RWE

Tween Bridge Solar Farm

Environmental Statement
Appendix 8.3: Geoarchaeological Assessment

Planning Act 2008
Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

APFP Regulation 5(2)(a)

Document Reference: 6.3.8.3

August 2025

Revision 1

QUEST

QUATERNARY SCIENTIFIC

TWEEN BRIDGE SOLAR FARM YORKSHIRE & HUMBER REGIONS

Geoarchaeological & Palaeoenvironmental Desk-based Assessment Report

NGR: centered on SE 73000 11500

Date: 4th June 2024

Written by: Dr C.P. Green

QUEST, School of Archaeology,
Geography and Environmental Science,
Whiteknights, University of Reading, RG6 6AB

Tel: 0118 378 8941
Email: c.r.batchelor@reading.ac.uk
http://www.reading.ac.uk/quest

DOCUMENT HISTORY:

Version	Date	Prepared By	Approved By	Reason for Issue
v3	03/06/24	C.P. Green	C.R. Batchelor	Addition of warping text
v2	08/03/24	C.P. Green	C.R. Batchelor	Amendments following client comments
v1	29/02/24	C.P. Green	C.R. Batchelor	First edition

CONTENTS

1. NON-TECHNICAL SUMMARY

The following report outlines the findings resulting from a geoarchaeological and palaeoenvironmental desk-based assessment of the Tween Bridge Solar Farm development. The work was commissioned by Pegasus Group on behalf of RWE Renewables. The aim of the work was to consider the geoarchaeological and palaeoenvironmental potential and heritage significance of the site, which in turn will help inform the need for any further mitigation measures. In order to achieve this aim, a range of documentary sources including geological mapping, satellite imagery and relevant Quaternary literature have been reviewed, enabling initial characterisation of the geography, topography, geology, geoarchaeological and palaeoenvironmental potential.

2. INTRODUCTION

2.1. Background

This report summarises the findings arising from a geoarchaeological desk-based assessment exercise undertaken for the proposed Tween Bridge Solar Farm development. Quest have been commissioned by Pegasus Group on behalf of RWE Renewables to prepare a desk-based geoarchaeological deposit model for the site. This report should be read in conjunction with the Environmental Impact Assessment Scoping Report (EIA) prepared by Pegasus Group (2024).

The site lies in the broad region around the Humber Estuary known as the Humber Wetlands (Figure 1). Within that region the site forms part of the Humberhead Levels and consists of several loosely linked sub-sites (Areas 1-10 as defined by Boreland (2023) within the EIA) occupying areas of farmland between the towns of Thorne in the East Riding of Yorkshire to the west, and Crowle in North Lincolnshire to the east. Several transport routes cross this area from east to west - the Stainforth and Keadby Canal and alongside it the railway, and further south the A18 road and the M180 motorway. There are numerous drains and ditches and part of the site in Area 9 is already occupied by the Tween Bridge Wind Farm. The overall area in which the sub-sites lie extends ca. 9.0km from east to west and ca. 7.0km from north to south. The individual sub-sites are irregular in outline and the links between them are mainly existing roads and farm tracks. Farms and other commercial and residential buildings and the major transport routes are all outside the individual sub-sites.

As well as reports prepared as part of the preliminary evaluation of the site (Pegasus Group 2023, Boreland 2023), there is a considerable literature on the geomorphological and palaeoenvironmental history and archaeology of the Humber Wetlands, including in particular the results of the Humber Wetlands Project commissioned and funded by English Heritage between 1992 and 2000, directed by Robert Van de Noort who summarises the results of the project in his 2004 book *The Humber Wetlands – The Archaeology of a Dynamic Landscape*. (see also Van de Noort & Etté 1995, Metcalfe et al 2000, Neumann 1998, Lillie & Gearey 2000). The present study area was not a focus of intensive research during the project, but the findings of shallow borehole transects and field walking within the study area are described in the project literature and provide insights into its alluvial history and archaeology (Dinnin 1997a, Head et al 1997).

2.2. Geoarchaeological and palaeoenvironmental potential

The site traverses a range of landscapes determined by their varying geography, topography and geology. These variations include the type and height of the underlying bedrock, as well as the type, thickness and potential age of the overlying superficial deposits; the superficial deposits being those which encompass the Pleistocene and Holocene periods. Each of these deposits has varying potential to represent an area that might have been utilised or even occupied by prehistoric and historic people, evidence of which may be preserved in the archaeological (e.g. features and structures) and palaeoenvironmental record (e.g. changes in vegetation composition).

The Pleistocene

Pleistocene remains are the geological and biological deposits laid down by various agents – water, wind and ice between 2.6 million and 11,500 years ago. Sediments and their contained faunal and floral remains enable us to reconstruct former landforms and environments that were occupied by prehistoric communities (between approximately 959 and 11.5 thousand years ago).

The Holocene

The Holocene encompasses the last 11,500 years and spans all cultural periods from the Mesolithic to the present day. During this period, sediments have been deposited by water and wind to form alluvial and head deposits. Variations in the elevation and thickness of these different deposits can be significant as they represent different environmental conditions that would have existed in a given location during the Holocene. For example: (1) the presence of peat or soil horizons represent former terrestrial or semi-terrestrial land-surfaces, and (2) the various alluvial units represent periods of changing fluvial conditions, possibly driven by hydrological variability (e.g. relative sea-level and/ or anthropogenic activity within the river catchment). Thus, by studying the sub-surface stratigraphy in greater detail, it will be possible to build a more detailed understanding of the former landscapes and environmental changes that took place across space and time.

Fine grained alluvial and organic-rich sediments (in particular peat) also have high potential to provide detailed reconstructions of past environment and may contain evidence of human occupation in the form of geoarchaeological remains. They provide an opportunity to increase knowledge and understanding of the interactions between hydrology, human activity, vegetation succession and climate during the Holocene. Such investigations are carried out through the assessment/analysis of palaeoecological remains (e.g. pollen, plant macrofossils & insects) and radiocarbon dating.

2.3. Aims & objectives

As stated in section 2.1, the primary aim of this report is to consider the geoarchaeological and palaeoenvironmental potential and heritage significance within the proposed development footprint (Figure 1). This in turn will help inform the need for any further mitigation measures.

In order to achieve this aim, a range of documents and sources has been reviewed including, but not limited to: (1) an Historic Environment Record (HER) search; (2) historical mapping; (3) LIDAR imagery and aerial photography; (4) historical borehole data held by the BGS (http://mapapps.bgs.ac.uk), and (5) relevant geological, Quaternary and archaeological literature.

3. TOPOGRAPHIC SETTING

The following account describes the topographic features of the site (Figure 2) as a whole in the area between Thorne and Crowle in which the sub-sites are located (referred to hereafter as 'the study area').

Most of the study area is low-lying at levels between 0.0m and 2.0m OD, with only small areas rising above 3.0m OD or falling below 0.0m OD. The pattern of relief reflects two major landscape elements - (a) in the north-west (Areas 8 and 9/10), a remnant of the floor of the Late Devensian pro-glacial Lake Humber; and (b) to the south and east (Areas 1-7) - the floodplain and channels of the 'Old' River Don (Taylor 1987, Dinnin 1997a).

3.1. The Lake Floor

Within the site (Areas 8 and 9/10) the lake floor is an almost featureless landscape sloping very gently down in an easterly direction from levels between 2.0m and 1.0m OD to levels close to 0.0m OD. To the west of Area 9/10, the ground rises more steeply to levels up to 6.0m OD beneath the town of Thorne. Thorne Moor lies to the east of Area 9, forming part of the Humberhead Peatland National Nature Reserve, the largest area of raised peat bog in the UK (Van de Noort et al 1997, Dinnin 1997b).

3.2. The River Don channels and floodplain

The original course of the River Don (Figure 3) extended across the present site, passing south of Thorne in an east-south-easterly direction to be joined from the south by a substantial right bank tributary, the River Idle, before turning north-north-east to pass to the west of Crowle. Both the Don and the Idle were diverted from their natural courses in a major scheme of land drainage directed by Cornelius Vermyuden in the 1620s (Tomlinson 1882, Dinnin 1997c). The Don appears to have had two active channels where it passed west of Crowle and also between Thorne and its confluence with the Idle, where the Boating Dike is now considered to mark the course of the more northerly channel.

