WALNEY SUBSTATION SITE, HEYSHAM, LANCASHIRE

Archaeological Evaluation and Strip, Map and Record

Oxford Archaeology North

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SUMMARY

Oxford Archaeology (OA) North was commissioned by Royal HaskoningDHV (RHDHV), acting on behalf of their client Dong Energy, to conduct a programme of archaeological evaluation by trial trenching, followed by a further phase of strip, map and record (commissioned directly by Dong Energy). The works took place at the proposed site of an electricity substation near Heysham, Lancashire, forming part of the wider Walney Extension Offshore Windfarm in Morecambe Bay. The initial phase of trenching was conducted in order to inform the planning process and any subsequent phase of archaeological mitigation that may be required. Based upon the speculative results of the initial archaeological works, a subsequent phase involving a process of strip, map and record was undertaken in order to examine two specific areas of archaeological potential. This was required by Lancashire County Archaeology Service (LCAS), in response to the potential impact eventual works may have upon any archaeological remains and the archaeological potential of the site. The initial works comprised the excavation of 45 trial trenches, mostly across and around the location of a suspected palaeochannel, and the recovery of borehole samples from two locations. The subsequent strip, map and record phase comprised the stripping of two large areas, intended to further expose several features and their wider surround, in order to clarify and expand upon the interpretative results of the initial works.

The initial phase of work was conducted between 3rd and 18th September 2014 and revealed evidence for a suspected palaeochannel and potential tributaries. It confirmed a stratigraphic sequence that comprised peat, overlain by deeply stratified deposits of marine alluvial flood deposits, into which the palaeochannel/s had been cut. The channel/s had subsequently silted up, and a further period of peat formation followed, with such deposits in-filling much of the remaining channel/s. This later peat horizon probably represents a remnant of Heysham Moss, which is now confined to the north of the site, and which is believed to have formed from the time of the Mesolithic/Neolithic transition onwards.

Excavations also revealed a series of putative linear and discrete archaeological features. These features produced no finds and could not consequently be dated, but included the potential remains of a ring ditch, or drip gully, associated with a possible prehistoric/Romano-British round house, as well as the remains of a poorly defined potential field system and additional activity. The fills of these features were characterised by peat formation and could not be easily distinguished from those of a more natural origin that presumably represent the remains of a marsh land environment. Consequently, a natural origin for some or all of these features could not be ruled out entirely. The exact nature and extent of these features was, therefore, difficult to gauge within the confines of the trenching, but was thought to potentially represent activity associated with late prehistoric (Iron Age to Roman) settlement of the floodplain.

In addition, a number of well-defined linear features and several pits were also identified. These were mainly confined to the south-eastern corner of the site and produced material evidence of a late post-medieval or modern origin, probably relating to the enclosure of the area towards the end of the nineteenth century.

While some ambiguity therefore existed in relation to the interpretation of the archaeological features recorded during the initial phase of archaeological works, the potential remained for the presence of prehistoric activity to be preserved within the area of development. This was considered to be of enough significance to warrant further investigation and a scheme of strip, map and record was subsequently carried out during March 2015. This phase of works comprised the removal of topsoil and subsoil within two large areas, each targeting zones of potential prehistoric archaeological activity defined by the previous trenching, and was intended to further expose the archaeological remains in order to clarify their exact nature and composition, and mitigation against their subsequent loss. However, it soon became apparent that, while several new features were uncovered relating to post-medieval activity across the site, features previously held to represent potential prehistoric activity, in fact derived from a system of minor palaeochannels and associated remains of a wetland environment. Limited excavation of the archaeological and natural features, exposed during this subsequent phase of works, were conducted sufficient to confirm their date and nature, but given the absence of earlier postulated activity the project was curtailed following discussion with LCAS and the client.

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The fieldwork was undertaken by Adam Tinsley, assisted by Becky Wegiel, John Onraet, Steve Clarke, Sarah-Jayne Clements, James Hodgson, Emma Fishwick and Marta Golibiewska. The report was written by Adam Tinsley and the drawings produced by Adam Tinsley and Mark Tidmarsh. The project was managed by Stephen Rowland, who, together with Adam Tinsley, edited the report.

1. INTRODUCTION

1.1 CIRCUMSTANCES OF PROJECT

1.1.1 Oxford Archaeology (OA) North was commissioned by the Principal Archaeologist at Royal HaskoningDHV (RHDHV), acting on behalf of their client Dong Energy, to conduct a programme of archaeological evaluation by trial trenching at the proposed site of an electricity substation in the area of Heysham, Lancashire (NGR centred SD 42425 60216). This was conducted in order to inform the planning process, and assist in the formulation of an appropriate scheme of archaeological mitigation relating to the development, which forms part of the wider Walney Extension Offshore Windfarm in Morecambe Bay. This was necessary as the proposed development area (PDA) is located within an area of archaeological potential and, consequently, Lancashire County Archaeology Service (LCAS; the county council's statutory body responsible for advising planning authorities on heritage matters) requested that the development should be accompanied by an appropriate scheme of archaeological investigation and recording. Following on from the initial evaluation, at the request of LCAS a further targeted scheme of archaeological strip, map and record was undertaken as a pre-construction mitigation measure for the development. This focused upon the excavation of two areas of archaeological potential highlighted during the previous phase of works.

