The Lake Lothing (Lowestoft) Third Crossing Order 201[*]

Lake Lothing THIRD CROSSING

Document 6.3: Environmental Statement Volume 3 Appendices

Appendix 9B

Deposit Model

Author: Suffolk County Council

Lake Lothing Third Crossing, Lowestoft, Suffolk

Deposit Model

Lake Lothing THIRD CROSSING

Prepared for:

Suffolk County Council

Prepared by:

mouchel
building great relationships

St John's House
2-10 Queen Street
Manchester
M2 5JB

T 0161 832 4542
W www.mouchel.com

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Organisation	Contact	Copies
Suffolk County Council	Michael Wilks	e
Suffolk County Council Archaeological Service	Abby Antrobus	e
Historic England	Will Fletcher	e

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1 Introduction

1.1 Background

Suffolk County Council (SCC) will implement a programme of ground investigations during 2017 to supplement existing borehole information, and determine ground conditions underlying the location of the proposed Lake Lothing Third Crossing (LLTC).

This document uses the existing borehole information to produce a deposit model to assess the potential for survival of deposits with high palaeoenvironmental and archaeological potential in the vicinity of the proposed location of the LLTC in advance of the forthcoming ground investigation.

The deposit model will inform implementation of a programme of geoarchaeological work co-ordinated with the ground investigation to assess and analyse high potential deposits, should the deposit model show that such deposits survive. The scope of any geoarchaeological work will be agreed with Suffolk County Council Archaeological Service (SCCAS) and Historic England (HE).

1.2 Site location

The LLTC will comprise the construction of a new road crossing at Lake Lothing, a large saltwater lake which forms the inner harbour of the Port of Lowestoft. Lake Lothing separates the north and south of Lowestoft, measuring c.180m at its widest point.

The proposed scheme (Figure 1) consists of a new single carriageway road across Lake Lothing linking the B1531 Waveney Drive on the south side to the C971 Peto Way on the north side and will include the provision of a new bascule bridge in Lake Lothing, a new rail bridge on the north side and a new road bridge on the south side as well as associated changes to the local highway network and landscaping.

1.3 Geology and Topography

The solid geology of the Lowestoft area is Cretaceous Chalk. A thick deposit of Tertiary London Clay lies above the chalk, the clay is capped by Pliocene and Early Pleistocene marine sands of the Crag Group. At higher ground the Crag Group is overlain by a succession of glacigenic tills comprising the Happisburgh Formation (formerly Corton Formation) and the Lowestoft Formation. In the lower lying area of Lake Lothing the Crag Group is overlain by Pleistocene glaciofluvial sands and gravels, which are covered by Holocene alluvium and peat.

Lake Lothing is an artificial channel which connects the River Waveney to the North Sea; it is located at the base of a broad, shallow, east-west aligned valley.

The land based area of the LLTC lies broadly level at c.3.0m AOD. However, this height is largely artificial, resulting from land reclamation and levelling completed to form dockside in the 19th and 20th centuries.

2 Archaeological Background

2.1 General

This section provides a brief outline of the archaeological and historic background of the area of the LLTC, which was prepared during Options Appraisal (Mouchel 2016a). Information on heritage assets is derived from records held by the Suffolk Historic Environment Record (HER) and the National Heritage List for England (NHLE). The heritage asset data is supplemented with information collated for the Lowestoft Urban Regeneration Company (URC) Area, Cultural Heritage Assessment (Scott Wilson, 2006) and other readily available documentary sources. A more detailed archaeological and historical background will be produced as part of forthcoming Environmental Impact Assessment.

2.2 History and Archaeology

Heritage assets are described in the context of a timeline of archaeological periods from prehistoric through to modern. The time periods discussed can be broadly divided as follows:

- Prehistoric:
  - Palaeolithic c.800,000 – 10,000 BC
  - Mesolithic 10,000 – 4,000 BC
  - Neolithic 4,000 – 2,500 BC
  - Bronze Age 2,500 – 700 BC
  - Iron Age 800 BC – AD 43
- Roman AD 43 – 410
- Early Medieval AD 410 – 1066
- Medieval AD 1066 – 1540
- Post-Medieval AD 1540 – 1900
- Modern AD 1900 – present

Palaeolithic

There is limited evidence of Palaeolithic activity in the vicinity of the LLTC; in the 19th century five early Palaeolithic flints, including one possible handaxe, were recovered from ‘Cannon-shot’ gravels at Normanston. However, well preserved evidence, comprising Lower Palaeolithic worked flints, associated palaeoenvironmental material and animal bone dated to c.700,000 BP, has been discovered within the Cromer Forest Bed Formation at Pakefield, c.2.5km to the south. This geological formation includes evidence of the earliest known presence of pre-modern humans in northern Europe, comprising footprints dated to c.800,000 BP, which were discovered in 2013 at Happisburgh Beach, Norfolk. The Cromer Forest Bed Formation may be present at Lowestoft, but will be deeply buried beneath alluvial, marine and glacial deposits.

Mesolithic to Iron Age

Evidence for activity of the Mesolithic, Neolithic, Bronze Age or Iron Age periods is restricted to an isolated Neolithic pit found at Walton Road, Lowestoft and scatters of Neolithic flint tools found at Victoria Road, Lowestoft and Heath Road, Oulton.