In the modern landscape, the river channels can be traced as 'roddons', topographic features rising very slightly above the general level of the floodplain. In the pattern of roddons, the channels of the Don and the Idle that were active immediately prior to the diversion of the rivers in the 17th century can be recognised (Figure 3). This pattern can be verified by reference to contemporary and later maps on which the courses of the rivers are identifiable. In a few places minor water courses still follow the alignments of the roddons – for example to the south-west of Crowle a minor water course is still named 'Old River Don' on Ordnance Survey maps. In addition to these traces of the 17th century rivers, the topographic evidence reveals the presence of former widely meandering courses of the river which must pre-date the early 17th century channel pattern.

The roddons rise to levels generally between 2.0m and 4.0m OD and in a few places are above 4.0m OD. The surrounding floodplain is mainly between 0.0m and 2.0m OD and in a few places is below 0.0m OD. The ground surface slopes gently away from the roddons to the lower levels of the wider floodplain (0.0 – 1.0m OD) to rise again slightly towards the edge of the floodplain (2.0 – 3.0m OD). Within the site, higher ground representing the floodplain margin is limited in extent, mainly in Areas 2, 6 and 7.

For the purposes of this assessment, the alluvial landscape is regarded as comprising three main elements: (a) the river channels (roddons); (b) the adjacent low-lying (proximal) floodplain; and (c) the outer and more elevated (distal) floodplain (see below Section 6, Table 1 and Figure 9).

4. GEOLOGICAL SETTING

4.1. Bedrock

The study area is underlain by rocks of the Triassic New Red Sandstone Super Group (Figure 4). In the east, underlying Areas 1 and 2, is the Mercia Mudstone (formerly Keuper Marl) consisting mainly of red or less commonly grey-green mudstones and siltstones. Underlying the Mercia Mudstone are rocks of the Sherwood Sandstone Group. They form the bedrock beneath the western part of the study area, comprising undifferentiated sandstone, mainly red in colour beneath Area 9, but identified as the Chester Formation (formerly Bunter Pebble Beds) in the south, also predominantly red in colour.

4.2. Superficial Geology

The superficial deposits that underlie the study area provide a record of the events that have shaped the landscape during the past 20,000 years (Figure 4). As noted above, there is a considerable literature on the geomorphological and palaeoenvironmental history and archaeology of the Humber Wetlands during that period. However, the valley of the Old River Don has never been a focus of intensive research interest and literature specific to the present study area is quite limited (Dinnin 1997a, Head et al 1997).

4.2.1. Glaciation

The whole of the study area was overrun by Late Devensian glacial ice which extended southward as far as Wroot, about 6.0km south of Area 7. The only visible evidence of this glacial episode within the study area is an upstanding body of Devensian fluvio-glacial sand and gravel that forms the margin of the Don floodplain in Areas 6 and 7.

4.2.2. Pro-glacial Lake Humber

During the late stages of the Devensian glaciation, extensive pro-glacial lakes formed in the Humber lowlands. Lake Humber spread across the whole of the study area, resulting in the deposition of lacustrine clays, sands and silts that form the Hemingbrough Formation. These lacustrine deposits underlie Areas 9/10 and the western part of Area 8. They originally extended across the whole of the study area and remnants of the Hemingbrough Formation outcrop in several places to the south of the M180 motorway. Remnants may also be present beneath later deposits within the study area. Boreholes in Areas 9/10 record lacustrine deposits up to 15.0m thick resting on bedrock at levels down to -14.0m OD. The lower part of these deposits, up to about -7.0m OD is generally sandy and often gravelly, whereas the upper part is rather consistently a laminated silty clay.

4.2.3. New fluvial drainage network

Following the withdrawal of the Devensian ice and the associated draining of Lake Humber (Fairburn & Bateman 2016), during the final cold sub-stage of the Devensian the Loch Lomond Stadial (12.7 – 11.5ka BP), the ancestral River Don became established on the lake floor and thereafter was the principal agent reshaping the relief of the study area. A record of this fluvial activity is preserved in the Alluvium which is mapped by the British Geological Survey (BGS) (bgs.ac.uk/geoindex/home) across much of the study area (large parts of Areas 1, 3, 4, 5, 6 and 8, and smaller parts of Areas 2 and 7). However detailed investigation of this record has never been undertaken in the Don valley and it is not known therefore whether deposits relating to the earliest stages of river activity are preserved in the alluvial record.

4.2.4. Aeolian re-working

The Loch Lomond Stadial witnessed a period of aeolian reworking of fine-grained sediments exposed at the ground surface, resulting in the formation of cover sands which are widely preserved in eastern England (Bateman 1995, Bateman et al 2000). Two phases of cover sand deposition are recognised by BGS within the study area. The earlier phase is recorded as the Breighton Sand Formation, regarded by BGS as Devensian in age. Generally 1.0-2.0m in thickness, but locally up to 6.0m, and represented in the study area where its outcrop extends into Area 7. The later phase is recorded as the Sutton

Sand Formation which may be up to 7.0m in thickness and has been dated to the end of the Devensian and the earliest Holocene (Bateman 1995). Beds of peat may be present in the sand and/or at its base. Within the study area, spreads of Sutton Sand are mapped by BGS in Areas 2, 3, 4, 7, 8 and 9/10. These are all small outcrops apart from Areas 2 and 7. Here boreholes SE70NW29, SE70NW30, SE71SE21, SE71SE22 and SE71SE23 record the Sutton Sand Formation as near surface units of fine sand or silty sand between 1.8m and 3.3m thick.

4.2.5. Fluvial down-cutting and aggradation

Evidence recorded elsewhere in the Humber Wetlands (Neumann 1998, Lillie & Gearey 2000) shows that soon after the establishment of the post-glacial drainage network, the rivers cut down into the weakly consolidated glacial and lacustrine sediments, grading to a sea level at least 20m below present OD and creating deeply incised valleys. As sea level rose during the Holocene there followed a period of aggradation which led to the infilling of these valleys and ultimately to the development of the broad aggradational floodplains that form the present alluvial landscape in the study area.

In the valley of the Old Don the available borehole records comprise the BGS archive record and boreholes in three hand-augered transects (Figure 4) undertaken as part of the Humber Wetland Project (Dinnin 1997a). These records are widely and randomly scattered and of variable quality. Many of the boreholes are shallow relative to the full depth of the alluvial sequence which, judging by the deeper boreholes maybe in excess of 9.0m in many places beneath the low-lying (0-1m OD) parts of the floodplain. Of the 43 BGS archive boreholes put down within the mapped outcrop of the Alluvium and examined during this assessment only seven could be interpreted with reasonable confidence as penetrating to bedrock, and of these, four were in the outer margins of the floodplain. In addition, in some borehole logs identifying the Bedrock/Alluvium boundary is difficult due to similarities between the Alluvium and underlying weathered Sherwood Sandstone. There is also the possibility that lacustrine sediments of Lake Humber may survive in places beneath the alluvium, e.g. the laminated clay recorded in borehole SE71SE23 is in the right height range (see Transect 2, Figure 6). Many of the hand-augered boreholes recorded during the Humber Wetland Project were less than 3.0m in depth, and none extended beyond 8.0m. However, despite the limitations of the borehole record, some broad stratigraphic patterns can be recognised.

All the individual boreholes mentioned below are in the BGS archive and are identified here by their BGS number (see Transects 1, 2 and 3, Figures 5, 6, 7)

Three of the boreholes that penetrated to bedrock (SE71SW10, SE71SW11, SE70NW3) are situated on or very close to roddons and seem likely therefore to record in-channel sequences. In these boreholes bedrock was encountered at, respectively -16.0m, -11.6m and -12.0m OD (see Transects 1 and 2, Figures 5 and 6). However, the deepest alluvial sequence was recorded in borehole SE71SW23 which penetrated to -17.5m OD without reaching bedrock. This borehole is situated in the floodplain of the Old River Don south-west of Crowle (see Transect 3, Figure 7). In all these boreholes, gravel or gravelly sand formed the lowest part of the sequence. Gravel was also present in five other boreholes (including SE70NW6, SE71SW30, SE71SW29) as the lowest recorded unit at levels of, respectively -10.4m, -6.8m, -5.9m, -4.8m and -2,5m OD. Three of these boreholes are situated on or very close to roddons (SE70NW6, SE71SW37, SE61SE78), the other two are close to borehole SE71SW23 on the floodplain of the Old River Don south-west of Crowle.