1.1.2 The PDA lies north of the A683 and covers *c* 13 ha of agricultural land, within which the substation affects a square area covering *c* 3 ha. Impact within the substation footprint is currently believed to comprise general ground reduction to a depth of *c* 0.5-0.6m below the current ground level (bgl), with localised areas of deep piling (exceeding 4m depth). Around the substation, the development impact is thought to be generally associated with soil stripping within the wider working area, which is likely to have an impact to about 0.5-0.6m bgl. This report sets out the results of the trenching in the form of a short document, outlining the findings and assessing the impact of the proposed development. It also includes the results of the subsequent strip, map and record programme and a definitive assessment of all features in the light of those results.

1.2 LOCATION, TOPOGRAPHY AND GEOLOGY

1.2.1 The PDA lies just to the south-east of Higher Heysham, on the northern side of the A683 (Fig 1). It lies at the southern edge of Heysham Moss (and arguably within the former area of that morass; Middleton *et al* 1995, 120, fig 59), and is bounded to the east by agricultural land, to the north by marshy scrub land used for animal pasture, to the west by industrial land currently under development as part of the wider Windfarm onshore infrastructure, and to the south by the A683. Further to the west is Morecambe Bay, whilst the River Lune lies to the east, with its estuary just to the south. The topography is flat and low-lying (*c* 4-4.5m aoD across the PDA, although the south-western corner rises to approximately 9m aoD) and is currently used for hay production. An extensive network of land drains has

been recently installed at the site, but it is believed that the ground still has a propensity for dampness (F Scadgell pers comm).

1.2.2 The solid geology of the immediate area is characterised as sedimentary sandstone of the Ward's Stone Sandstone formation and sedimentary mudstone of the Caton Shale formation (BGS 2014). The overlying drift geology is characterised as raised tidal flats comprising loamy and sandy soils with naturally high groundwater and a peaty surface (Cranfield 2014) overlying deeply stratified alluvial clays and natural gravely sand (Quest 2014).

1.3 HISTORICAL AND ARCHAEOLOGICAL BACKGROUND

1.3.1 The PDA has been the subject of several previous studies, including an *Onshore Archaeology and Cultural Heritage Baseline Assessment* (RSK 2013), an *Environmental Statement: Archaeology and Cultural Heritage* (Royal HaskoningDHV 2013), and a *Geoarchaeological Deposit Model* (Quest 2014). In addition, the nearby Heysham Moss was investigated as part of the North West Wetland Survey (Middleton *et al* 1995). It is not the intention of this section to repeat information that is dealt with more comprehensively in those documents, but rather to provide a brief synopsis to contextualise the archaeological investigation.

1.3.2 The deposit model (Quest 2014) has indicated that the natural gravely sand, till, and mudstone that represent the underlying geology of the proposed site, form a natural depression, channel, or glacial scour in the footprint of the substation. The depression appears to coincide almost exactly with the square substation site, so that the surface of the drift geology at the base of the depression lies at *c* -4m aoD (*c* 8.5m bgl), rising to *c* -1m aoD (5.5m bgl) at the very south-eastern corner of the substation site. The natural deposits continue to rise to the south-east, with a high point of 4m aoD (*c* 1.7m bgl) located at the south-eastern edge of the wider application site (an area currently thought to be impacted to around 0.6m bgl). The depression contains deposits of fibrous woody peat between 0.9m and 2.2m thick, the upper surface of which lies at *c* –2m- -3m aoD (*c* 6-7m bgl). The peat is thought to represent the development of semi-terrestrial conditions and the growth of Fen Carr woodland. The peat is sealed by a considerable deposit of clay, interpreted as marine alluvium that has filled the depression and other low points in the natural geology, leaving an essentially flat and featureless landscape. Accordingly, the alluvium seems to be *c* 6m thick across the majority of the substation footprint, gradually shallowing as the underlying drift deposits rise, so that the clay is only *c* 1.2m thick at the south-eastern edge of the wider application site. Several of the boreholes identified peaty material within the alluvium, perhaps suggesting episodes of stabilisation during the period of clay deposition; however, such observations were not consistent within all the boreholes across the scheme area.

1.3.3 Whilst the alluvium is likely to relate to one of the several marine transgressions to affect the Lancashire coast since the end of the last ice age, the date of the clay, and of the peat deposits, is uncertain. Middleton *et al*

(1995, 121) suggest that the peat at Heysham Moss dates to the Flandrian II/III Transition (essentially the Mesolithic to Neolithic transition, *c* 4000 cal BC), but there the peat sealed, rather than underlay, the marine clay as it appears to do so in the present development site (Quest 2014). Accordingly, the deeply buried peat at the substation site could be considerably earlier.