Episodes of marine transgression affected the area during the latter part of the Neolithic, the early part of the Bronze Age and the late Iron Age. Any evidence of these periods situated at lower lying areas may have been buried by marine, alluvial and peat deposits.

Roman

It has been suggested that a Roman road from Colchester to Burgh Castle passed through Lowestoft. Archaeological remains tentatively interpreted as part of this road, or an associated bridge, were found during 19th century excavation of peat in the vicinity of the current Bascule Bridge. The evidence comprised several large tree trunks, 10-12 feet in length, laid out parallel and approximately two feet apart.

The closest settlement evidence, including a coin hoard, a possible cremation urn and the skeletons of a number of horses was found approximately 700m to the north east of the LLTC during the 19th century at a part of Lowestoft now known as “Roman Hill”. The HER also records five isolated findspots of Roman coins.

The lower lying parts of the area continued to be affected by a marine transgression and its use may have been limited to exploitation of marine and estuarine resources.

Early Medieval

The villages of Lowestoft and Kirkley are mentioned in the Domesday Book and consequently had been founded by the latter part of this period. The early focus of Lowestoft is thought to have been located some distance away from the present town centre, perhaps in the vicinity of St Margaret’s church. It is probable that the area of the LLTC was marginal land exploited for estuarine and wetland resources

Medieval

Lowestoft was granted markets in 1308 and 1445 and by the end of the medieval period it was a significant fishing port and the most important settlement in the area. Until the latter part of this period the core of Lowestoft may have retained its focus around St Margaret’s church.

Lake Lothing is a remnant of a turbary, an extensive area of medieval peat cutting. The speed of the peat cutting is currently uncertain, but the eastern end of Lake Lothing including Kirkley Ham inlet was open to the sea by the 14th century when the northern side was known as the Inner Harbour and ships were being constructed on the southern side to the east of Kirkley Ham inlet.

Post-medieval

The town and port of Lowestoft saw significant growth during the 19th century and the conurbation eventually expanded to the south of Lake Lothing. The eastern end of the Lake was used as a harbour, with quayside, boat and ship building yards, fish processing, ancillary marine and manufacturing industries constructed along each side. The higher ground in proximity to the LLTC remained agricultural land for the majority of this period.

Modern

Lowestoft continued to expand into the early part of the 20th century with the fishing fleet, boat building and associated trades being the mainstay of its economy. By 1911 the population had reached 37,886, which reflects the peak in production for the British fishing industry.

The First World War saw some of the more capable local boats requisitioned by the Admiralty for patrolling and minesweeping. The town was bombed on a number of occasions, and on 25th April 1916, the German High Seas Fleet shelled the town and harbour leaving forty houses destroyed, two hundred damaged and four people killed.

During the inter war period the fishing industry and the town suffered a decline, but the start of the Second World War saw the town transformed into an important naval base with an all-round defensive perimeter of trenches, pillboxes and dense belts of barbed wire. None of the defences now survive but many of their locations have been recorded by the HER and the Defence of Britain project. The town was extensively bombed during the Second World War and much redevelopment was necessary during the post war period.

During the latter part of the 20th century the port remained a focus of shipbuilding and developed as a focal point for operations of the oil and gas industries in the southern North Sea.

3 Aims, Objectives and Standards

3.1 Aims

The principal aims of the deposit model are to:

- Establish the presence or absence of deposits with high palaeoenvironmental or archaeological potential at the proposed location of the LLTC through desk based research;
- Establish the extent and depth of any high potential deposits;
- Establish any variability in extent and depth of high potential deposits which may suggest the presence of localised geomorphological features, such as infilled palaeochannels;
- Assess the palaeoenvironmental and archaeological significance of any high potential deposits, where possible; and
- Understand the impact of the LLTC upon any high potential deposits.

3.2 Objectives

The principal objective of the deposit model is:

- To use the results to inform the scope of any necessary mitigation strategy.

3.3 Standards

The deposit model was completed with reference to *Requirements for Palaeoenvironmental Assessment (*SCCAS 2011), *Research and Archaeology Revisited: A Revised Framework for the East of England* (Medlycott 2011), the Chartered Institute for Archaeologists (CIfA) Code of Conduct and other relevant CIfA Standards and Guidance documents.

4 Methodology

4.1 General

The deposit model has been produced after review of relevant geotechnical reports and available borehole logs situated in close proximity to the LLTC. Archaeological reports detailing results of investigations located within 500m of the LLTC have also been examined.

4.2 Sources

Information from the following sources has been reviewed:

- British Geological Survey (BGS) online borehole record viewer;
- Lake Lothing Third Crossing: Geotechnical Feasibility Report (Mouchel 2016b);
- Suffolk Historic Environment Record (HER);
- Suffolk Record Office; and
- National Heritage List for England.

4.3 Consultees

The following were consulted during preparation of this document:

- Suffolk County Council Archaeological Service; and
- Historic England.

5 Results

5.1 Previous Deposit Model

An attempt was made to produce a deposit model during cultural heritage assessment of the Lowestoft Urban Regeneration Company (URC) Area (Scott Wilson 2006). The URC area covered approximately 250 ha of the town, including part of Lowestoft's High Street, the Beach Industrial Estate, the inner and outer docks, and land surrounding Lake Lothing.