The upper part of the alluvial sequence beneath the low-lying parts of the floodplain (proximal floodplain) and in the roddons consists everywhere of fine-grained mineral sediment or peat. More than 80 boreholes put down in four transects during the Humber Wetland Project (Dinnin 1997a) provide a useful detailed record of the local variability of the upper part of the alluvium. The uppermost part of the sequence is often a unit of sand but the bulk of the alluvium is described in borehole logs as clay or less commonly silt, or as laminated clay with silt in partings or with pockets of silt. Organic material is often present either as peat or clayey peat, or in peaty clay or sand, or as 'organic traces'. Peat/clayey peat units up to 7.0m thick are recorded in some boreholes (e.g. SE71SW30, SE70NW26).

The margins of the floodplain (distal floodplain) are not well represented in the borehole record, but an interesting group of five boreholes is present in the valley of the Old River Don close to the western boundary of the study area (SE61SE82, SE61SE90, SE61SE91, SE61SE95, SE6NE122; see Transect 2, Figure 6). Here the ground level is between 2.0m and 3.0m OD, the alluvial floodplain is narrow and the ground rises sharply at the floodplain edge onto an upstanding area of Devensian fluvio-glacial sand and gravel. In all five boreholes the alluvial sequence is relatively thin (4-5m) and gravel is present at the base of the sequence resting on bedrock at levels between -2.5m and -4.0m OD. Overlying the gravel are fine-grained sediments consisting mainly of laminated silts and clays.

4.2.6. Peat

Within the study area, substantial outcrops of peat are recorded by BGS in Area 2. Smaller outcrops are mapped in Areas 1 and 9, where they represent the southern fringe of the extensive raised bog preserved on Thorne Moor as part of the Humberhead Peatland National Nature Reserve. There are few boreholes in these areas and such as they are in Area 2, they record only thin beds of peat – SE71SE21 0.6m, SE71SE22 0.3m, or none at all (SE70NW13).

4.2.7. Warp

In the 18th and 19th centuries various attempts were made to improve the fertility of soils, mainly on the extensive areas of peat in the Humber Wetlands and the Lower Trent Valley. The principal method adopted is termed 'warping' or 'flood warping'. Described in detail by Stephenson (1912), warping involved the construction of embanked enclosures and sluices to trap tidal water from which the suspended sediment load of fine sand, silt and clay settled on the peat surface to create an artificial alluvial soil, termed 'warp'. Stephenson (1912) indicates that in general the warping process was allowed to continue for two to three years resulting in the accumulation of a thickness of up to three feet of alluvial sediment. The thickness of the warp layer recorded by Lillie (1997) in a study of 58 borehole sequences was between 0.69m and 1.60m.

Within the study area, the evidence of warping is limited in extent (Fig. 4). Lillie (1997 Figs 9.1 and 9.2) indicates the presence of warp, as mapped by BGS, on the southern fringe of the peat that underlies Thorne Waste, in the eastern part of Area 9 and along the north-western margin of Area 1. During the 19th century various schemes were proposed to enable a more extensive warping of Thorne Waste. Limbert (1990) describes drainage channels created to facilitate this work but indicates that none of these schemes progressed as far as warping any of the areas involved.

5. PREHISTORIC ARCHAEOLOGICAL POTENTIAL

Twenty-seven HER sites are recorded within the study area (Areas 1-9) (Figure 8). Most of them are of Roman or medieval interest, but there are two of Mesolithic interest (in Area 9), four of Neolithic interest (in Areas 2 and 7) and two of Bronze Age interest (in Areas 1 and 2). During field walking forming part of the Humber Wetland Project in the valley of the Old River Don (Head et al 1997), within or near the study area, four prehistoric flint scatters were identified, two of probable Late Mesolithic/Early Neolithic origin. Fifteen other isolated flakes were also recorded and nine pieces of unworked flint. Investigations elsewhere in the Humber Wetlands (Van de Noort & Davies 1993, Head et al 1997) have revealed a history of prehistoric occupation which provides a basis for an understanding of likely patterns of occupation within the study area. There is evidence in the wider Humber Wetlands of Mesolithic occupation particularly in riverine locations, but it has to be remembered that sea level, though rising, remained substantially depressed during the Mesolithic period and any evidence of occupation associated with the rivers and floodplains within the study area is likely to be deeply buried within the Alluvium. Once sea level had risen to the point at which aggradation on the wider floodplain began, the development of eutrophic wetlands, mainly alder carr woodland and reed swamp, discouraged occupation of the floodplain in the later prehistoric period.

6. ASSESSING THE LANDSCAPE AND ITS ARCHAEOLOGICAL, GEOARCHAEOLOGICAL & PALAEOENVIRONMENTAL POTENTIAL

In the light of the topographical, geological and archaeological information outlined above, it is possible to recognise landscape types which may be helpful in assessing and investigating the palaeoenvironmental and prehistoric archaeological potential of the study area. Four main landscape types can be identified (Table 1 and Figure 9).

6.1.1. The Lake Floor

The lake floor is a remarkably uniform area both topographically and in terms of the underlying superficial geology. The likelihood of prehistoric archaeological remains being preserved in the lake sediments is very low. However, the area will have been accessible throughout the prehistoric period and it is therefore possible that Mesolithic and later prehistoric groups or individuals were occasionally present on the lake floor where they might have discarded artefacts or left evidence of temporary occupation. Two HER sites of Mesolithic interest are recorded within Area 9 and one each of respectively Neolithic and Bronze Age interest.

6.1.2. River Channels

Evidence of historic and prehistoric river channels is preserved in the landscape in the form of ribbons of mainly mineral sediment (roddons) upstanding slightly above the surrounding floodplain. These channels were deepened in the Late Devensian and Early Holocene in response to sea levels at least 20m below the present. The subsequent aggradation of sediment within these channels has the potential to provide an extended palaeoenvironmental record of landscape and land-use change throughout the Holocene.

6.1.3. Low-lying Floodplain

Low-lying floodplain is the most extensive landscape type within the area mapped as Alluvium by BGS. It is underlain by sediments which represent accumulation during much of the Holocene including substantial beds of peat. Floodplains within the Humber Wetland appear to have been attractive to Mesolithic hunter-gatherers, so there is the possibility that evidence of transitory Mesolithic occupation will be preserved in the early part of the alluvial sequence. An HER site of Bronze Age interest is recorded in Area 1.

6.1.4. The wetland/dryland boundary zone

This landscape type embraces the outer margins of the floodplain and the neighbouring higher ground. The wetland/dryland boundary has been shown in many contexts to have been attractive to prehistoric groups due to the range of resources that it provides. The areas assigned to this landscape type in this assessment reflect the position of the wetland/dryland boundary in the historic period. It must be remembered that as the rising sea level encroached on the low ground of the original Don valley the position of the wetland/dryland boundary will have changed and archaeological evidence associated with it may be preserved beneath what is now the low-lying floodplain. Five HER sites of Neolithic interest and one of Bronze Age interest are recorded within the wetland/dryland boundary zone in Areas 2 and 7.

7. CONCLUSIONS

The shaping of the Humber Wetlands during the past 20,000 years has been well documented thanks mainly to the work of the Humber Wetlands Project (1992-2000). Although published accounts relating specifically to the study area are limited in number, it is nonetheless possible to recognise in the landscape and the underlying geology of the area, evidence of the several stages of landscape development identified in the wider region (see Table 2).

Geoarchaeological potential in the study area is low due either to deep burial of prehistoric land surfaces or unfavourable landscape and palaeoenvironmental conditions for prehistoric occupation.

In terms of the proposed site development, probably the most significant landscape characteristic, especially in the fluvial landscape of Areas 1 and 3-7, is the likely wide variety of near surface ground conditions due to the diversity of alluvial depositional environments and the resultant variety of sediment associations.

8. BIBLIOGRAPHY

Bateman, M.D. (1995) Thermoluminescence dating of the British coversand deposits. *Quaternary Science Reviews*, **14**, 791-8.

Bateman, M.D., Murton, J.B. & Crowe, W. (2000) Late Devensian and Holocene depositional environments associated with the coversands arount Caistor, north Lincolnshire, *Boreas*, **29**, 1-15.

Boreland, K. (2023) Land at Tween Bridge. Initial Phase 1 Ground Conditions Desk Study. Intégrale unpublished report.

Dinnin, M. (1997a) The palaeoenvironmental survey of the Rivers Idle, Torne and Old River Don. In Van de Noort, R. and Ellis, S. (eds) *Wetland Heritage of the Humberhead Levels, an Archaeological Survey*. Hull. 81-155.

Dinnin, M. (1997b) The drainage history of the Humberhead Levels. In Van de Noort, R. and Ellis, S. (eds) *Wetland Heritage of the Humberhead Levels, an Archaeological Survey*. Hull. 19-30.