1.3.4 The heritage assessments identified that there were no known archaeological sites within the site of the substation and its surrounding working area (RSK 2013; RHDHV 2014). Nonetheless, the immediate area contains sites and artefact findspots of Mesolithic and Neolithic date (Middleton *et al* 1995, 121-2). Of particular interest is an apparent palaeochannel that is visible on satellite imagery and traverses the substation site on a north-east/south-west alignment. The feature appears to post-date the deposition of marine alluvium at the site, but may follow an earlier channel. Such natural features frequently attracted human activity during prehistory.

1.3.5 The most extensively excavated example in the wider region is that identified on the Carlisle Northern Development Route, Cumbria (Brown *et al* in prep). At that site, OA North revealed evidence of Mesolithic, Neolithic, and Bronze Age activity, including flint artefacts and tool-making debitage scatters, burnt mounds (substantial heaps of heat-affected stones and charcoal, potentially associated with a range of prehistoric cultural activities), and apparently ritualised deposition of artefacts within the palaeochannel, including stone tools and a pair of wooden tridents. Closer to Heysham, OA North identified a small group of prehistoric remains on the edge of a palaeochannel/peat-filled depression, at the site of the Harbour (formerly Whyndyke Farm), on the outskirts of Blackpool (OA North 2014). The findings included a Bronze Age burnt mound (scientifically dated to *c* 1600-1450 cal BC), and several pits and gullies, some of which contained evidence of burning similar in character to the burnt mound, and one of which was scientifically dated to the Late Neolithic-Early Bronze Age (*c* 2400 cal BC). In addition, a kite-shaped flint arrowhead of Late Neolithic date was found in the vicinity of the prehistoric features. Similar remains have been identified elsewhere in the Over Wyre mosses to the east of Blackpool and the Fylde coast (Middleton *et al* 1995, 69, 111).

1.3.6 OA North's recent work on the M6 Link Road, between Lancaster and Heysham, has also produced evidence of prehistoric activity in association with palaeochannels (OA North forthcoming). The results are presently being collated, but at one site at Beaumont, just to the north of Lancaster, multi-phase prehistoric remains were again identified in association with a probable palaeochannel. These comprised a soil horizon containing late Mesolithic/Early Neolithic flint tools and working debris, and a number of pits and possible postholes, several of which contained burnt stony material very similar to that which is so characteristic of burnt mounds. At all three of the case studies, it is apparent that the channels and areas of former wetland attracted human activity in several prehistoric periods, with repeated, if not necessarily continuous, activity at those locations.

1.3.7 The presence of any Iron Age, Roman and medieval remains within the PDA is harder to define, but the wet area may have been suitable for pasture prior

to drainage schemes and moss reclamation in the medieval and post-medieval periods (Middleton *et al* 1995).

1.3.8 The current scheme of work involved an initial phase of archaeological evaluation trial trenching, undertaken during the course of September 2014. This revealed a limited number of probable post-medieval ditches as well as a series of less well defined features of potential prehistoric origin (*Section 3.2*). On the basis of these findings, and in order to clarify and expand upon them, LCAS requested a programme of strip, map and record to target areas of potential prehistoric activity. Under this requirement, two areas, collectively encompassing 1.7ha, were opened and investigated during March 2015. The results of this final phase of work or amalgamated in the text, with that of the previous phase (*Section 3.2*).

2. METHODOLOGY

2.1 INTRODUCTION

2.1.1 A Written Scheme of Investigation (WSI; *Appendix 1*) was submitted by OA North in response to a request by RHDHV, relating to the initial phase of archaeological evaluation. A second WSI was subsequently issued relating to the strip, map and record programme (*Appendix 2*). Both WSI's were adhered to in full, and the work was consistent with the relevant Chartered Institute for Archaeologists (CIfA) and English Heritage guidelines (CIfA 2014a, 2014b, 2014c; English Heritage 2006).

2.2 EVALUATION

2.2.1 ***Trial Trenching***: during the initial evaluation phase, a total of 45 trenches, of various sizes and orientations, were excavated across the PDA. Details of the trenches, including specific aims for investigation, are presented in *Appendix 1*, and are shown on Figure 2. Several Archaeological Trial Trenches (ATT016, 022 and 031) were placed so as to straddle the palaeochannel in areas of deep development impact (*i.e.* piling) in order to gain an understanding of the deposits within the palaeochannel, and of any archaeological remains that may have lain on its banks. A further trench (ATT018) was excavated outside of this area in order to locate and confirm the presence of the palaeochannel but otherwise did not investigate its stratigraphic sequence. Others (ATT 002-005, 008, and 010-015) were placed close to one or other edge of the palaeochannel in order to test for the presence of archaeological remains in those areas. ATT 019, 036, and 039-040 were placed at the southern edge and south-eastern corner of the site, where the geo-technical data suggests that the alluvium is likely to be more shallow, as the underlying natural drift geology rises at that location. The remainder of the trenches represent a scatter across the landscape in order to establish the presence and nature of archaeological remains across the rest of the PDA. Within the substation footprint, several trenches were placed within areas of deeper impact away from the palaeochannel. A sondage (a localised deep excavation by mechanical excavator) within each of those trenches (ATT 007, 011, 023, 027, 029) aimed to characterise the alluvium to a safe depth in order to establish whether the alluvium contains deposits indicative of intermittent stabilisation (i.e. periods where dry land surfaces developed that would have been suitable for, and attractive to, prehistoric human activity).