The deposit model was derived from the results of eighteen widely dispersed geotechnical boreholes and five archaeological investigations. The small number of sources meant that it was not possible to provide detail of archaeological deposits or horizons, the level of ground disturbance or depth of reclamation deposits. Nonetheless, a considerable depth of marine sands was noted overlying the natural glacial deposits at the area surrounding the High Street, the outer docks and Beach Industrial Estate (URC Cultural Heritage Assessment Zones 1 and 2), and a considerable depth of alluvium was noted at the inner docks and land surrounding Lake Lothing (URC Cultural Heritage Assessment Zones 3 and 4).

Made ground deposits appeared to be thicker at the base of a cliff situated to the east of the High Street (Zone 1), and around Lake Lothing (Zones 3 and 4). Whilst archaeological evidence suggested that deposits at parts of the sloping topography of Zone 1 had been modified by post medieval terracing.

5.3 Archaeological Evidence

The HER includes a total of eight archaeological investigations situated within 500m of the LLTC (Figure 1). The investigations comprised a trial trench evaluation at an undeveloped area (Barnard's Meadow) situated c.450m to the north west of the LLTC (**1**); a desk based assessment examining a site (Brooke Peninsula) located on the southern side of Lake Lothing c.400m to the west of the LLTC (**2**); two trial trench evaluations, respectively located c.300m east and c.450m south east (**3** and **4**); and the remaining four were trial trench evaluations or programmes of archaeological monitoring located around the southern end of the LLTC (**5** to **8**).

The trial trench investigations usually examined a relatively shallow depth, although a small number of deeper trial pits were occasionally completed to examine the extent of made ground. Results have illustrated that deep deposits of relatively recent levelling material / made ground are widespread, but have often failed to examine areas for the presence or absence of underlying Holocene deposits which may have high archaeological or palaeoenvironmental potential. A single exception is provided by results of trial trenching carried out c.450m to the south east near Clifton Road (4: Archaeological Solutions 2011). Made ground was relatively shallow in this location and an underlying layer of desiccated peat (max 0.25m deep), plus evidence of podsolization, including "iron panning", was observed at the eastern half of the site.

The desk based assessment of the Brooke Peninsula (**2:** CgMS 2013) included an examination of a geotechnical investigation of the undeveloped eastern part of this area. The results of thirteen trial pits and three boreholes showed that c.1.5m to c.2.8m of made ground was present. The made ground overlay alluvial deposits which were

c.1.0m to 1.5m deep, except at the southern edge of the site where alluvium was absent. In addition two test pits located at the western edge of the investigated area contained localised peat deposits up to c.0.4m thick, which were situated beneath, or toward the base of the alluvium at a depth of c.2.9m to c.3.5m bgl (approx. 0.5m to 0.2m OD). The alluvium and peat overlay glaciofluvial river sands and gravels laid down on earlier sands interpreted as belonging to the “Corton Sands” (now part of the Happisburgh Formation).

5.3 Geotechnical Evidence

General

A geotechnical feasibility report (Mouchel 2016b) produced during the LLTC Options Appraisal examined available ground investigation data from 62 exploratory boreholes and seven trial pits located close to, or on the footprint of the LLTC (Figure 1). Results were used to produce a geological cross section across the LLTC (Figure 2).

The earliest of the ground investigations was completed on the southern side of Lake Lothing by the East Anglian Ice Company in 1909. A small number of other ground investigations date from the 1960s through to the 1980s, but the majority of borehole logs containing sufficient detail to enable preparation of the deposit model were completed during the 1990s in advance of southern relief road (A12) improvements.

The southern relief road information was presented in two documents:

- BH32 to BH55, BH56A and BH57A, BH58 to BH71, 40 No., Ground Engineering Ltd 1992, Factual Report. Additional boreholes are included within this report but lie outside of the subject area. Supplementary to Acer Consultants Interpretive Report (1994).
- BH35, BH38 to BH42, BH53, BH55, BH56A, BH57A, BH60, BH62, BH76 to BH78: A12 Kessingland to Pleasurewood Improvement, Acer Consultants 1994.

The borehole and trial pit logs generally extend to depths of between approximately 2.0m bgl to 40m bgl, although the record dating to 1909 extends to approximately 558m bgl. Inferred sub-surface conditions are summarised in the following sections and the location of boreholes which have encountered deposits with high archaeological and palaeoenvironmental potential (alluvium and peat) are shown on Figure 2.

Made Ground

Made ground is widespread on each side of Lake Lothing and the borehole logs indicate that there is a general trend for thickening of the made ground toward the existing quay walls. However, the depth of made ground is variable locally (this is most evident on the north side of the Lake), which suggests the presence of topographic high and low points in the underlying deposits, perhaps resulting from the presence of partly infilled geomorphological features.

The made ground extends from the current ground surface to depths of between 1.4m bgl and 5.0m bgl. It is dominated by redeposited silty sand with varied flint gravel and clay content, although localised ash, construction rubble comprising brick, concrete and wood as well organic material are occasionally recorded as minor constituents.

Contamination, in the form of oily odours, was recorded at various depths in a number of boreholes located near the quay walls.

