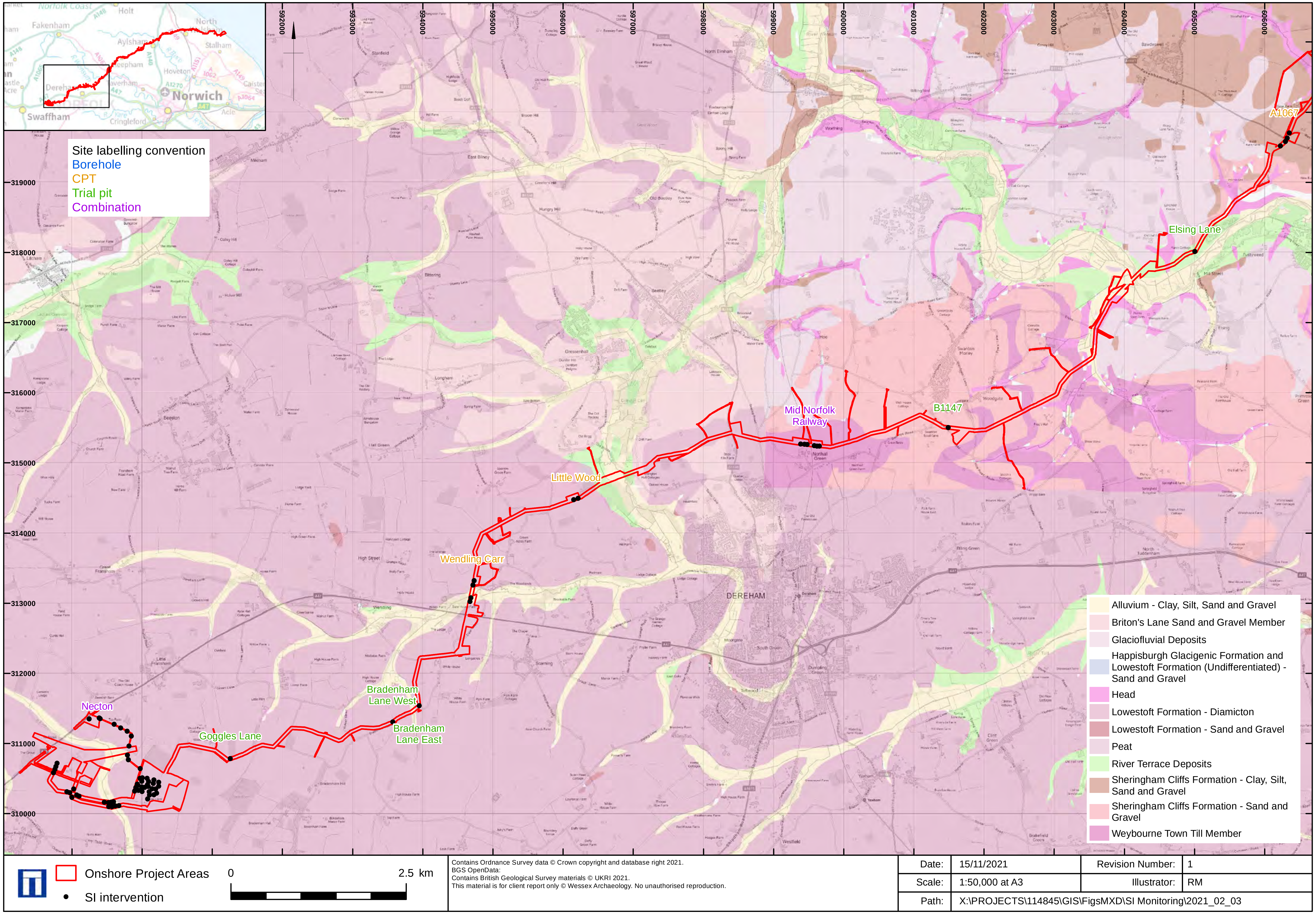
Superficial geology: central section

Figure 6



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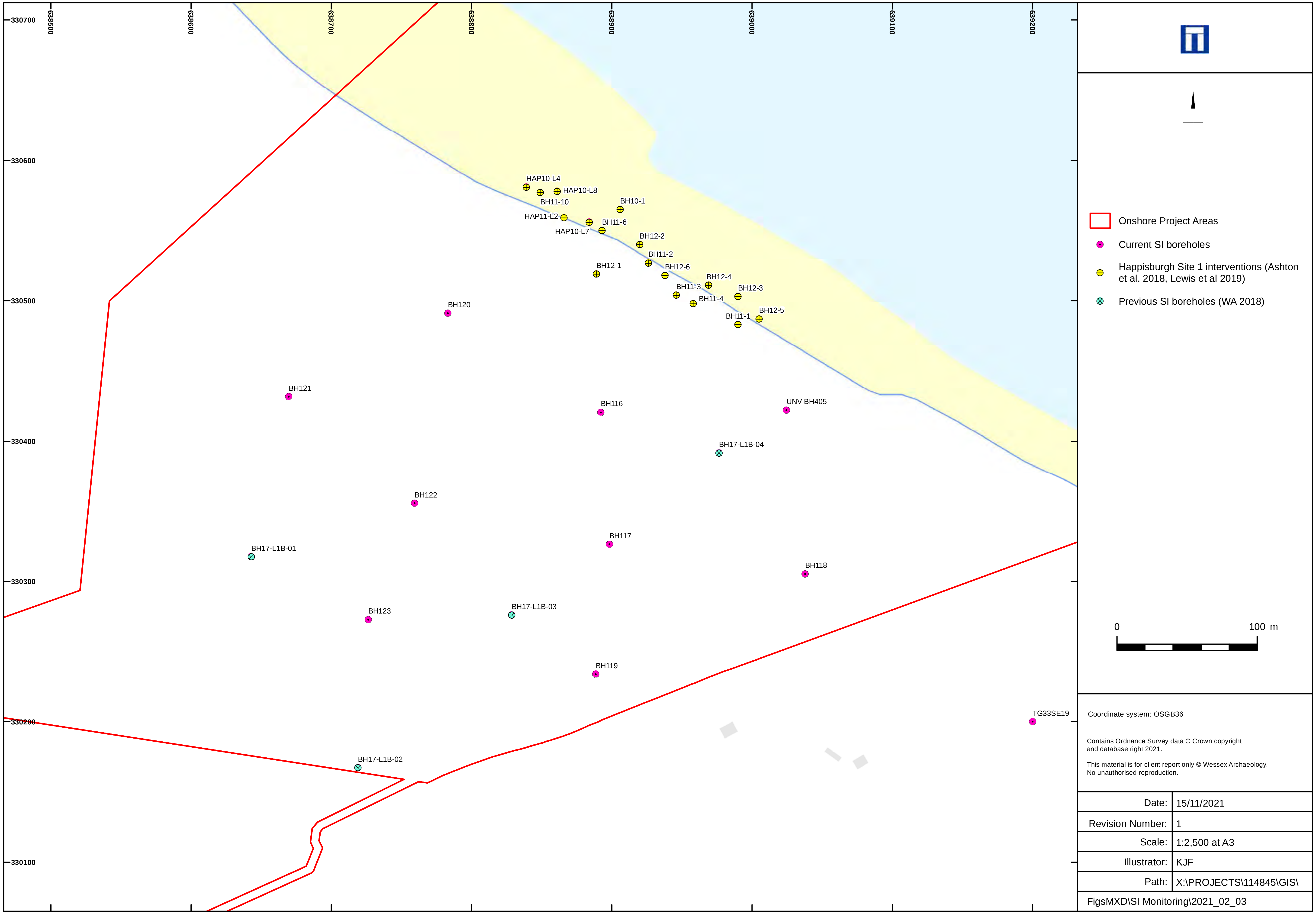
Superficial geology: western section