2.2.2 The overburden, comprising primarily of topsoil with isolated subsoil deposits, was removed in controlled spits, using a 360° hydraulically powered mechanical excavator (fitted with a toothless ditching bucket), operated under direct archaeological supervision. Excavations continued to the surface of the first significant archaeological deposit or natural horizon. At this point the trench was quickly cleaned by hand and inspected for archaeological features. All features of archaeological interest were subsequently investigated by hand and then recorded. Limited additional excavations beyond this depth were conducted within a number of trenches,

i.e. to investigate the palaeochannel or underlying alluvial deposits. Where this occurred, it was sometimes necessary to step the excavations in order to minimise the danger from edge collapse within the sondage. Once this had been carried out the sondage excavations continued in controlled spits down to the required depths under continued archaeological supervision.

2.2.3 All trenches were excavated in a stratigraphical manner. Trenches were located by use of a differential Global Positioning System (dGPS), and altitude information has been established with respect to Ordnance Survey Datum.

2.2.4 All information identified in the course of the site works was recorded stratigraphically, using a system adapted from that used by the former Centre for Archaeology of English Heritage, with an accompanying pictorial record (plans, sections, and digital photographs). Primary records were available for inspection at all times.

2.2.5 Results of all field investigations were recorded on *pro-forma* context sheets. The site archive includes both a photographic record and accurate large-scale plans and sections at an appropriate scale (1:50, 1:20 and 1:10).

2.2.6 ***Borehole***: two locations within the area of maximum development impact (*i.e.*, within the area of the substation footprint) were selected for the excavation and recovery of borehole samples. The borehole samples were intended to capture a complete profile through the sequence of deposits between the surface of the natural glacial till drift deposits, and the base of the topsoil. This permitted the safe and close examination of the deposits, the testing (or 'ground truthing') of the deposit model (Quest 2014) and the opportunity to examine the potential of the material to be informative about the nature and history of the surrounding environment through a range of palaeoenvironmental analyses.

2.2.7 A terrier-type rig was used to collect 10m of sediment from the two locations. Duplicate cores were taken. All the cores were placed in plastic sleeves and returned to the laboratory for lithological description and an assessment of potential for palaeoenvironmental work. The cores and monolith samples from the trenches were cleaned, prior to lithological description and assessment for potential palaeoenvironmental work. Following assessment, the samples were wrapped in black polythene and stored at constant temperature at OA North offices.

2.3 STRIP, MAP AND RECORD

2.3.1 Based upon the results of the trial trenching, and in order to expand upon and clarify those results, two large areas, targeted upon trenches in which archaeological potential had been highlighted, were examined by a process of strip, map and record (Figure 3; *Appendix 2*). Area A measured approximately 1.3ha and was arranged in a roughly triangular formation extending between trench ATT020 in the south and ATT004 in the north, and ATT009 in the east and ATT010 to the west. It therefore also took in trenches ATT005, ATT006, ATT008, ATT011, ATT015 and ATT031, as well as limited aspects of ATT032 and ATT044. Area B was again roughly triangular in shape, but much smaller, measuring approximately only 0.4ha.

It incorporated trenches ATT013 to the south-east, ATT021 to the west, and ATT024 as well as part of ATT023 to the north.

2.3.2 Following the same techniques employed during the trial trenching, the overburden was removed in controlled spits, using a 360° hydraulically powered mechanical excavator (fitted with a toothless ditching bucket), operated under direct archaeological supervision. Spoil was removed from the area to designated bunds using bulldozers. This was undertaken in order to minimise the anticipated detrimental result, upon soil quality and archaeological remains, associated with alternative soil removal techniques such as the use of moxi dumpers. At no point were the bulldozers allowed to track over the stripped area, in order to preserve the integrity of the exposed surface and any associated archaeological remains and deposits.

2.3.3 Excavations continued to the surface of the first significant archaeological deposit or natural horizon. At this point the area was quickly cleaned by hand and inspected for archaeological features. All features of archaeological interest were subsequently investigated by hand and then recorded.

2.3.4 A selection of features, exclusively exposed in Area A, were subjected to excavation in a stratigraphical manner, in order to further characterise and confirm their nature. All excavations were located by use of a differential Global Positioning System (dGPS), and altitude information has been established with respect to Ordnance Survey Datum. However, not all features were examined, as a quick visual inspection indicated many were obviously natural in origin. On this basis, and following the recommendation of LCAS, subsequent to a site meeting between Oxford Archaeology, LCAS and the client on the 25th of March, works were called to a halt. At this point excavations in Area A had been largely limited to the eastern half, while in Area B, no features had been examined, the majority representing further natural features as well as limited additional examples of post medieval drainage and boundary features.

2.3.5 All information identified during the course of the site works was recorded stratigraphically, using a system adapted from that used by the former Centre for Archaeology of English Heritage, with an accompanying pictorial record (plans, sections, and digital photographs). Primary records were available for inspection at all times.