Alluvium and Peat

Alluvium, generally comprising a soft grey silty sand or dark grey clayey silt with variable organic and gravel content, is recorded in numerous boreholes located on the northern side of Lake Lothing, although the depth to the surface of the alluvium varies locally, i.e. at some areas alluvium is first encountered at c.2m bgl, but at other areas it is recorded at c.5m bgl. However, the alluvial deposits show an overall trend to thicken as they near Lake Lothing, with a maximum depth of c.6m of alluvium recorded adjacent to the existing north quay wall.

At the south of Lake Lothing alluvium was only encountered in three boreholes, located c. 30m west of Kirkley Ham (BH01), c.10m south of Waveney Drive (BH33**),** and c.60m north of Waveney Drive (BH56A) where the alluvium extended from 3.2m bgl to 5.7m bgl (-0.16m to -2.66m OD).

Alluvial deposits are also present within Lake Lothing, extending from the lake bed to a maximum thickness of c.2.5m. The lake bed alluvial deposits are generally described as a silt with variable sand content, also containing occasional gravel clasts and plant remains. The Lake is regularly dredged to 4.7m CD (-6.2m OD) to reduce the thickness of the river bed deposits in order to maintain sufficient water depth for commercial shipping requirements.

A number of the boreholes situated at the northern side of Lake Lothing have recorded the presence of thin lenses of peat within the alluvium, but only two of the boreholes examined for the deposit model have encountered deep deposits of peat.

- At the north side of Lake Lothing BH57A (offset c.10m west of the LLTC) encountered c.1.3m of fibrous sandy peat situated beneath the alluvium and above the glaciofluvial deposits, between -1.76m and -3.06m OD; and
- At the southern side of Lake Lothing BH56A (offset c.20m west of the LLTC) recorded c.0.4m of peat situated immediately below made ground and above alluvial deposits, between 0.24m to -0.16m OD.

Glaciofluvial Deposits

The glaciofluvial deposits underlie the alluvium and peat and result from channel infill, they are generally granular in nature and are dominated by layers of medium dense to dense sands, flint gravels and gravelly sand.

To the south of Lake Lothing the surface of the glaciofluvial deposits may rise slightly from c.1.0m OD near Waveney Drive to c.2.0m OD near the junction of Riverside Road and Canning Road, but then exhibits an overall south to north downward trend to -1.5m OD (c.4.0m bgl) at the quay wall.

A general south – north upward trend is evident to the north of Lake Lothing, where the surface of the glaciofluvial deposits is recorded at c.8.0m bgl near the north quay wall, then at c.1.5m bgl near Denmark Road. However, intermediate boreholes show much greater local variability in surface height than is evident to the south.

The maximum and minimum thicknesses of glaciofluvial deposits were recorded in BH56A and BH46, respectively 18.8m (between -2.6m to -21.4m OD) and 12.6m (between -8.2m to -20.8m OD). A basal layer of clay is often noted as forming the boundary with the underlying Crag Group. The clay layer generally comprises a grey thinly to thickly laminated silty clay with interlaminations of fine to coarse sand.

Lowestoft Till and Corton Formation

BGS Sheet 176 shows that the Lowestoft Till and underlying Corton Formation (now part of the Happisburgh Formation) are present at higher ground to the north and south of Lake Lothing. Neither formation was recorded in examined boreholes.

Crag Group

The full depth of the Crag Group (mostly formed of marine sands and gravels) has only been proven in a single borehole which was completed in 1909 at the southern side of Lake Lothing. The surface of the Crag Group was poorly defined in this borehole, but the Craq was observed to extend to a depth of approximately 67m bgl (-60m OD). Recent boreholes (BH55, BH56A and BH67) located in close proximity to the 1909 borehole have recorded the surface of the Crag Group at between 21.5m bgl (-19.0m OD) and 26.5m bgl (-23.5m OD) and an approximate total thickness of 42m is inferred.

The Crag Group is described as a medium dense to very dense fine to coarse grained sand with shells and occasional gravel clasts and clay pockets. Overbank deposits of the Cromer Forest Bed Formation, which sometimes form the upper part of Crag Group, do not appear to have been encountered and may be absent, perhaps as a consequence of erosion prior to deposition of the overlying glaciofluvial deposits.

Palaeogene and Cretaceous Deposits

The exploratory borehole undertaken by the East Anglian Ice Company in 1909 shows that the Thames and Lambeth Groups, and the Ormsby Clay Formation of Paleogene age underlie the Crag Group, extending from about -72m to -160m OD. Cretaceous deposits of the Chalk Group underlie the Paleogene deposits.

6 Conclusions

6.1 General

Overall, the archaeological evidence has limited applicability to the deposit model and to the definition of human activity pre-dating the late post medieval period. In part because the available evidence has a restricted distribution as a result of the focus of recent development, with the majority of work situated at the southern side of Lake Lothing. Additionally, the full depth of archaeological deposits has not been examined by the majority of investigations and the interpretation of “made ground” and ‘natural’ layers appears variable.