Figure 7



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Revision Number:	1
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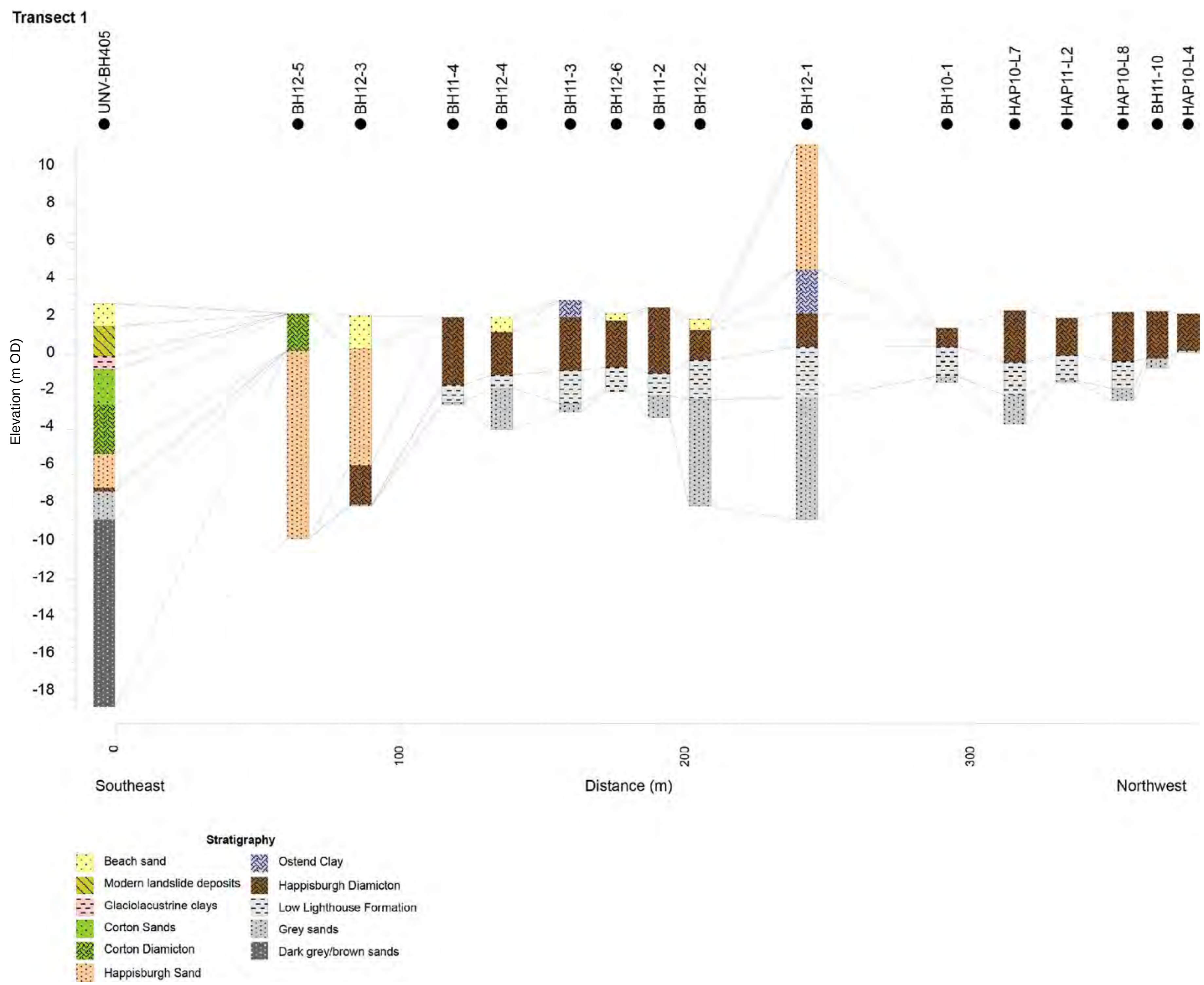
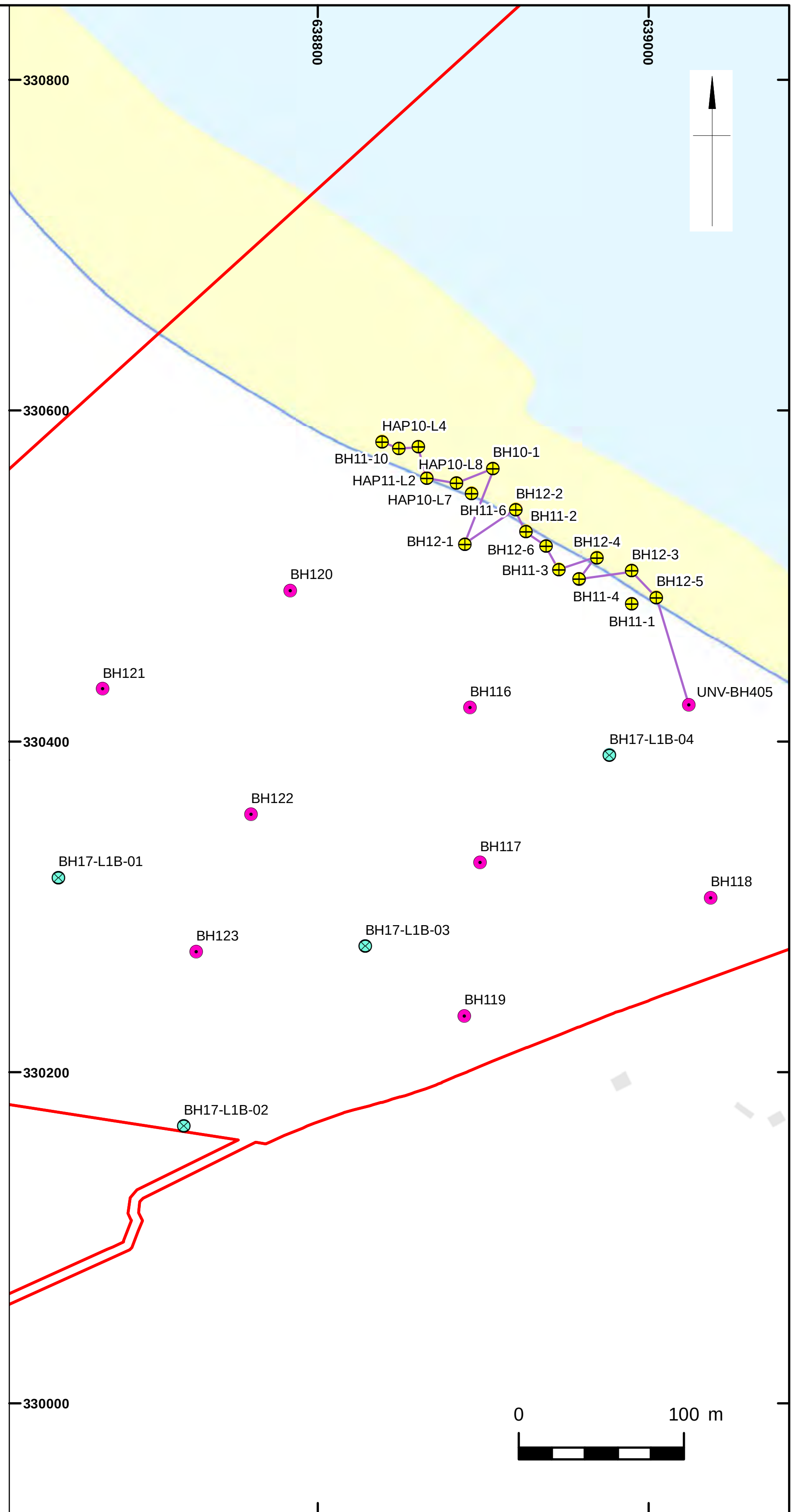
Happisburgh Landfall site plan