2.3.6 Results of all field investigations were recorded on *pro-forma* context sheets. The site archive includes both a photographic record and accurate large-scale plans and sections at an appropriate scale (1:50, 1:20 and 1:10).

2.4 FINDS

2.4.1 The recovery of finds and sampling programmes were carried out in strict adherence to the WSI and in accordance with best practice (following current Institute for Archaeologists guidelines), and subject to expert advice in order to minimise deterioration. All artefacts recovered from the evaluation trenches were retained.

2.5 PALAEOENVIRONMENTAL SAMPLING

2.5.1 A targeted programme of palaeoenvironmental sampling was implemented in accordance with the WSI as well as Oxford Archaeology *Environmental Guidelines and Manual* (OA 2005) and English Heritage guidance paper on Environmental Archaeology (2011).

2.5.2 In general, one bulk sample measuring up to 40 litres was retrieved from each excavated feature. In addition two monolith samples were recovered from each sondage across the main palaeochannel and any additional features identified as warranting such sampling by the onsite palaeoenvironmentalist. The monolith samples were intended to recover a sequential sample across all relevant deposits within the feature, although differential drying rates and consequent small-scale edge collapse sometimes prevented a record of the full stratigraphic sequence.

2.5.3 In addition to the sampling of individual features, two borehole samples were recovered from each of two locations within the area of deep development impact (Fig 2). The borehole samples were intended to provide an assessment of the full stratigraphic sequence to a depth of approximately 10m bgl and specifically to allow the examination of peat deposits identified during previous geo-technical investigations. They were excavated by representatives of EGS, using a terrier rig, and monitored by an OA North palaeoenvironmentalist.

2.6 ARCHIVE

2.6.1 A full professional archive has been compiled in accordance with the WSI (*Appendix 1*), and in accordance with current IfA and English Heritage guidelines (English Heritage 2006). The paper and digital archive will be deposited with the Lancashire Record Office, Preston on completion of the project. Any finds suitable for retention will be deposited with the Lancaster Museum.

3. FIELDWORK RESULTS

3.1 INTRODUCTION

3.1.1 This section details the results of excavations carried out during both the initial phase of evaluation, involving a trial trenching and borehole sampling programme, as well as the subsequent strip, map and record programme of works. The discussion is set out according to the broad chronological phases distinguished across the site during both programmes of work. The various features comprising each phase are outlined and discussed in relation to the initial individual evaluation trenches, in which they were originally identified, arranged in numerical order, before an ultimate appraisal of their form and definition is offered in the light of their further exposure and examination during the strip, map and record programme. This will retain and reflect the preliminary interpretations of the features, which subsequently prompted the secondary phase of works, before confirming the final interpretation. Where features were exposed exclusively during the strip, map and record phase they will be discussed towards the end of each section relating to chronological phasing.

3.1.2 A total of 45 trenches, of various sizes and orientations, collectively covering an area equivalent to 3080m², were excavated across the PDA. This equates to a sample of the total 13 ha site of more than 2%. Details of the trenches, including specific aims for investigation, dimensions and orientation, depths achieved and results are presented in *Appendix 3* with locations shown on Figure 2. In short, the trenches were variously positioned, as set out in *Section 2.1.2* of this report, the WSI and summarised in *Appendix 3*, in order to specifically examine the known palaeochannel traversing the centre of the site and its immediate surrounds as well as to generally sample the wider area of the PDA. The programme of excavation was carried out over the course of approximately three weeks, between 3rd and 18th September 2014, with a post-excavation appraisal of the palaeoenvironmental borehole and monolith samples conducted thereafter. All context numbers assigned during investigations reflect the numerical designation of the trench within which it was identified (see *Appendix 4*).

3.1.3 Based upon an initial assessment of the results from the evaluation, and at the request of LCAS, two areas were subject to a programme of strip, map and record. The excavation areas were positioned in order to target and expand upon points of archaeological potential, identified by the phase of trial trenching, as set out in Figure 3. In addition, a smaller area was also stripped under archaeological control in order to establish site access and a sufficient compound area for welfare purposes, towards the south-eastern corner of the site. No archaeological features were observed within the compound area. The entire programme was undertaken over a period of approximately four weeks during March 2015, with a post-excavation appraisal of the results conducted thereafter. All context numbers assigned during the strip, map and record programme operate independently from the previous phase of work (see *Appendix 4*).

3.2 EVALUATION AND STRIP, MAP AND RECORD RESULTS

3.2.1 The topsoil deposit encountered across the site can be characterised as a friable light to medium grey brown silty clay with few inclusions. On the whole, it was up to 0.30m thick, although occasionally it reached a maximum of 0.80m in depth.

3.2.2 The presence of subsoil was noted, particularly among trenches located towards the north-western corner of the site, and generally can be characterised as a very firm light grey clay up to 0.40m thick. This deposit was very difficult to distinguish from the underlying natural clays and, consequently, some depths may reflect over machining of the natural deposits.