The quality, distribution and terminology of the geotechnical investigations often makes direct comparisons with the archaeological evidence difficult. Examination of the wider distribution of geotechnical work in the Lowestoft area shows dispersed clusters centred on proposed new development, similar to the distribution of the archaeological evidence. Fortunately, the proposed location of the LLTC was subject to relatively comprehensive geotechnical investigation during the 1990s and this has enabled production of a reasonably robust deposit model.

The deposit model shows that localised areas of peat deposits survive at both sides of Lake Lothing (further discussed in sections 6.2 and 6.3). The peat illustrates semi terrestrial episodes when the surrounding land may have been more readily exploited by prehistoric people in comparison to episodes when the area was inundated and alluvium was being deposited. The intercalated sequence of Holocene alluvium and peat is of archaeological and palaeoenvironmental significance as it will enable better understanding of the local and regional Holocene environments at the time of peat formation / alluvial deposition and may preserve evidence of prehistoric human activity.

It has not been possible to determine if the Cromer Forest Bed Formation (with potential to contain Lower Palaeolithic archaeological evidence) is present or absent at the upper part of the Crag Group. It is tentatively suggested that it may be absent, perhaps eroded prior to deposition of the overlying glaciofluvial deposits, however, the level of detail presented in the existing geotechnical records is insufficient to enable secure interpretation.

6.2 South of Lake Lothing

The deposit model suggests that archaeological evidence pre-dating the post medieval period may be absent from much of the area located adjacent to the southern side of Lake Lothing. The bulk of made ground here is recorded as sterile redeposited silty sand with varied amounts of flint gravel and clay which directly overlies glaciofluvial deposits. The absence of Holocene alluvium or peat suggests that extensive truncation has occurred, which will have removed any archaeological evidence pre-dating the post medieval period. Deposits of alluvium and peat are recorded toward the southern end of the LLTC scheme, and archaeological evidence pre-dating the post medieval period may survive here.

Palaeoenvironmental potential appears to be restricted at the southern side of the Lake as alluvium and peat is absent from many of the geotechnical records, with made

ground directly overlying glaciofluvial deposits. However, three exceptions are recorded:

- borehole BH01, located c.30m west of Kirkley Ham, encountered alluvium from a depth of 1,8m bgl;
- borehole BH56A, located c.60m north of Waveney Drive, encountered c.0.4m of peat overlying c.2.5m of alluvium; and
- borehole BH33, located c.10m south of Waveney Drive, encountered c.0.7m of alluvium.

The recorded distribution of the alluvium and peat makes the origin and extent of these deposits difficult to interpret, although the alluvium in BH01 may be associated with Kirkley Ham, and deposits at BH33 and BH56A perhaps infill a palaeochannel, or other body of water, which drained north east into Kirkley Ham.

6.3 North of Lake Lothing

Extensive deposits of made ground are present to the north of Lake Lothing. The bulk of the made ground is recorded (as to the south) as sterile redeposited silty sand with varied amounts of flint gravel and clay and is likely to possess little archaeological potential. It generally shallows to the north, from c.5.0m deep near the quay wall to c.1.4m deep near Denmark Road, although much greater localised variability in the depth of made ground is evident than was observed to the south. The variation in depth suggests the presence of topographic low points, perhaps resulting from truncation of the underlying alluvial deposits or the presence of partly infilled drainage features such as palaeochannels.

Deep alluvial deposits survive beneath the made ground at the north side of Lake Lothing. The depth to the surface of the alluvium varies locally, i.e. it is first encountered at c.2m bgl at some areas, but at c.5m bgl elsewhere. However, the alluvial deposits show an overall trend to thicken as they near Lake Lothing, with a depth of c.6m of alluvium recorded adjacent to the existing north quay wall. The alluvium is generally described as soft grey silty sand or dark grey clayey silt containing variable organic material, with occasional lenses of gravel and peat.

Only one borehole (BH57A) situated to the north of Lake Lothing (located c. 8m south of the railway and offset c.7m west of the LLTC) encountered a deep deposit of peat, recorded as c.1.3m of fibrous sandy peat situated beneath the alluvium and above glaciofluvial deposits, between -1.76m and -3.06m OD. The presence of the peat immediately above the glaciofluvial sediments suggests that this perhaps localised organic deposit may have formed during the early part of the Holocene.

7 Recommendations

The borehole logs from the forthcoming ground investigation will be provided to Mouchel Heritage Consultants within 24 hours of their completion. Mouchel Heritage Consultants will review the logs to identify areas of high palaeoenvironmental / archaeological potential for targeted retrieval of an undisturbed core through surviving deposits of Holocene alluvium and peat. The deepest sequences of alluvium and peat (if encountered) will be prioritised for retrieval of the undisturbed core.

The undisturbed core will be completed by the geotechnical contractor during the time allowed for the programme of ground investigation and the undisturbed core will be collected solely for assessment and analysis by a fully qualified geoarchaeological contractor. The geotechnical contractor will offset the undisturbed core a maximum of 5m from the position of the ground investigation core which recorded high potential deposits. The location (NGR co-ordinates) and ground level height (m OD) of the retrieved undisturbed core will be recorded with GPS survey equipment.

If necessary, the geotechnical contractor will retain the undisturbed core at an off-site sample store until collection by the geoarchaeological contractor. The geoarchaeological contractor will ensure that the core is collected from the sample store a maximum of five working days after being deposited.