Figure 8





Onshore Project Areas

Current SI boreholes

Happisburgh Site 1 interventions (Ashton et al. 2018, Lewis et al 2019)

Previous SI boreholes (WA 2018)

Transect 1

Coordinate system: OSGB36

Date:	15/11/2021	Revision Number:	1
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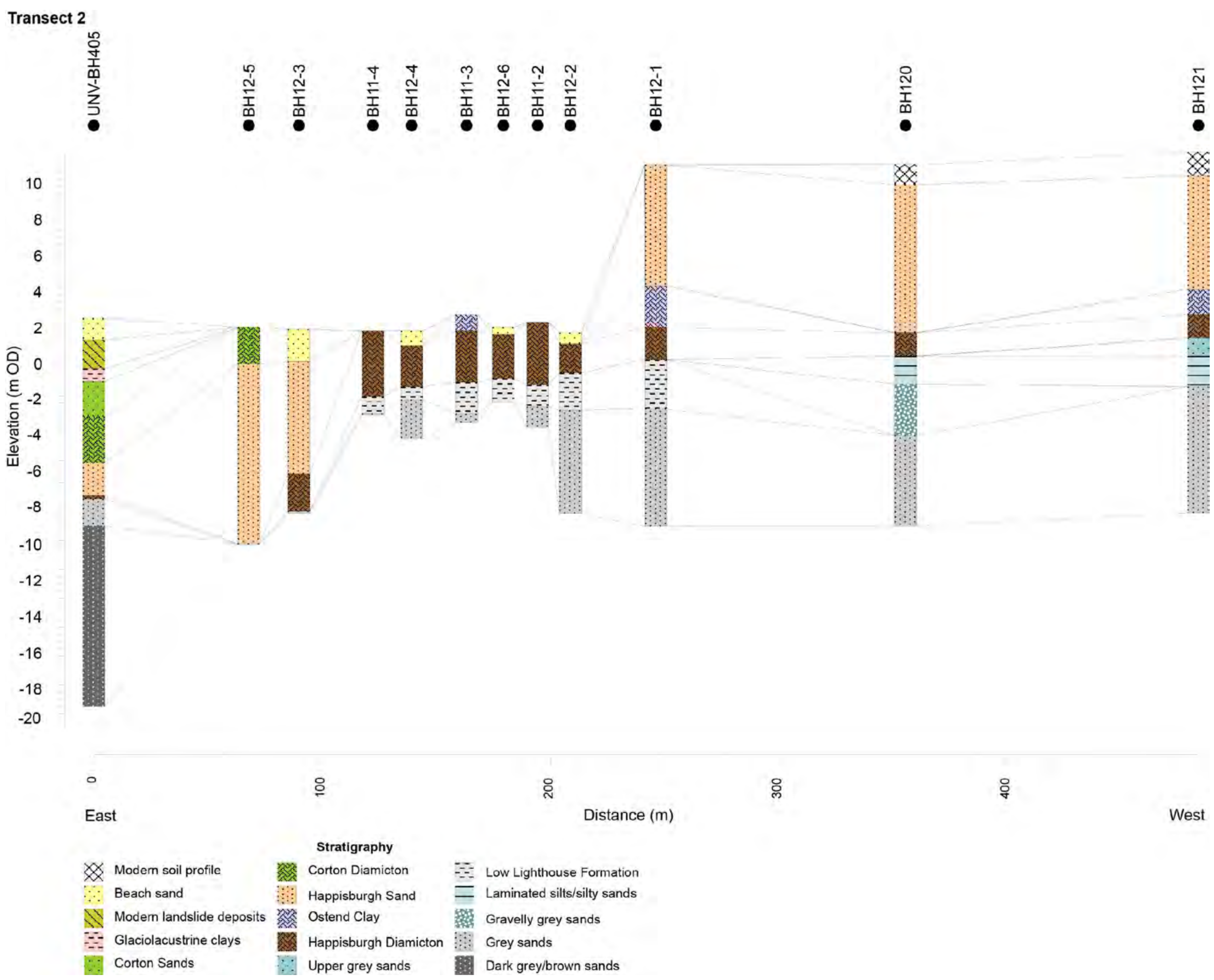