3.2.3 The predominant natural deposits encountered across the site, exposed by removal of the overburden, consisted of a firm light yellowish-grey clay with few visible inclusions. Variation of this upper natural layer occurred towards the south-east of the site, where a natural rise in the ground surface appears to correspond with a change in the local geology (ATT019, 036, 039, 040 and 041). Here the natural horizon was characterised by a light yellowish-grey sandy silty clay with large stone and boulder inclusions, particularly in ATT036 and 019.

3.2.4 All observed features, both natural and potentially or certainly archaeological, were cut into the top of this deposit, with the possible exception of one feature in ATT011, which appeared to be cut through the topsoil (see *Section 3.2.27* below). In addition, ATT037 revealed a dark brown peaty layer throughout the trench immediately below the topsoil. This layer was also noted at the western end of ATT039 and 041 and corresponds with the base of a slope rising sharply from west to east. It is unclear if this peaty deposit relates to the peat formations identified below the alluvial deposits (QUEST 2014), or, as is more likely, subsequent additional periods of peat formation, as can be identified in the upper fill of the palaeochannel and most other features, both natural and archaeological, encountered across the PDA.

3.2.5 ***Phase 1: The Palaeochannel and Alluvial Deposits***: a total of four evaluation trenches were positioned in order to examine the palaeochannel previously identified by aerial photography, three within the area of the substation footprint (ATT016, 022, and 031) and one just to the south-west of it (ATT018; Fig 2). In addition machine sondages were excavated in trenches ATT007, 015, 023, 027 and 029 in order to investigate the reported alluvial deposits and check for the possibility of any buried soil horizons that may hold archaeological potential.

3.2.6 Due to its position outside of the footprint of the substation, excavations in ATT018 were intended to simply locate the palaeochannel and consequently did not extend beyond removal of the topsoil to expose the upper fills of the feature. This confirmed that the palaeochannel measured approximately 5m in width and extended through the trench on a north-east to south-west axis at a depth of approximately 0.30m bgl, or more precisely, 4.17m aOD (Plate 1).

The upper fill consisted of a dark brown silty clay with an organic, near peaty, component, the edges of which proved irregular and consequently slightly ill-defined in plan.

Plate 1. The palaeochannel exposed in ATT018. Viewed facing east.

3.2.7 Examination of the palaeochannel in ATT016, 022 and 031 involved the excavation of a machine sondage through the channel deposits to a depth, after creating a stepped section, of approximately 1.50m bgl or *c* 3m aOD. A near-identical sequence of deposits were revealed in each trench, summarised below and depicted in the sample section (Fig 3 and Plate 2).

3.2.8 At the base of each sondage, a medium to light blue-grey silty clay was observed (***1603***, ***2203*** and ***3105b***). This was very soft and moist with occasional dark grey or black organic mottling running throughout, but no other inclusions. Only the top 0.40m-0.50m of the deposit was excavated, but it was clear that the deposit represented part of the marine alluvial clays identified in the geo-technical modelling of the site (Quest 2014, 8).

*Plate 2. Oblique shot of the north-facing section of palaeochannel **1601** in ATT016. Viewed facing south-west*

3.2.9 Above this alluvial deposit, a light yellow-grey clay deposit with occasional orange mottling (***1608***, ***2206/7*** and ***3102b***) extended to the base of the topsoil and constituted the natural layer recorded in the majority of other trenches. This deposit was up to 1m thick and entirely sterile.

3.2.10 The palaeochannel itself was seen to cut from the top of the upper natural clay layer (***1608*** *etc*), although the edge of the channel (cuts ***1602***, ***2204*** and ***3106b***) was often vague and not easily discerned. By and large, the channel was recognised as forming a rough V-shape, approximately 3-5.5m wide and 1m deep. It contained a primary fill (***1606***, ***2202*** and ***3104b***) comprising a sterile light grey clay, distinguished from the surrounding natural deposits only by its greater homogeneity, i.e. the absence of orange mottling. Above this deposit, and forming the most visible aspect of the feature when exposed in plan, was a dark to medium brown silty clay layer with a high organic, peat component, up to 0.40m thick (***1605***, ***2201*** and ***3103b***; Plate 2 and Fig 3). This deposit suggests that a marsh-like environment, with peat formation, developed following the silting of the channel, probably representing the development of the wider Heysham Moss.

3.2.11 No finds were produced by either of the palaeochannel fills. Two monolith samples were recovered from each of the sondages across the channel, one of which (that from ATT016) was selected for analysis (see *Section 3.4* below). A bulk sample was also recovered from the peaty upper fill in ATT031.

3.2.12 The main palaeochannel defined above, was further exposed during the subsequent programme of strip, map and record within Area A only. Here it was observed to extend on a south-west to north-east axis, as predicted by the ariel photographic record and previous trenching. It occupied a slight, yet

prominent depression in the natural clays and was represented by a dark band of peaty material that varied greatly in width along its entire course (Fig 3). In plan it formed the nexus for an extensive series of further palaeochannels that meandered in various directions across the area, all of which were previously unknown and unrecorded and are discussed, together with other probable remnants of former marshland environments and natural features according to Phase 1a below (*Section 3.2.17*).