Dinnin, M. (1997c) The palaeoenvironmental survey of West, Thorne and Hatfield Moors. In Van de Noort, R. and Ellis, S. (eds) *Wetland Heritage of the Humberhead Levels, an Archaeological Survey*. Hull. 157-89.

Fairburn, W.A. & Bateman, M.D. (2016) A new multi-stage recession model for Proglacial Lake Humber during the retreat Of the last British-Irish Ice Sheet. *Boreas*, **45**, 133-151.

Head, R., Chapman, H., Fenwick, H., Van de Noort, R & Dinnin, M. (1997) The archaeological survey of the Rivers Idle, Torne and Old River Don. In Van de Noort, R. and Ellis, S. (eds) *Wetland Heritage of the Humberhead Levels, an Archaeological Survey*. Hull. 157-89.

Lillie, M. (1997) Alluvium and warping in the Humberhead Levels: the identification of factors obscuring palaeo-landsurfaces and the archaeological record. In: Van de Noort, R. & Ellis, S. (eds) *Wetland Heritage of the Humberhead Levels, an archaeological survey*. Hull, 191-218.

Lillie, M. & Gearey, B. (2000) The palaeoenvironmental survey of the Hull valley and research at Routh Quarry. In Van de Noort, R. and Ellis, S. (eds) *Wetland Heritage of the Hull Valley, an Archaeological Survey*. Hull. 75-101.

Limbert, M. (1990) The drainage of Thorne Waste in the 19th century. *Thorne & District Local History Association, Occasional Papers*, No. 5.

Metcalfe, S.E., Ellis, S., Horton, B.P., Innes, J.B., McArthur, J., Mitlehner, A., Parkes, A., Pethick, J.S., Rees, J., Ridgway, J., Rutherford, M.M., Shennan, I. and Tooley, M.J. (2000) The Holocene evolution of the Humber Estuary: reconstructing change in a dynamic environment. In: Shennan, I. & Andrews, J.E. (eds) *Holocene Land-Ocean Interaction and Environmental Change around the North Sea*. Geological Society of London, Special Publication No. 166, 97-118.

Neumann, H. (1998) The palaeoenvironmental survey of the Ancholme Valley. In Van de Noort, R. and Ellis, S. (eds) *Wetland Heritage of the Ancholme & lower Trent Valleys, an Archaeological Survey*. Hull. 157-89.

Pegasus Group (2023) Tween Bridge Solar Farm Environmental Impact Assessment Scoping Report. Unpublished report.

Stephenson, J. (1912) Warping. *Journal of the Royal Agricultural Society of England*, **73**, 104-13.

Taylor, M. (1987) *Thorne Mere and the Old River Don*. The Ebor Press, York.

Tomlinson, J. (1882) The Isle of Axholme before Vermuyden. *Agricultural History Review*, 1, 16-28

Van de Noort, R. (2004) *The Humber Wetlands – The Archaeology of a Dynamic Landscape*. Windgather Press, Macclesfield.

Van de Noort, R. & Davies, P. (1993) Wetland Heritage: and Archaeological Assessment of the Humber Wetlands. Hull.

Van de Noort, R. & Etté, J. (1995) The Humber Wetland Survey: background, Objectives and methodology. In In Van de Noort, R. and Ellis, S. (eds) *Wetland Heritage of Holderness, an Archaeological Survey*. Hull. 1-7.

Van de Noort, R., Chapman, H., Head, R. & Dinnin, M. (1997) The Archaeological Survey of West, Thorne and Hatfield Moors. In Van de Noort, R. and Ellis, S. (eds) *Wetland Heritage of the Humberhead Levels, an Archaeological Survey*. Hull. 157-89.

Table 1: Distribution of landscape types, masking sediments and elevation OD within the Tween Bridge sub-sites (Areas 1-10)

Area	Lake floor	River channel	Proximal floodplain	Wet/dry		Blown sand	Peat		<1m	0-1m	1-2m	2-3m	3-4m	>4m		Landscape types
1		x	x				x			x	x	xr	(xr)			ABC
2			(x)	x		x	x				x	x	x	(x)		BC
3		x	x	x		(x)	(x)			x	x	xr	xr			ABC
4		x	x			x	(x)			x	x	xr				AB
5		x	x								x	(xr)				AB
6		x	x	x					x	x	x	xr*	(xr)			ABC
7				x		x	x			x	x	x*	x*	x*		ABC
8	x	x	x	x		(x)				x	x	(xr)				ABD
9	x					(x)	x		(x)	x	x	x				D
10	x					(x)	x		(x)	x	x	x				D

Brackets indicate that the feature in question occupies a very small part of the sub-site.
'r' in the OD columns indicates that these elevations relate to the roddon-like traces of the Old Don drainage network.
* in the OD columns indicates that these elevations include upstanding areas of Devensian fluvio-glacial or River terrace sand and gravel.

<u>Landscape types</u>:
A River channel
B Low-lying (proximal) floodplain
C Wetland/dryland boundary zone
D Lake floor distal floodplain

Table 2: Landscape development stages

Development stage	Landscape/geological evidence	Location within study area
Late Devensian glaciation	Small upstanding outcrops of fluvio-glacial sand and gravel	Areas 6 and 7
Pro-glacial Lake Humber	Lacustrine sediments	Extensive outcrop in Areas 8 and 9
Establishment of post-glacial drainage pattern and incision of main river channels	Buried channels and in-channel fluvial deposits down to at least 17.5m OD	Associated with upstanding linear topographic features (roddons) in Areas 1 & 3-8
Aeolian re-working of fine-grained surface outcrops	Cover sands	Mainly in south of study area in Areas 2, 6 and 7
Development of alluvial floodplains	Clays, silts and sands often laminated, and peat	Widely present in Areas 1 and 3-7
17th century diversion of the Rivers Don and Idle		

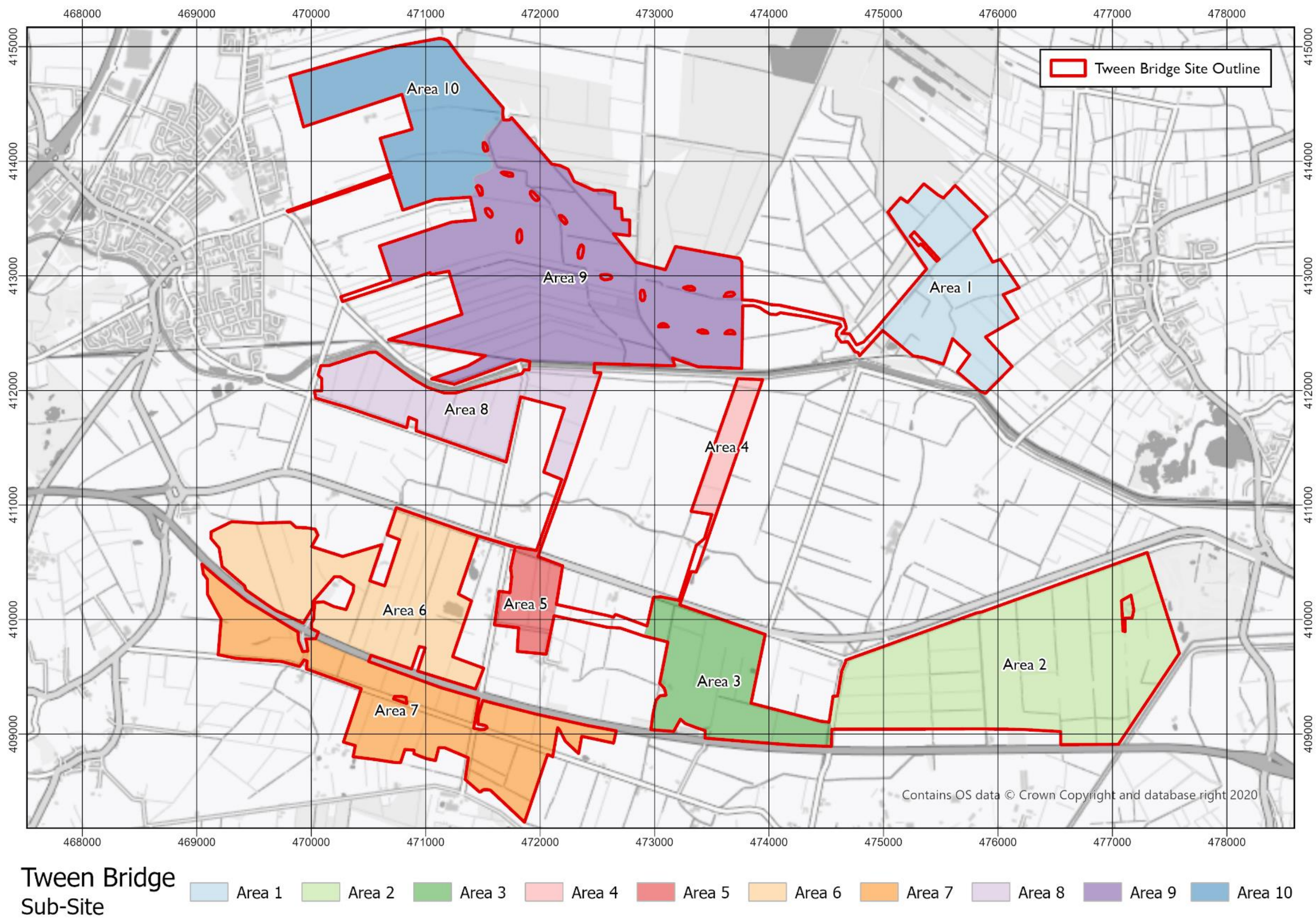

Figure 1: Tween Bridge Solar Farm site outline and individual sub-zones (as defined by Boreland 2023 in Pegasus Group, 2024)