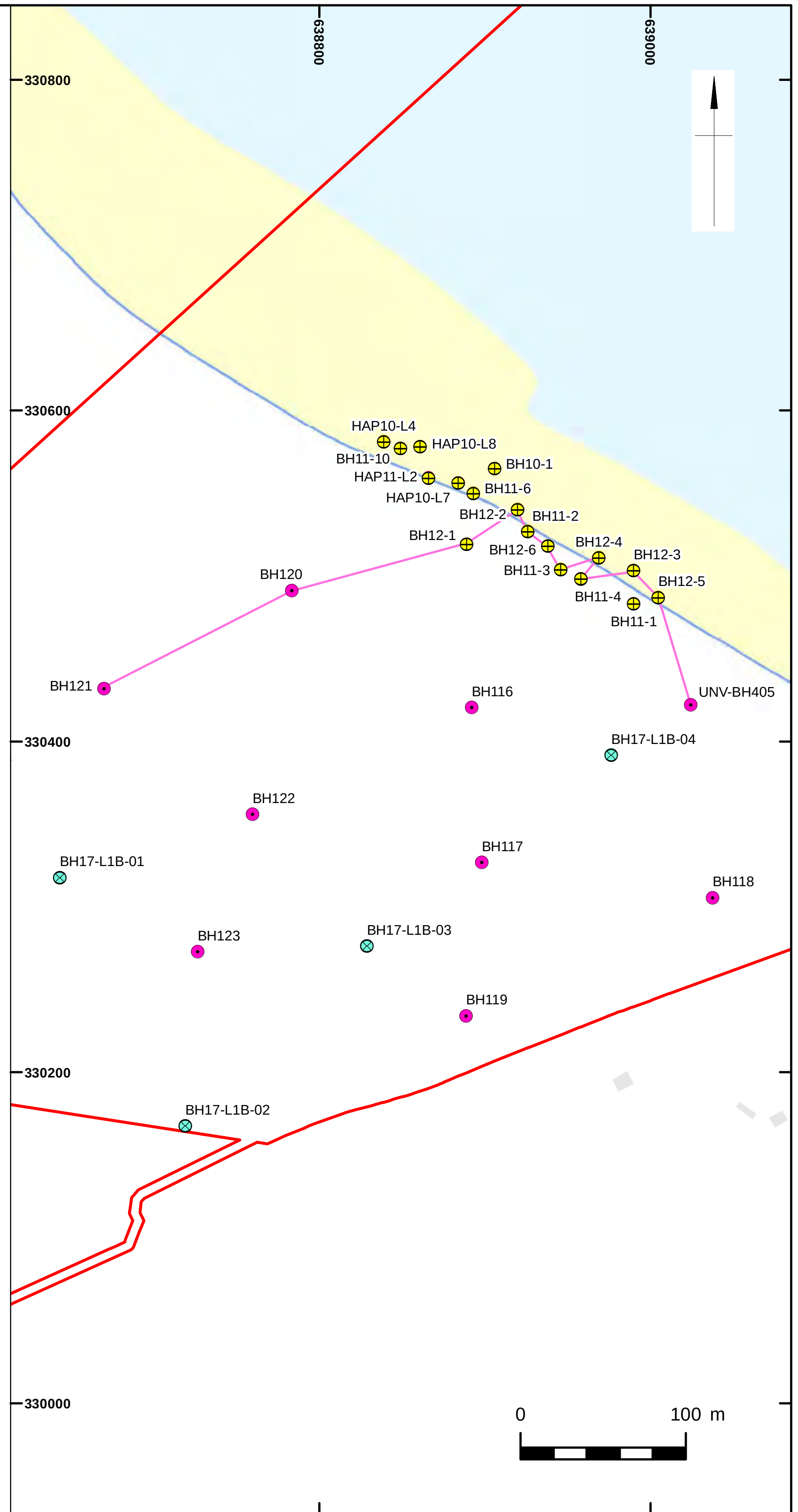
Cross section along Transect 1, Happisburgh Landfall





Onshore Project Areas

Current SI boreholes

Happisburgh Site 1 interventions (Ashton et al. 2018, Lewis et al 2019)

Previous SI boreholes (WA 2018)