3.2.13 In addition to the main palaeochannel previously identified by aerial photography and forming the main focus of the trenches outlined above, a further probable channel was also recognised in ATT016 during trial trenching. Here, a linear feature (cut ***1602***), extended roughly north/south, approximately 6m west of the main channel (Plate 3). In plan this feature measured approximately 2m wide and was distinguished by a similar upper peaty fill (***1607***) to that of the main channel. The sondage through the main channel was therefore extended to include this second feature and confirmed an identical stratigraphic sequence, with a diffuse edge (***1602***) cut into the upper natural clay layer (***1608***) and filled by a primary light grey clay (***1606***) followed by a peaty secondary fill (***1607***) (Fig 4).

Plate 3. General view of ATT016 showing the main palaeochannel extending north-east/south-west (foreground) and the second palaeochannel extending north/south (background). Viewed facing west.

3.2.14 Two further monolith samples were obtained from this additional channel but, due to the identical nature of the fill sequence to that of the main channel, were not processed.

3.2.15 The area of trench ATT016 was not encompassed by the strip, map and record programme. However, the additional channel identified within it, almost certainly relates to the series of channels observed further north within Area B (Fig 3). Here a main channel meandered in a northerly

direction across the area, with one or more subsidiary channels branching off to the west. After consultation with LCAS it was felt that examination of these palaeochannels was unwarranted.

3.2.16 In addition to the sondages examining the palaeochannel and additional features, a machine sondage was excavated in a number of trenches located within the footprint of the substation in order to examine the sequence of marine flood deposits. Each excavation extended to a maximum depth of *c* 4m bgl and, without exception, revealed an identical sequence of natural deposits to that encountered elsewhere. This comprised an upper band of light yellow/grey clay, varying between 1.20m and 1.70m thick, overlying a dark to medium grey sticky clay layer, representing the alluvial flood deposits, extending to the base of each sondage. The only variation of note was recorded in ATT023, where the substantial remains of a tree trunk were recorded within the very top of the alluvial deposits, at a depth of approximately 1.70m bgl or 2.69m aOD (Plate 4). This example of bog wood, a fallen tree preserved by the anaerobic conditions of a marshland environment, was sampled for environmental assessment (*Section 3.4* below).

Plate 4: The bog wood trunk encountered in the top of the marine alluvial deposits within ATT023 machine sondage. Viewed facing west.

3.2.17 ***Phase 1a. Additional palaeochannels and probable natural features***: in addition to the main palaeochannel and the subsidiary identified in trench ATT016 as well as ATT018, ATT022 and ATT031, an array of further palaeochannels were observed to extend across Areas A and B, during the strip, map and record programme. Some of these palaeochannels can clearly be related to linear features identified within a number of the previous evaluation trenches, some, for example in ATT015, were initially interpreted as probable post-medieval ditch features, while others were tentatively interpreted as potential evidence for prehistoric activity, for example

ATT005. These will be discussed relative to the initial observations according to trench location below. In addition a number of discrete features were also observed, and in some instances investigated, primarily during the evaluation phase. These features will also be discussed in relation to the individual trenches they were originally identified in. However, the failure to identify additional features, that collectively may have represented some form of deliberate and purposeful spatial patterning indicative of past human activity, indicates that many, if not all, of the discrete features, are almost certainly also natural in origin.

3.2.18 ***ATT004***: contained a single linear feature, approximately 5m long, curving slightly on a south-east/north-west axis approximately 2m from the eastern end of the trench. The cut (***0405***) measured approximately 0.50m wide and was very shallow, with a depth of no more than 0.10m (Plate 5; Fig 5). It contained a single medium brown clay fill (***0404***) that produced no finds. A box section was excavated across the feature but did not identify any further fill deposits. Given the shallow profile and slightly irregular shape of the feature in plan, together with its proximity to one of the meandering subsidiary palaeochannels identified during the strip, map and record programme, the feature is certainly natural in origin.

*Plate 5: Linear feature **0405** in ATT004. Viewed facing west.*

3.2.19 ***ATT005***: contained a single curvilinear feature located approximately 15m from the eastern end of the trench (Fig 6). The feature was initially interpreted as potentially representative of the northern half of a ring ditch or gully approximately 6.5m in diameter. In plan the gully was wider towards the east and tapered towards the west. It was examined within two box sections, where it was identified as cut ***0503*** to the east and ***0505*** to the west. In profile cut ***0503*** was up to 1.18m wide and 0.32m deep. The edges of the feature were, however, diffuse and very difficult to define, but potentially formed a V-shaped profile (Fig 6; Plate 6). It potentially contained a primary fill (***0508***) of very firm medium to light grey silty clay, which could not easily be distinguished from the surrounding natural, and an easily recognised predominant secondary fill (***0502***) of dark grey brown silty clay containing an organic peaty component. Some doubt may exist in relation to the veracity of the primary fill, in which case the cut would follow the base of the upper fill, and be highly irregular in nature. Cut ***0505*** measured approximately 0.70m wide and up to 0.35m deep, but otherwise followed a similar pattern to ***0503***. It had a V-shaped profile and a possible primary fill (***0507***), which was barely distinguishable from the natural and therefore equally diffuse and difficult to define, and a clear peaty upper fill (***0504***) (Plate 7). No finds were recovered from any of the fills.