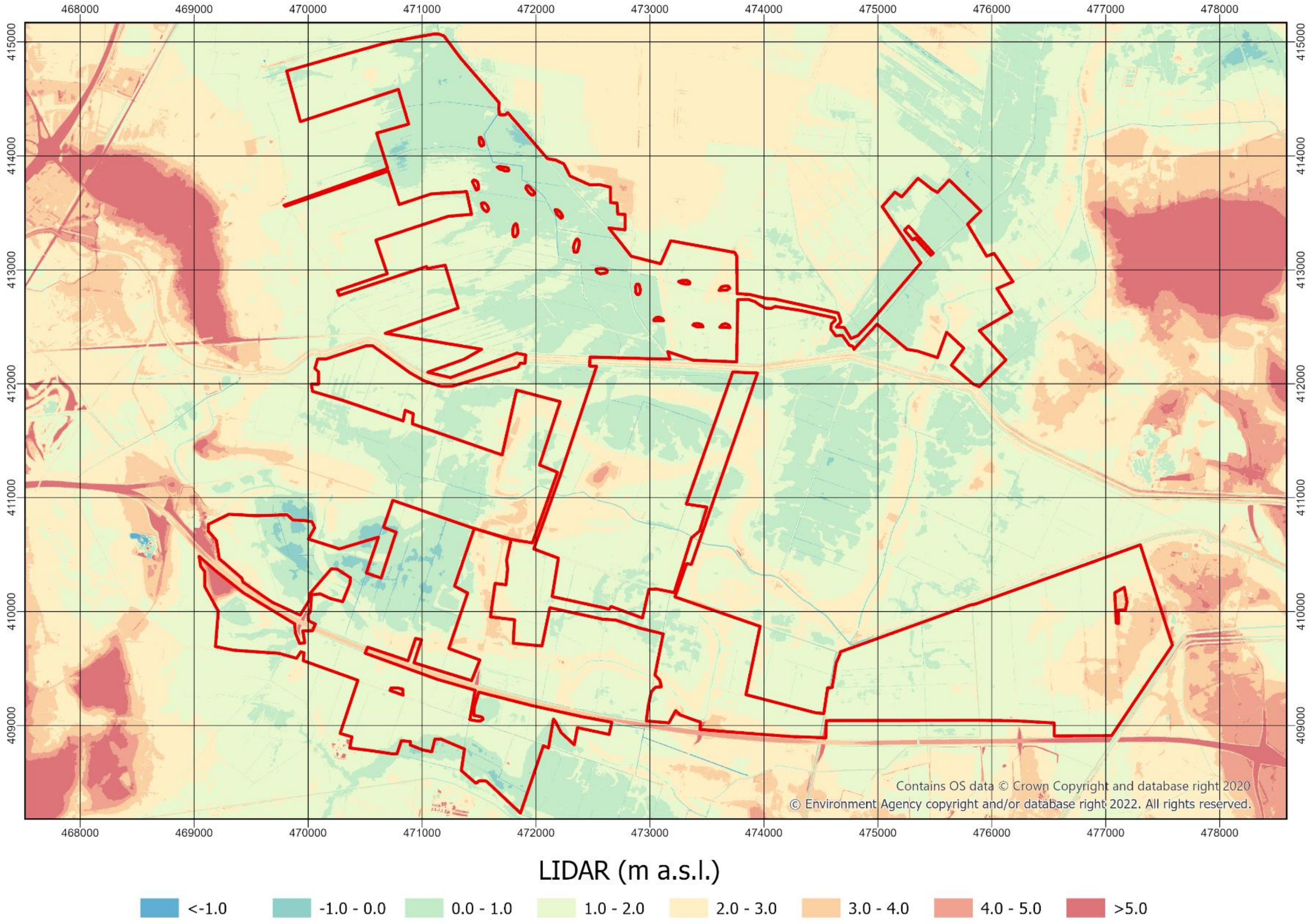

Figure 2: Topography (based upon LIDAR imagery)

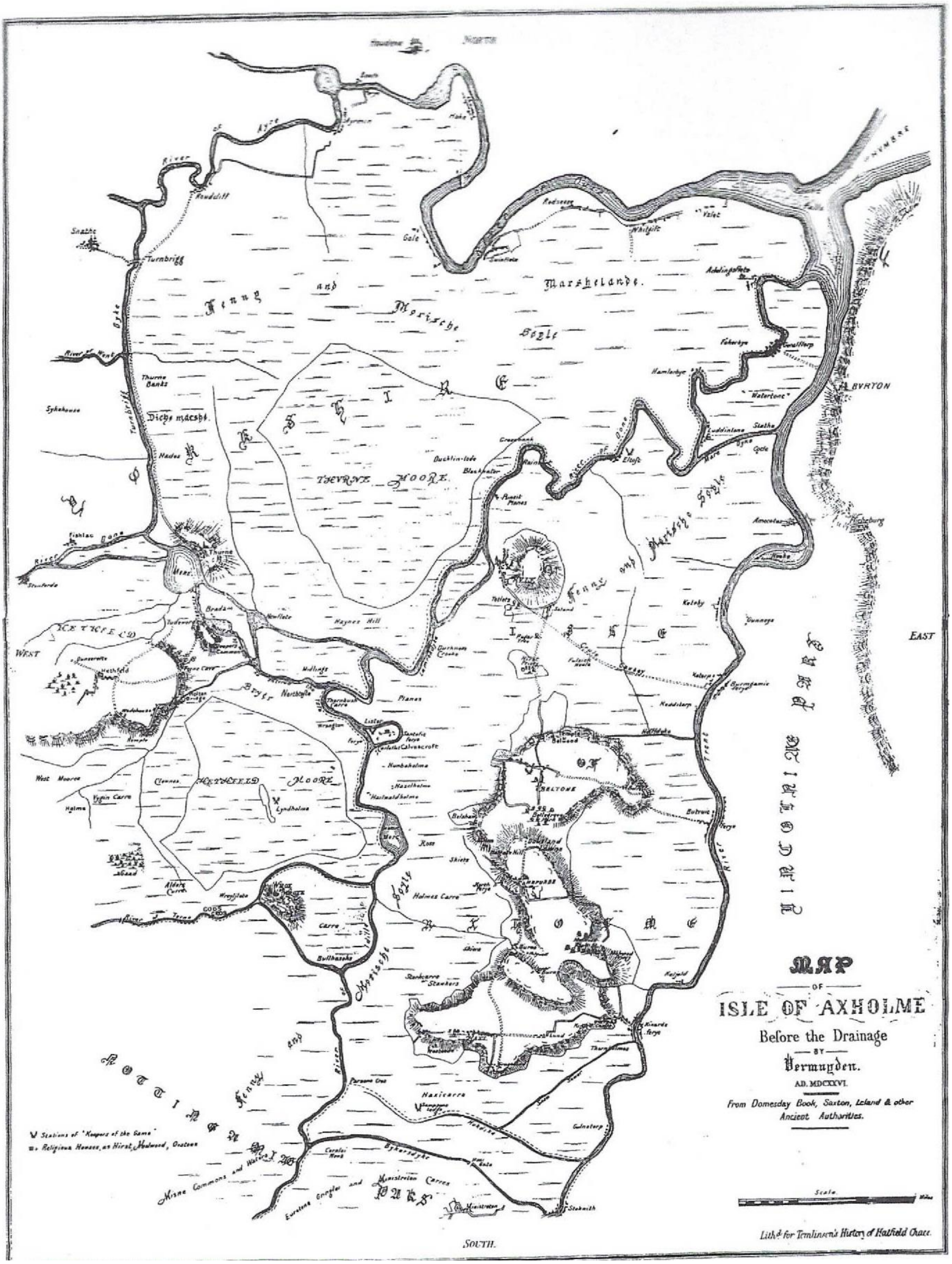

Figure 3: The historic River Don (Tomlinson, 1882)