Transect 2

Coordinate system: OSGB36

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Scale:	Location 1:4,000 at A3	Illustrator:	KJF
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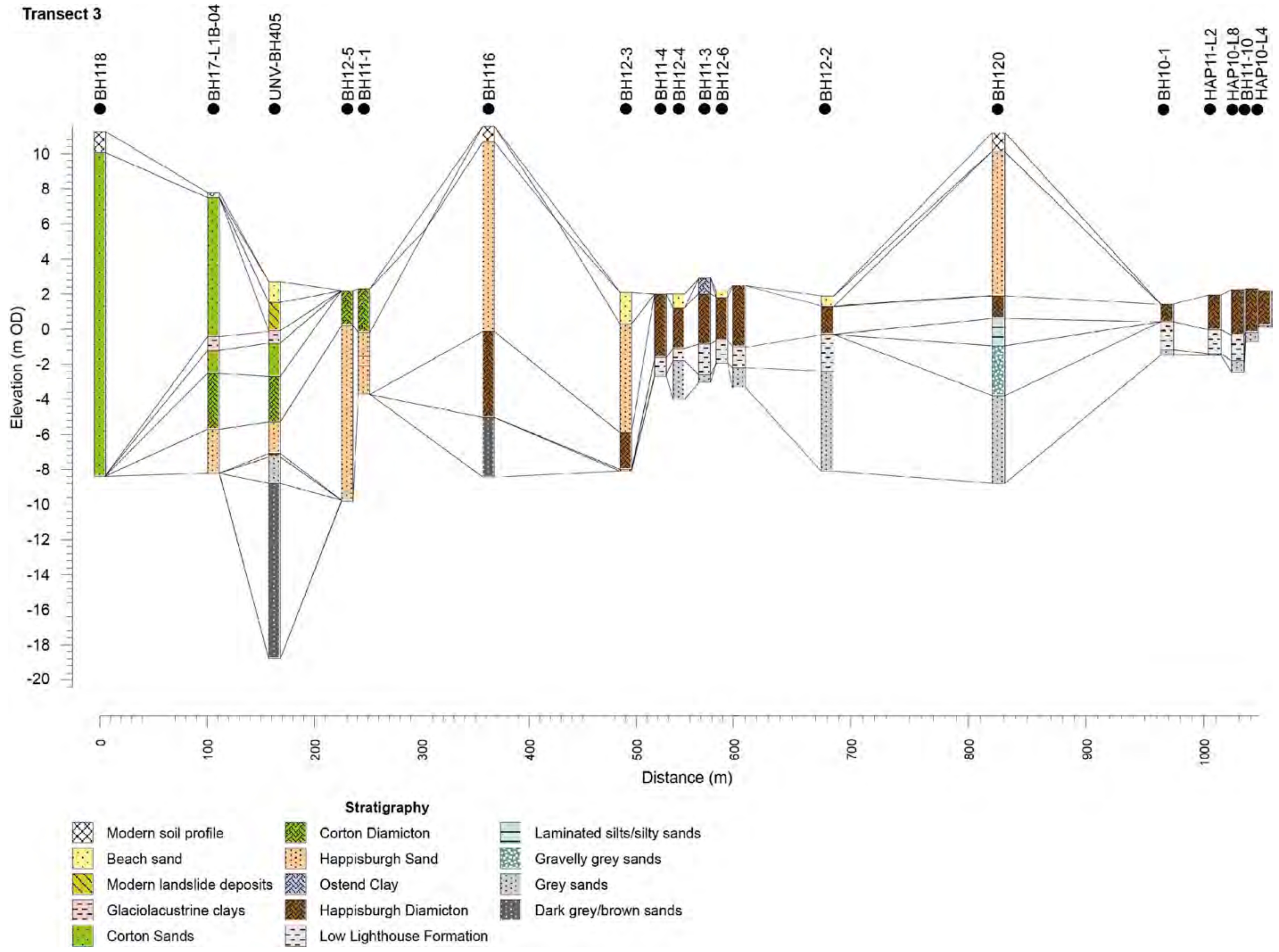
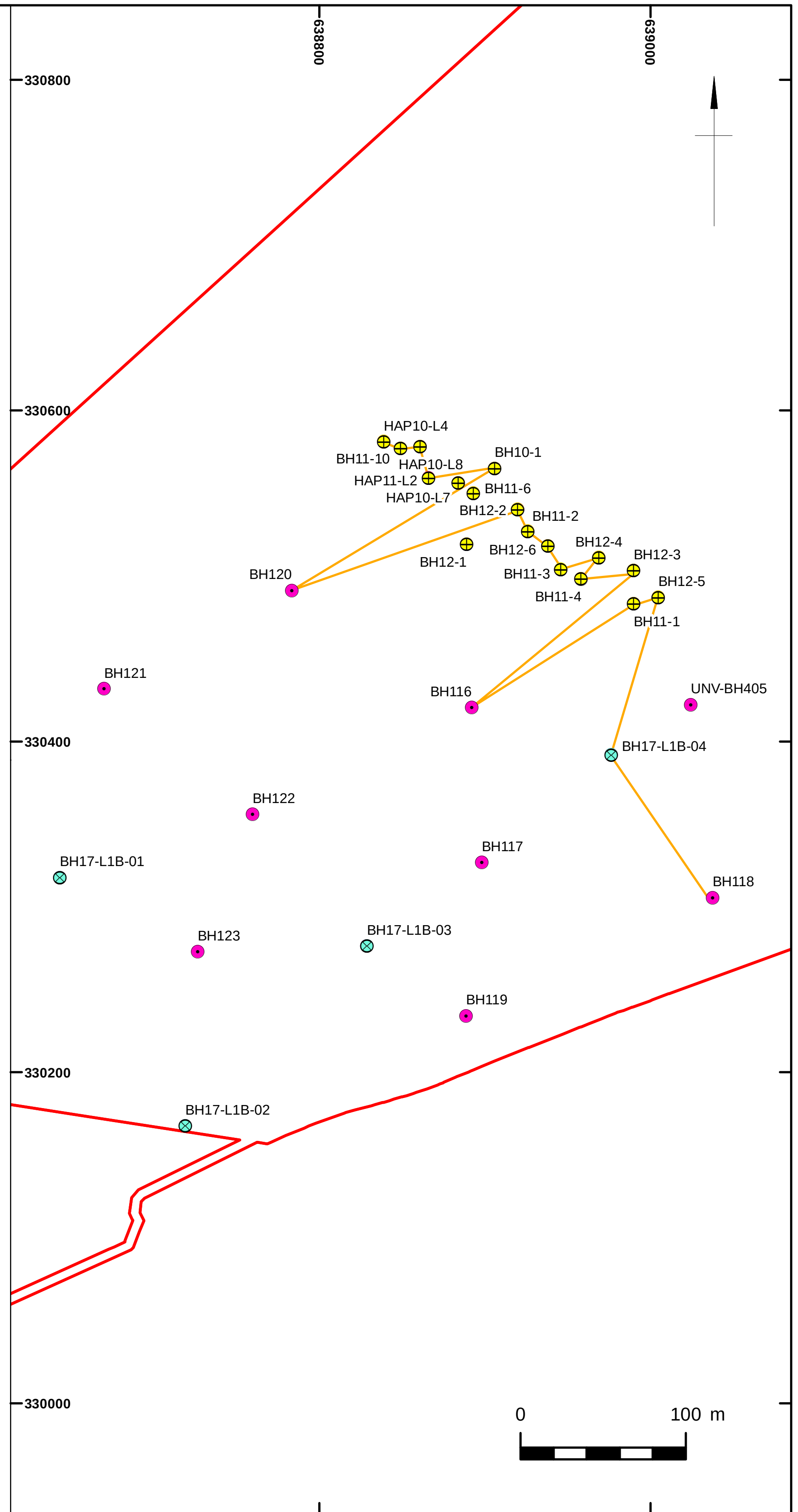
Cross section along Transect 2, Happisburgh Landfall