The scope of geoarchaeological assessment and analysis of the undisturbed core will be set out in a Written Scheme of Investigation to be agreed in consultation with Suffolk County Council Archaeological Service and Historic England.

As part of their assessment the geoarchaeological contractor will review all forthcoming geotechnical borehole logs to assess whether the Cromer Forest Bed Formation is present at the interface between the glaciofluvial deposits and the Crag Group. Results of this assessment would be used to enhance understanding of the distribution of this deposit, which contains evidence of the earliest pre-modern human presence known in northern Europe.

8 References

(Numbers in bold are the Mouchel reference for archaeological investigations discusssed in the deposit model text and shown on Figure 1)

Archaeological Solutions 2011. Land off Clifton Road, Lowestoft, Suffolk: An Archaeological Evaluation (**3**).

British Geological Survey – Geological Sheet 176, 1:50,000 Solid and Drift.

CgMS 2013. Land at Brooke Peninsula, Lowestoft, Suffolk: Heritage Desk Based Assessment (**2**)

Gurney, D 2003. Standards for Field Archaeology in the East of England. East Anglian Archaeology Occasional Papers 14

Historic England 2007. Understanding the Archaeology of Landscapes; a guide to good recording practice

Historic England 2011. Environmental Archaeology: A guide to the theory and practice of methods of sampling and recovery to post excavation

Historic England 2015. Geoarchaeology: Using earth sciences to understand the archaeological record

Medleycott, M 2011. Research and Archaeology Revisited: A Revised Framework for the East of England. East Anglian Archaeology Occasional Papers 24

Mouchel 2016a. Lake Lothing Third Crossing: Cultural Heritage Assessment.

Mouchel 2016b. Lake Lothing Third Crossing: Geotechnical Feasibility Report.

Parfitt, S.A., Barendregt, R.W., Breda, M., Candy, I., Collins, M.J., Coope, G.R.,Durbidge, P., Field, M.H., Lee, J.R., Lister, A.M., Mutch, R., Penkman, K.E.H., Preece, R.C., Rose, J., Stringer, C.B., Symmons, R., Whittaker, J.E., Wymer, J.J. and Stuart, A.J., 2005. 'The earliest humans in northern Europe: artefacts from the Cromer Forest-bed Formation at Pakefield, Suffolk, England'. Nature 438, 1008-1012

SCCAS 2005. South Lowestoft Relief Road, Lowestoft: Archaeological Monitoring Report. SCCAS Report No. 2005/9 (**6**).

SCCAS 2005. The Former Crown Works, Belvedere Road, Lowestoft: Archaeological Monitoring Report and Photographic Survey. SCCAS Report No. 2005/74 (Figure 1: **5**).

SCCAS 2009 Land at Barnard's Meadow. Lowestoft: Archaeological Evaluation Report **1**).

SCCAS 2011. Requirements for Palaeoenvironmental Assessment.

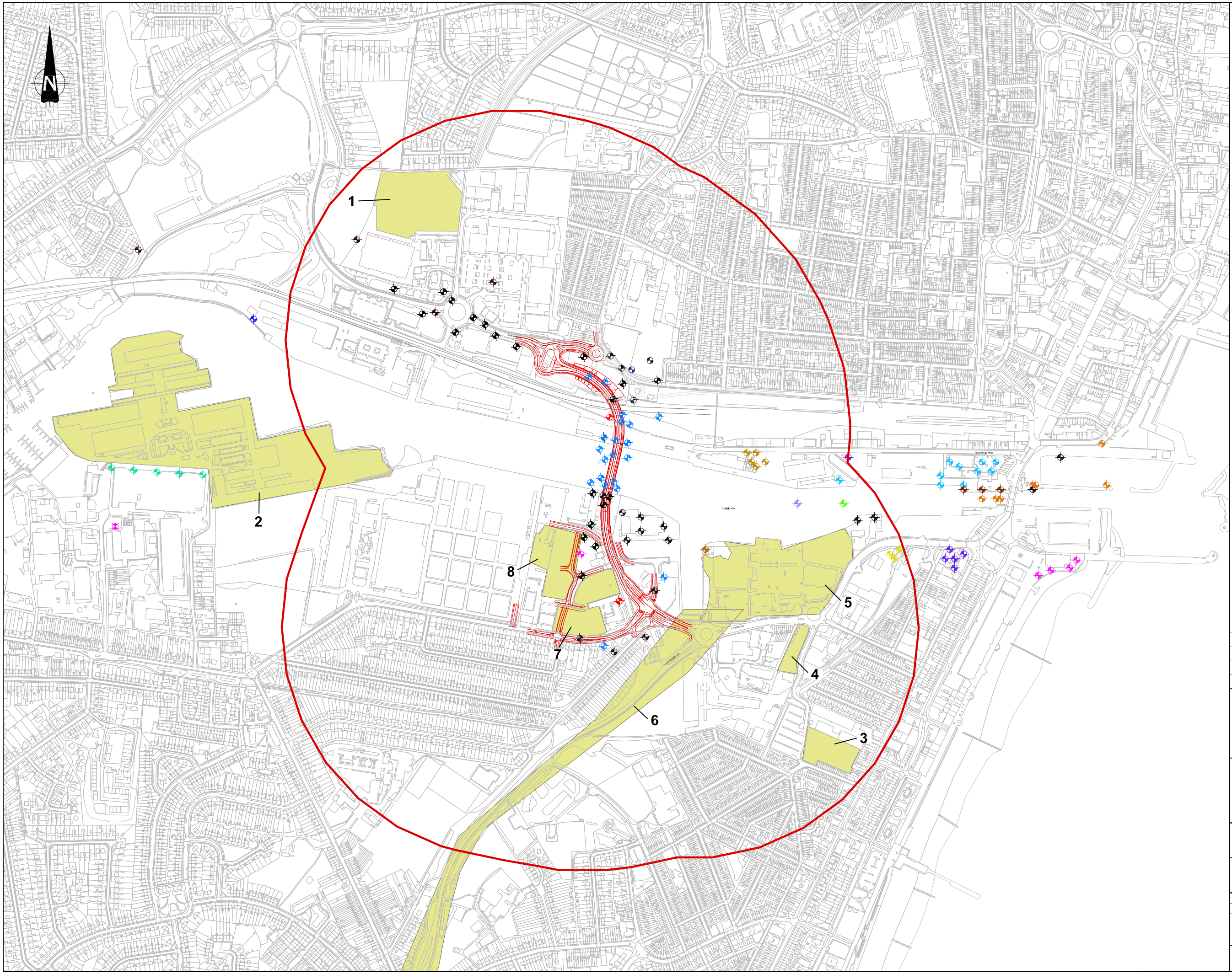
SCCAS 2013. Land off Canning Road, Lowestoft: Archaeological Evaluation Report. SCCAS Report No. 2013/111 (**8**).