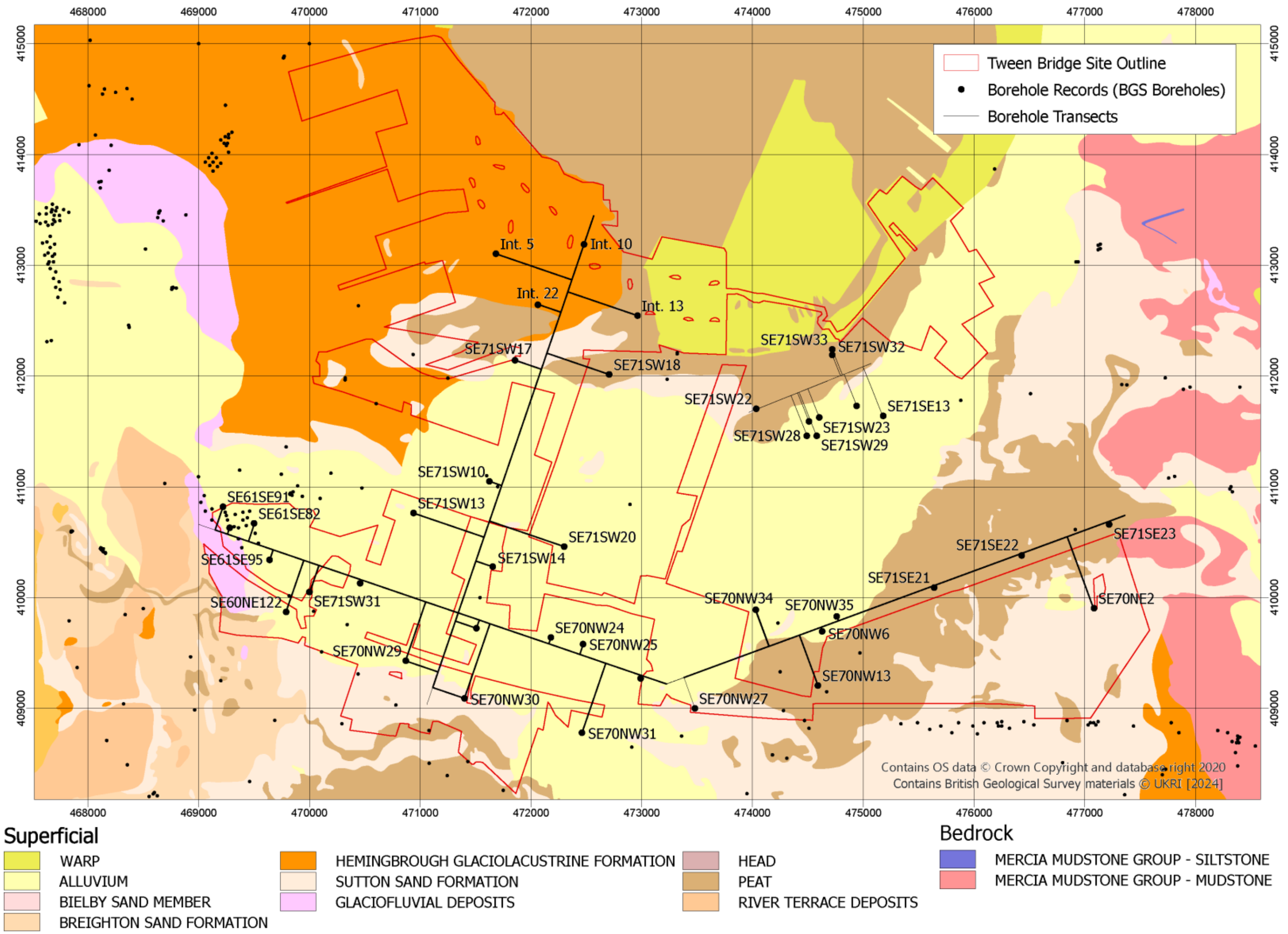

Figure 4: Map of the bedrock and superficial geology (Contains British Geological Survey materials (c) UKRI 2024). Also displaying the borehole transect locations.

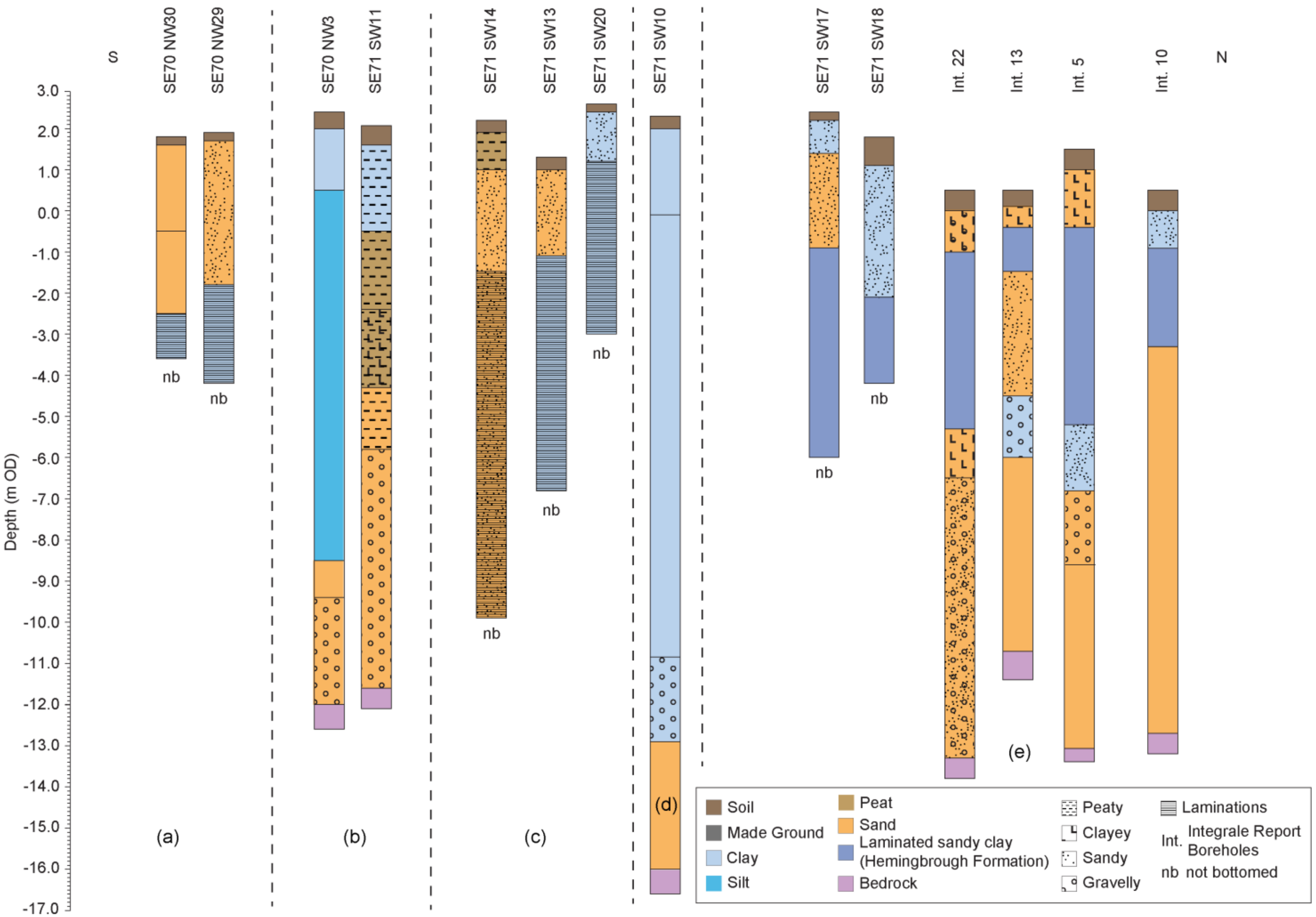

Figure 5: Borehole transect 1. This transect is thought to show from south to north: (a) two boreholes on the southern margin of the Don floodplain; (b) two boreholes penetrating the buried channel of the southern branch of the pre-diversion River Don; (c) three boreholes in the floodplain between the southern and northern branches of the pre-diversion river, one of them (SE71SW14) sited on a roddon and probably penetrating an earlier palaeochannel; (d) a deep borehole extending down to bedrock, sited on a roddon and probably penetrating an early palaeochannel, but also close to the course of the Boating Dike which is thought to mark the northern branch of the pre-diversion Don, but has no roddon associated with its course; (e) six boreholes in the deposits of Lake Humber.