Figure 10





Onshore Project Areas

Current SI boreholes

Happisburgh Site 1 interventions (Ashton et al. 2018, Lewis et al 2019)

Previous SI boreholes (WA 2018)

Transect 3

Coordinate system: OSGB36

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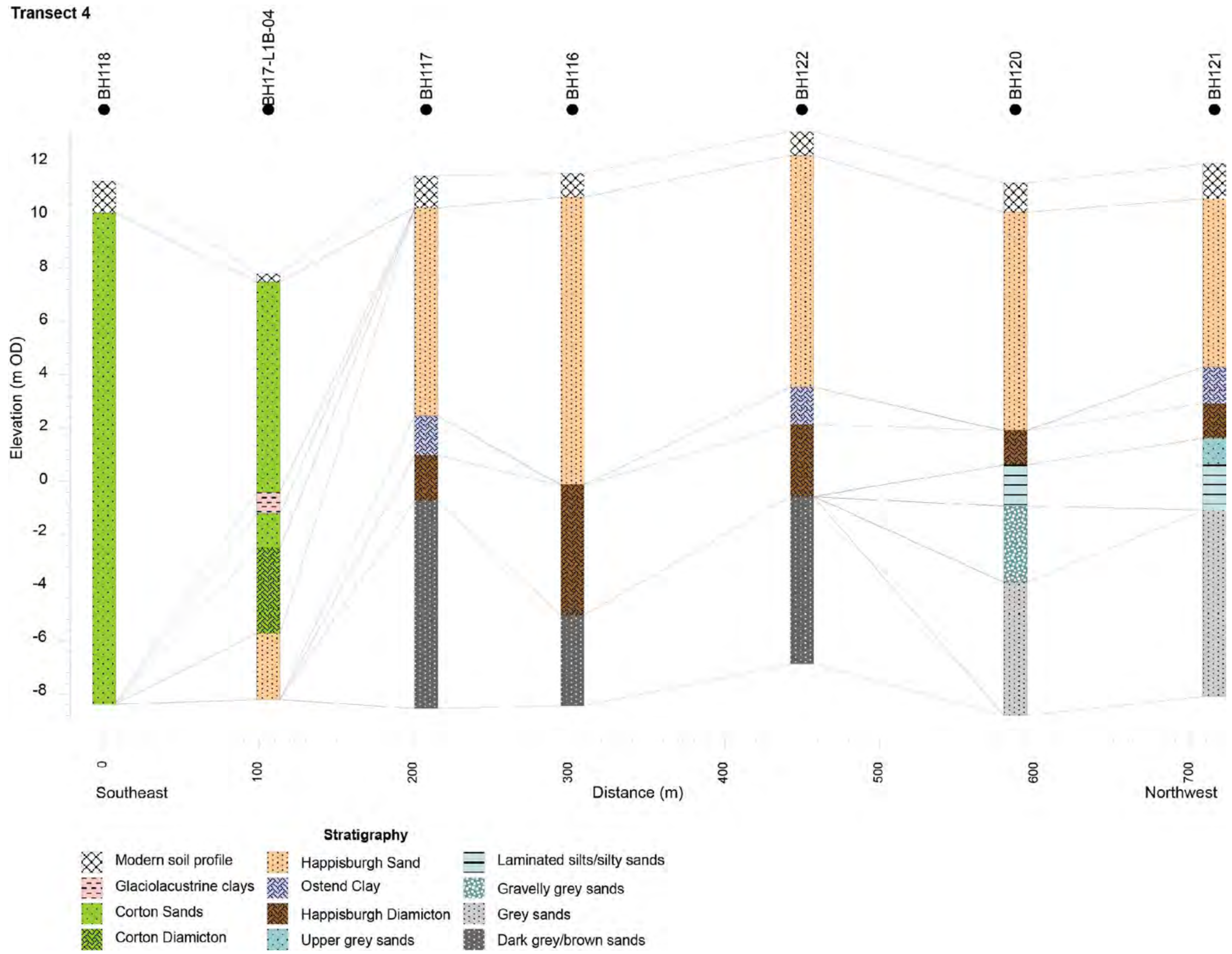
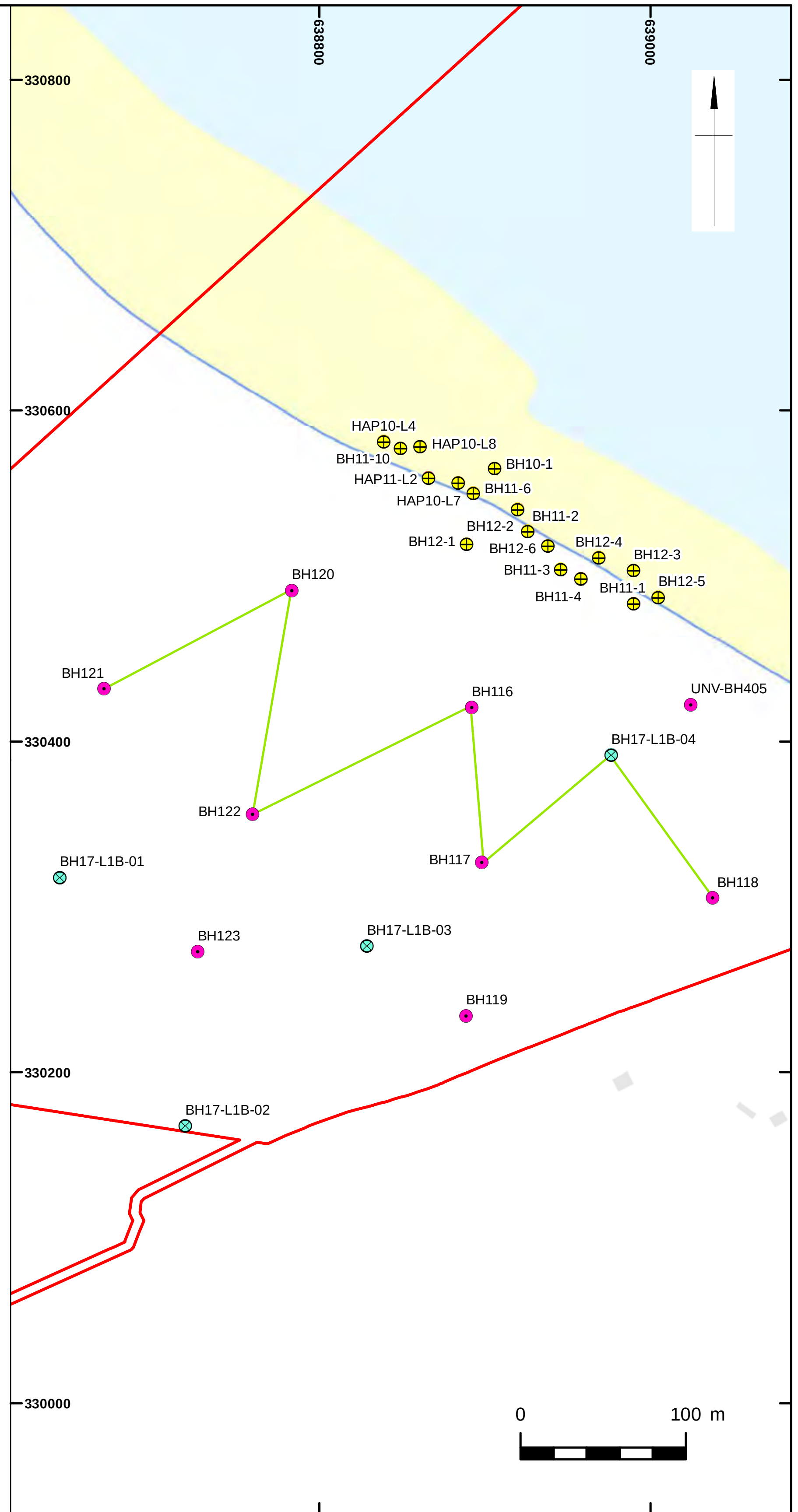
Cross section along Transect 3, Happisburgh Landfall