SCCAS 2013. St Mary's Water Treatment Works, Canning Road, Lowestoft, Suffolk: Archaeological Evaluation Report. SCCAS Report No. 2012/200 (**7**).

Scott Wilson 2006. Lowestoft URC Area, Suffolk: Cultural Heritage Assessment.

Williams, A., and Martin, G.H., (eds.) 2003. Domesday Book: A Complete Translation. Alecto Historical Editions. Penguin Books (London).

Figures



Legend

- LLTC AND 500M BUFFER
- ARCHAEOLOGICAL INVESTIGATIONS
- GEOTECHNICAL BOREHOLES (AND SAME SYMBOL IN OTHER COLOURS)

REF	DATE	REVISIONS	INITIALS

Client: Suffolk County Council

Produced by: mouchel — building great relationships

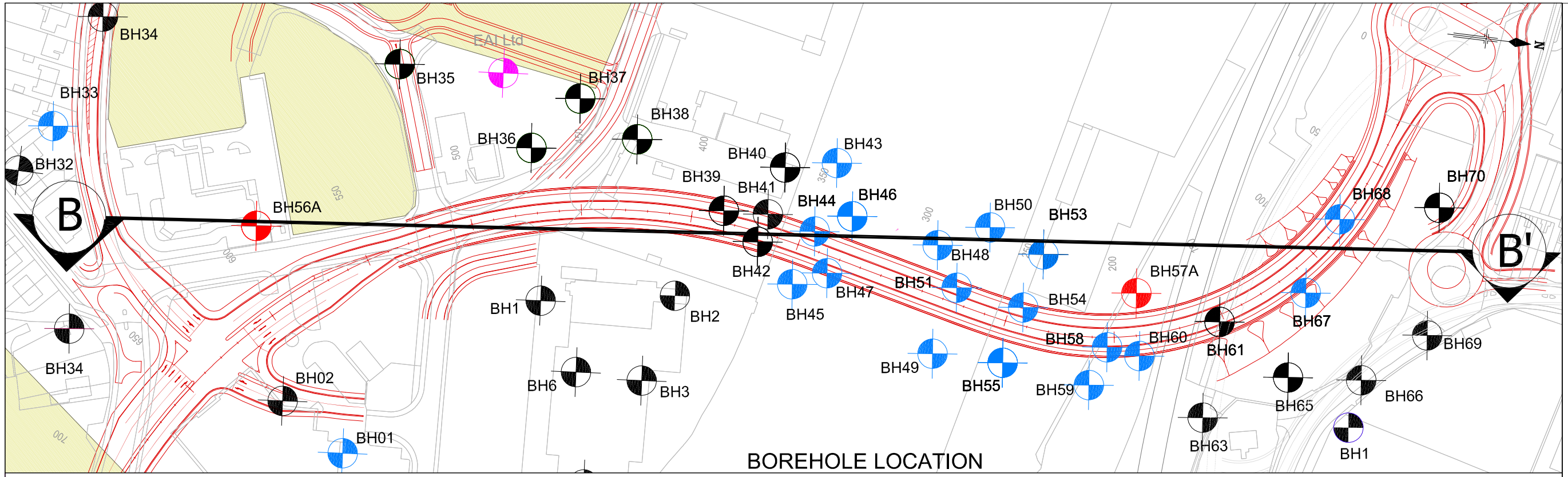
Project: LAKE LOTHING THIRD CROSSING

Title: LOCATION OF LLTC, BOREHOLES AND ARCHAEOLOGICAL INVESTIGATIONS

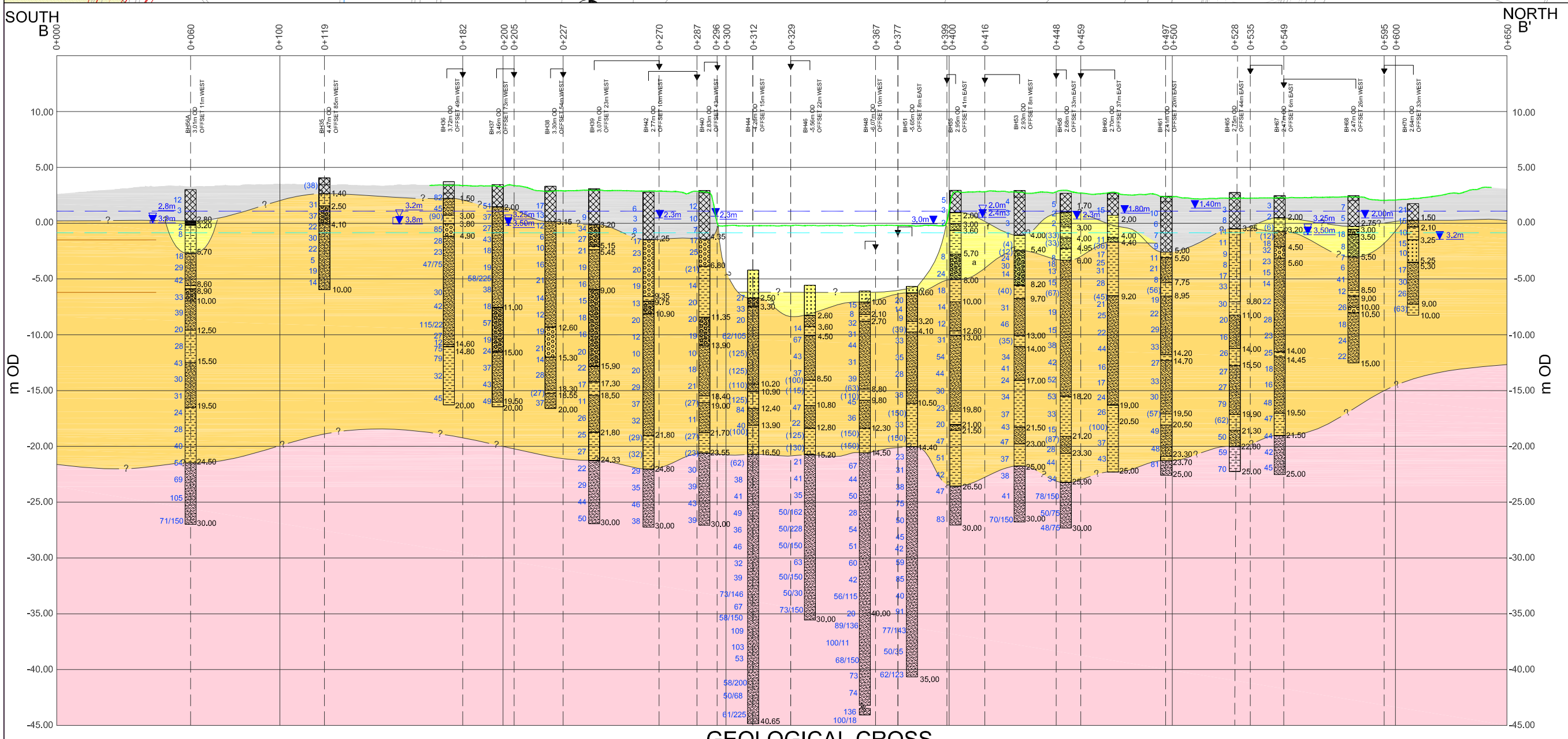
DESIGN BY		CHECKED BY	
DATE		DATE	
DRAWN BY		APPROVED BY	
DATE		DATE	