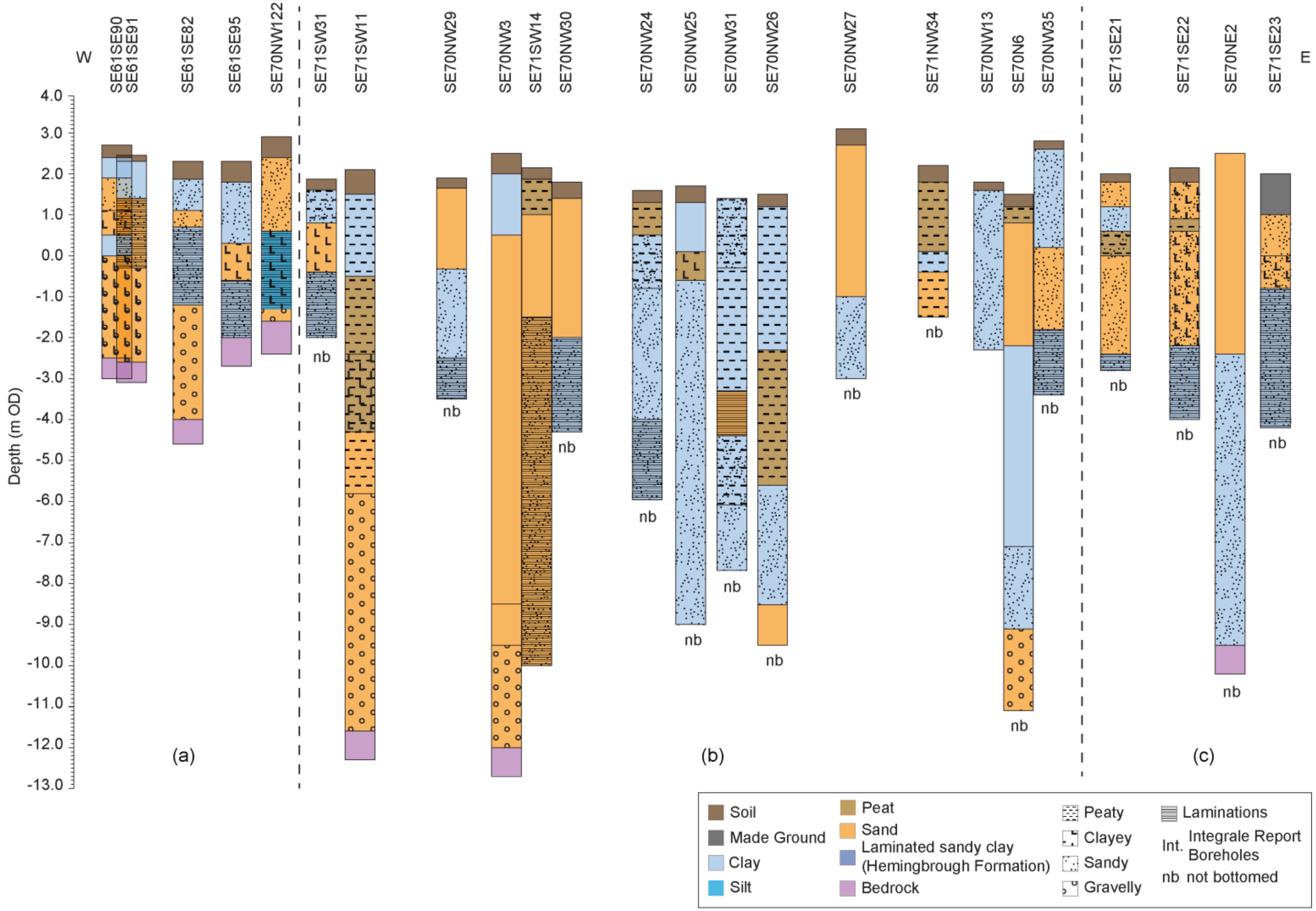

Figure 6: Borehole transect 2. This transect is thought to show from west to east, (a) five boreholes in the narrow floodplain to the south of the River Don, four of them penetrating to bedrock; (b) 14 boreholes in the floodplain and channel of the southern branch of the pre-diversion Don, illustrating a typical range of in-channel and floodplain depositional environments; (c) four boreholes in the broad area of low ground (?floodplain) to the east of the pre-diversion course of the River Don, mapped by BGS as either peat or blown sand (Sutton Sand Formation)

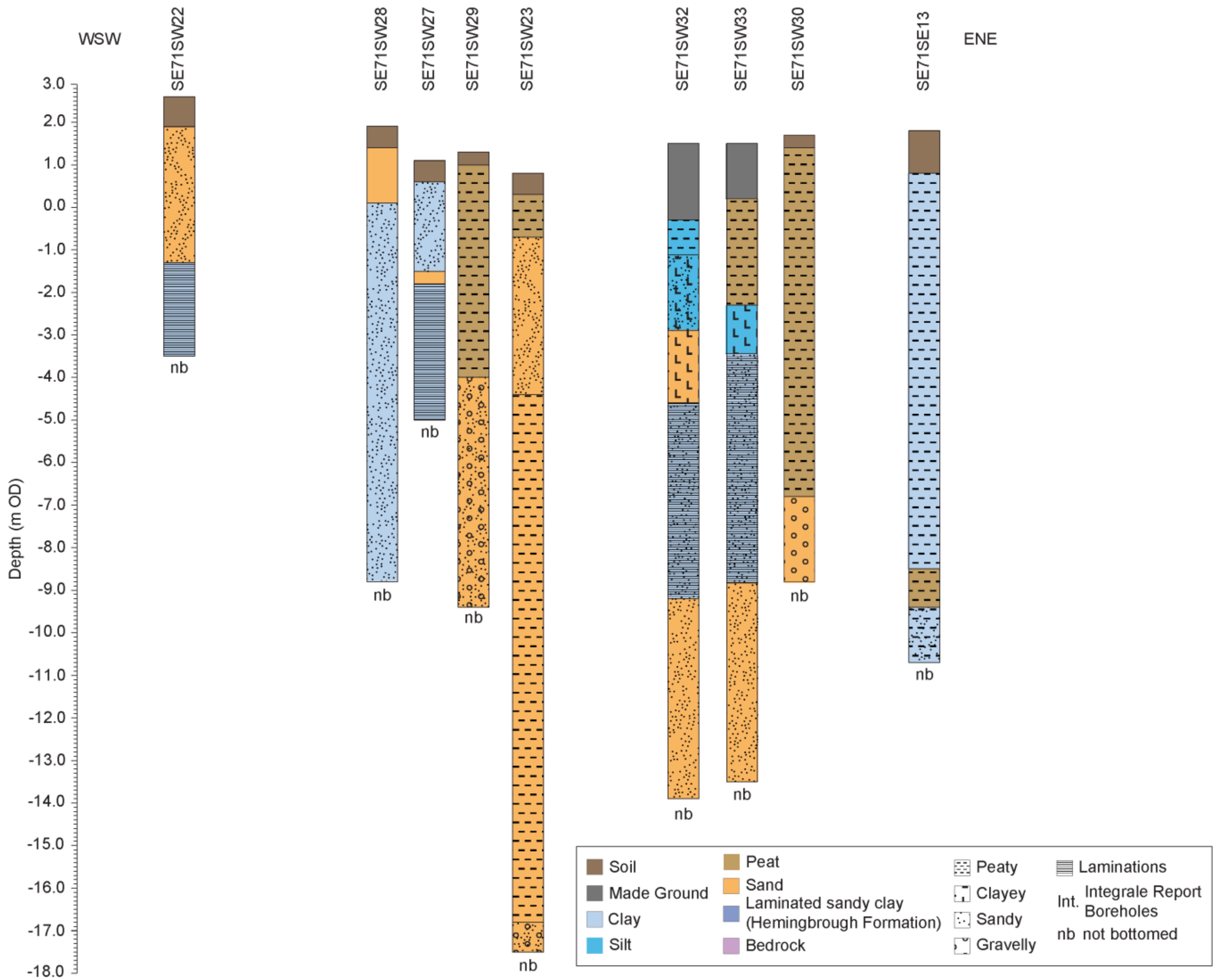

Figure 7: Borehole transect 3. A short transect across the western half of the floodplain of the pre-diversion River Don downstream from Transect 2. It illustrates a typical range of in-channel and floodplain depositional environments. The deeper boreholes seem likely to have penetrated palaeochannels, but these are not marked by the presence of roddons at the ground surface although the pre-diversion course of the Don is marked nearby in this way.