Figure 11





Onshore Project Areas

Current SI boreholes

Happisburgh Site 1 interventions (Ashton et al. 2018, Lewis et al 2019)

Previous SI boreholes (WA 2018)

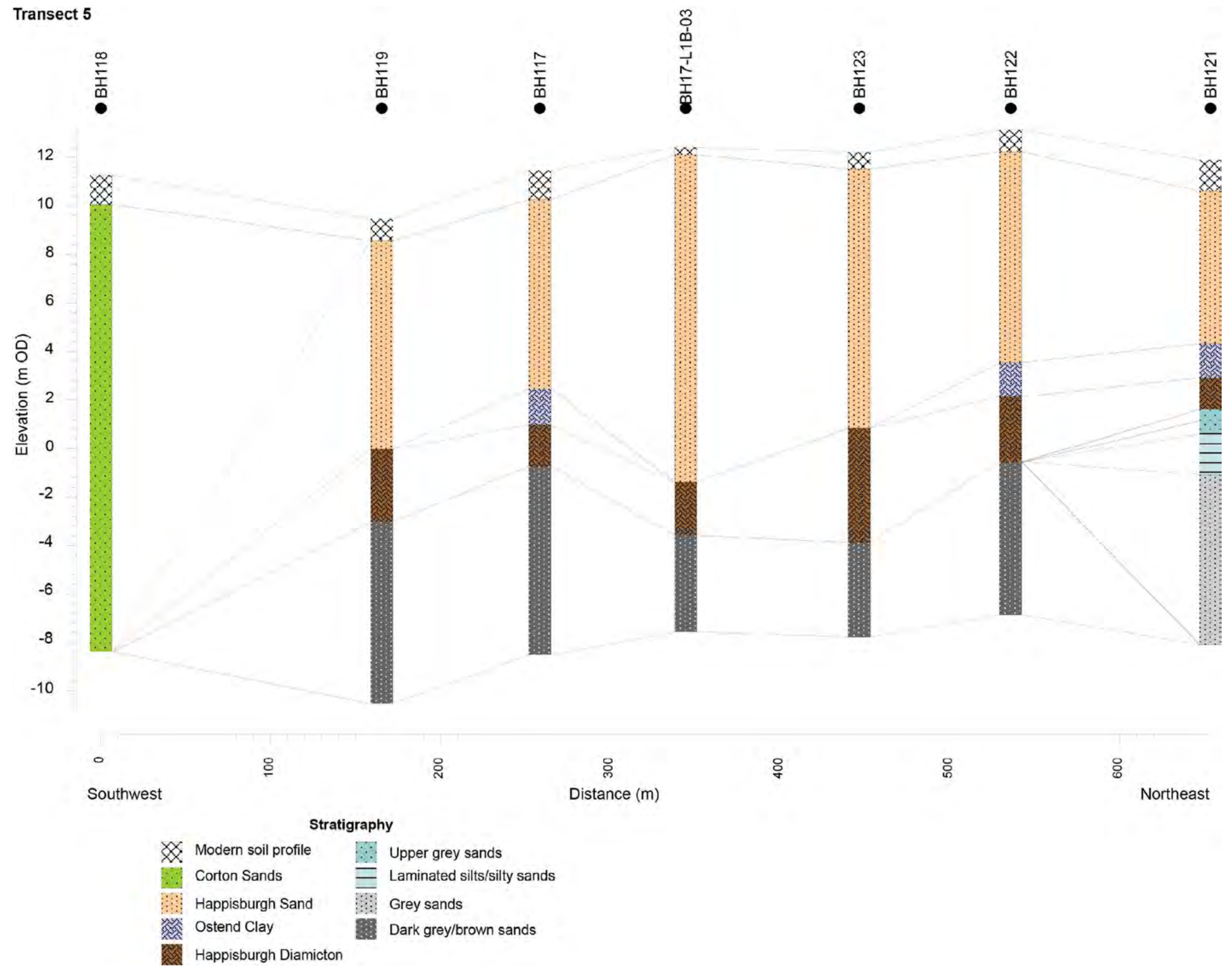
Transect 4

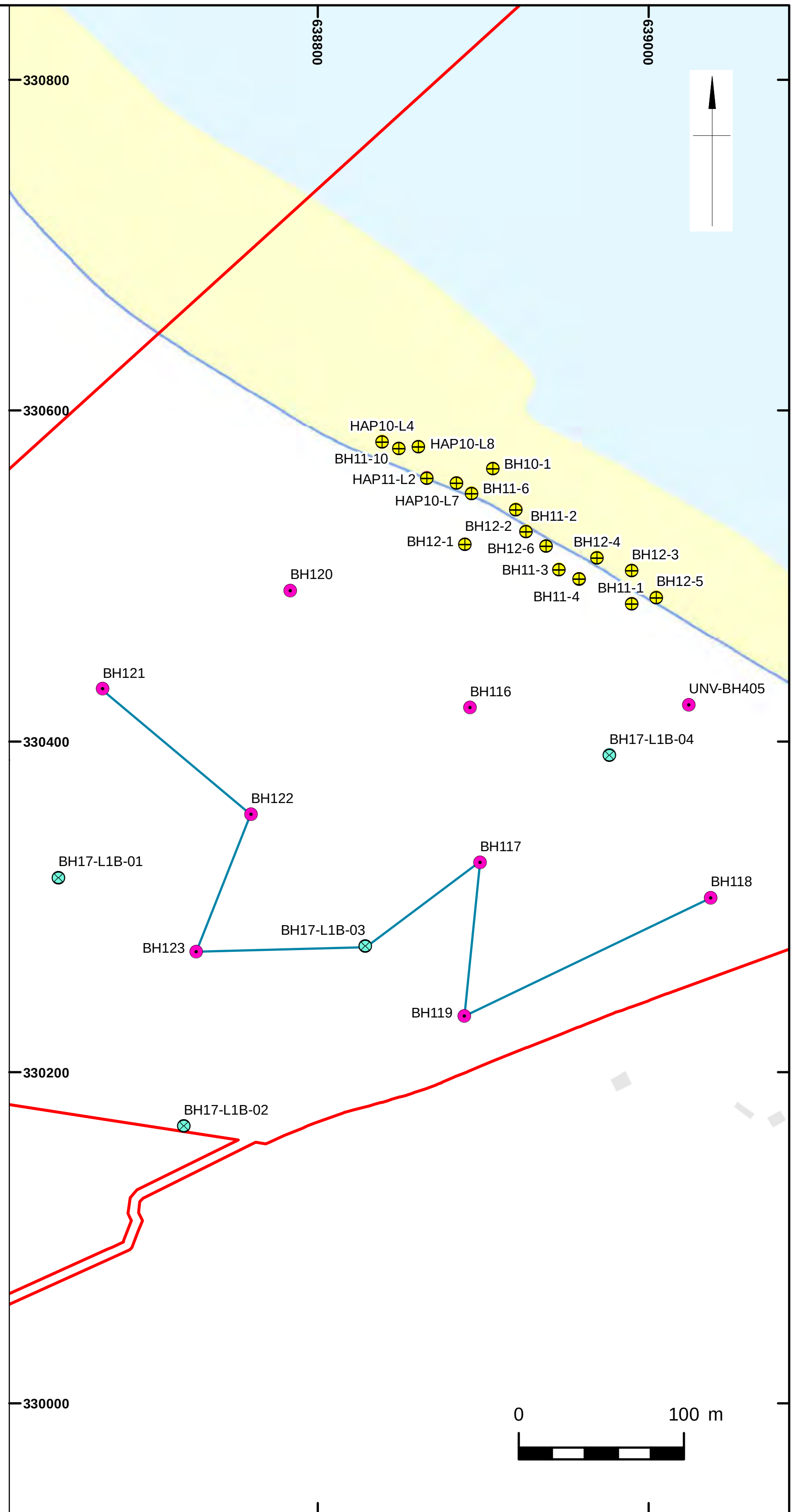
Coordinate system: OSGB36

Date:	15/11/2021	Revision Number:	1
Scale:	Location 1:4,000 at A3	Illustrator:	KJF
Path:	X:\PROJECTS\114845\GIS\FigsMXD\SI Monitoring\2021_05_25		

Cross section along Transect 4, Happisburgh Landfall

Figure 12





Onshore Project Areas
Current SI boreholes
Transect 5
Happisburgh Site 1 interventions (Ashton et al. 2018, Lewis et al 2019)
Previous SI boreholes (WA 2018)

Coordinate system: OSGB36

Date:	15/11/2021	Revision Number:	1
Scale:	Location 1:4,000 at A3	Illustrator:	KJF
Path:	X:\PROJECTS\114845\GIS\FigsMXD\SI Monitoring\2021_05_25		

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