X DRAFT | PRELIMINARY | TENDER | CONTRACT

SCALE - A3	DRAWING NO.	REV.
1:7500	1073877 FIGURE 1	A



BOREHOLE LOCATION



GEOLOGICAL CROSS SECTION B - B'

HORIZONTAL 1 : 1000 @ A1

VERTICAL 1 : 200 @ A1

Legend

BOREHOLES RECORDING:

- PALAEOGENE AND CRETACEOUS DEPOSITS (COMPLETED IN 1909)
- GLACIOFLUVIAL DEPOSITS
- ALLUVIAL DEPOSITS
- DEEP ORGANIC (PEAT) DEPOSITS

GEOLOGICAL CROSS SECTION DEPOSITS:

- MADE GROUND
- ALLUVIUM
- GLACIOFLUVIAL DEPOSITS
- CRAG GROUP

REF	DATE	REVISIONS	INITIALS

Client: Suffolk County Council

Produced by: mouchel — building great relationships

Project: LAKE LOTHING THIRD CROSSING

Title: DEPOSIT MODEL BOREHOLE LOCATION AND GEOLOGICAL CROSS SECTION

DESIGN BY		CHECKED BY	
DATE		DATE	
DRAWN BY		APPROVED BY	
DATE		DATE	

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SCALE - A3	DRAWING NO.	REV.
1:1000	1073877 FIGURE 2	A