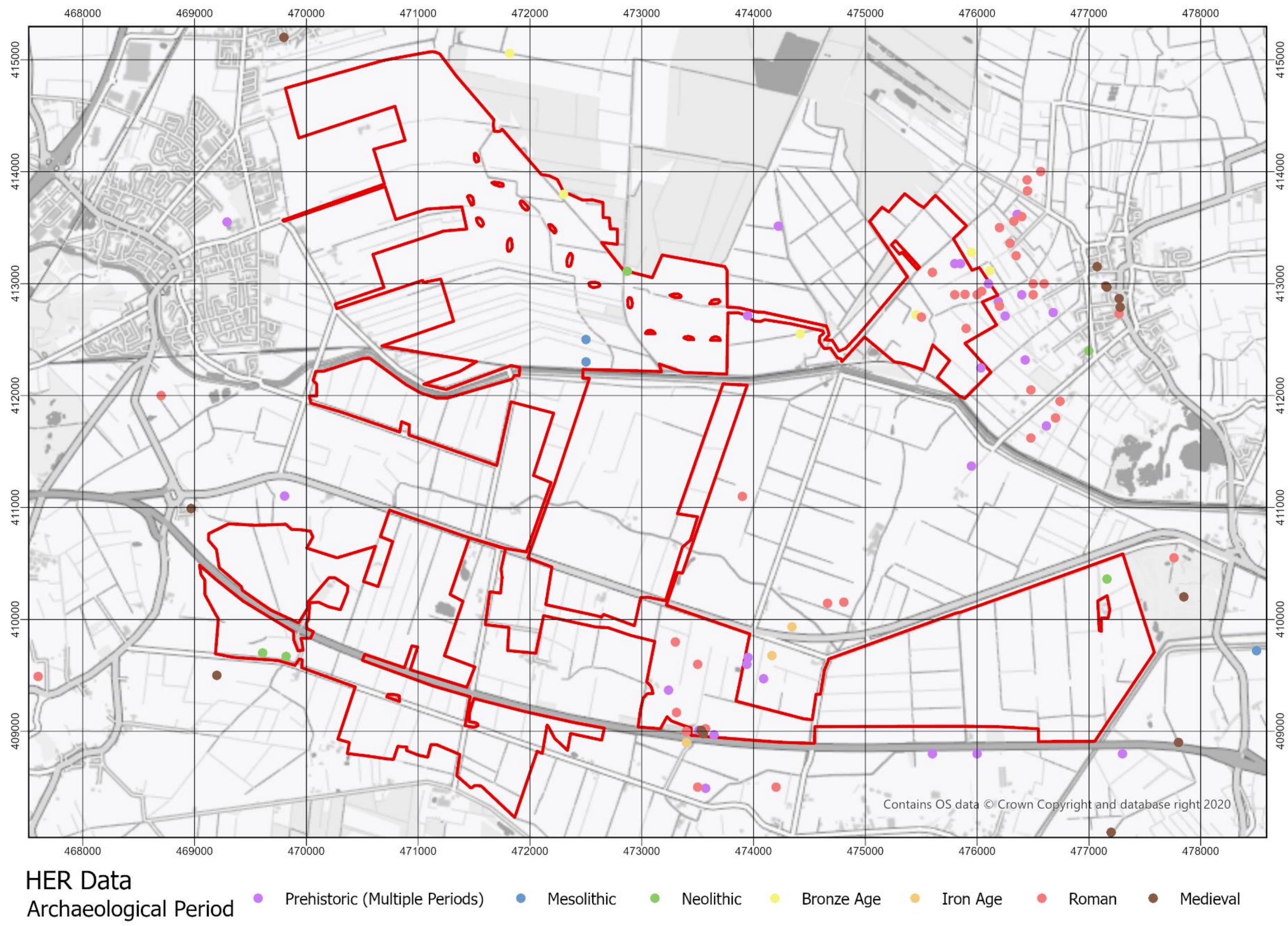

Figure 8: Map of the HER sites

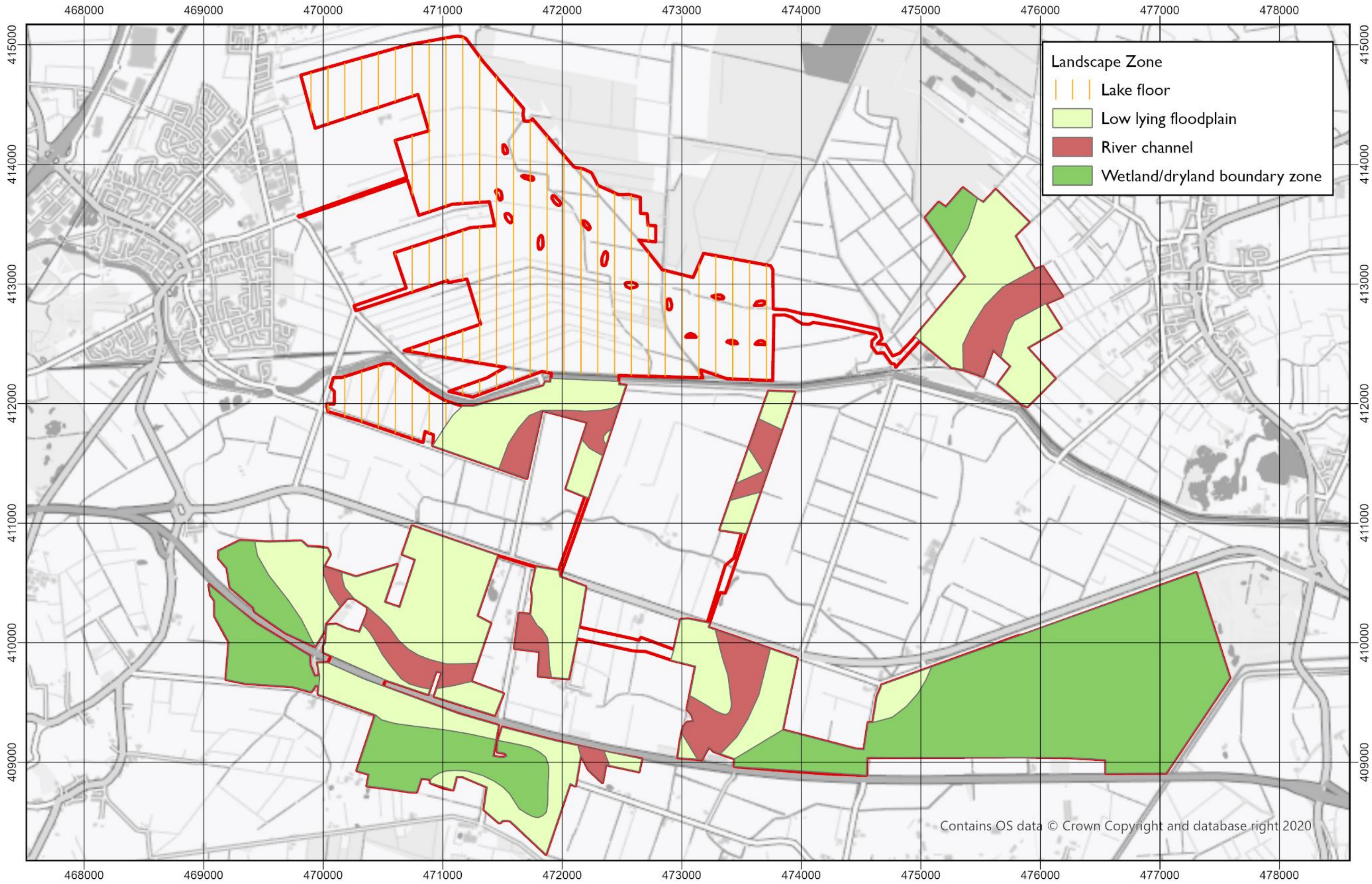

Figure 9: Map of landscape types