*Plate 6: The south-east-facing box section across cut **0503**. Viewed facing north-west.*

3.2.20 The only other feature identified in trench ATT005 related to a small equivocal stake hole located towards the centre of the curvilinear feature, approximately 0.30m from its inner edge. The cut of the possible stake hole (***0510***) was sub-circular in shape, measuring approximately 0.14m in diameter, and had a U-shaped but very shallow profile, only 0.06m deep (Plate 8). It contained a single fill (***0509***) of firm dark grey/brown silty clay that produced no finds. The shallow nature of the feature as well as its

relative isolation, casts some doubt upon its validity, although the possibility that other stake holes, forming part of a wider coherent formation, existed beyond the trench or else had been destroyed by truncation of the site could not be ignored. As it transpired, no additional structural features were identified in the immediate vicinity of ***0510*** during the programme of strip, map and record, and, given its isolation and the dismissal of the ring ditch as a natural feature, it is highly likely that it also has a natural origin.

*Plate 7: The south-west-facing box section across cut **0505**. Viewed facing north-east.*

*Plate 8: The west-facing section of the possible stake hole **0510**. Viewed facing east.*

3.2.21 The potential of the features in ATT005, no matter how slight, to derive from comparatively rare prehistoric settlement activity, and indeed to represent the remains of early domestic buildings, was a primary concern in the implementation of the strip, map and record programme of works. The intention of this subsequent phase of work was to further reveal and thereby expand upon our understanding of the nature of such potential archaeological features. However, further exposure of the linear feature in the former vicinity of ATT005, demonstrated that the curvilinear gully related to a pronounced bend in one of the palaeochannels observed to meander across the north-eastern extent of Area A (Fig 3). The palaeochannel was examined during the course of the strip, map and record programme, by two sections excavated across its width, to the south-east of the former location of ATT005. Here the linear feature was identified as both cut ***5052*** and ***5054*** (Plate 9), and found to be relatively shallow, between 0.10m and 0.22m deep, with a variable profile, and to contain a single, relatively homogenous peaty fill (***5051*** and ***5053*** respectively). Together with the meandering nature of the linear in plan, the sections demonstrated beyond doubt that the feature is natural in origin.

Plate 9: The east facing section of palaeochannel cut ***5052***, exposed during the strip, map and record programme. Viewed facing west.

3.2.22 ***ATT006***: contained a single, slightly irregular linear feature that extended north-west/south-east across the trench (Fig 7; Plate 10). At its widest point the feature measured approximately 0.85m wide, but tapered towards the north where it measured 0.60m. In profile, the cut (***0605***) was relatively shallow at 0.12m deep, with a soft V-shaped profile. It contained a single dark brown sandy clay fill (***0604***) that produced no finds. A further linear

feature (cut ***0602***), located further towards the western end of the trench, was also examined but found to be natural in origin, possessing a less regular shape in plan as well as in profile but otherwise containing a very similar fill (***0603***) (not illustrated).

3.2.23 Upon excavation of Area A, a number of meandering linear features, representing subsidiary palaeochannels, were observed but not investigated, extending into the north-western corner of the area. Given the proximity of these features to trench ATT006, they almost certainly relate to one or both of the linears originally identified.

3.2.24 Two discrete features were recorded towards the eastern end of the trench. The smallest of the features (cut ***0612***) was found to contain a single fill (***0611***) identical to the other features in the trench, but was highly irregular in both plan and profile, and thought to be natural in origin. The larger of the two features, cut ***0607***, was sub-circular in plan and 0.50m in diameter (Fig 7; Plate 10). It had a shallow, concave, and fairly even profile measuring 0.10m deep, and contained a single dark brown sandy clay, with an organic component (***0606***), but produced no finds.

3.2.25 No further discrete features were observed in this area during the strip, map and record programme.

*Plate 10. View of ATT006. With linear **0605** in the background and feature **0606** in foreground. Viewed facing west.*

Plate 11. Oblique shot of the west-facing box section across the features in ATT010. Viewed facing south-east.

3.2.26 ***ATT010***: contained a single linear feature approximately 2.80m wide, extending on a slight north-east to south-west axis across the trench (Fig 8). After excavating a box section across the feature, it was thought to consist of up to three or more individual cuts and associated fills, collectively up to 0.56m deep (Plate 11).

3.2.27 The earliest feature in the possible sequence was identified as cut ***1001***, which in section measured approximately 1m wide and up to 0.30m deep, and had a U-shaped profile (Fig 8). However, the edge was diffuse in places and not easily identified. It was recorded as containing up to two fills ***1002***, a light grey/blue silty clay, making up the greater part of the feature, and ***1008***, a dark brown silty clay with apparent organic inclusions, restricted to the northern edge of the feature. However, deposit ***1008*** appears to extend almost vertically up the edge of the cut and consequently only makes sense if regarded as a primary fill truncated by a subsequent re-cut. This sequence of events would then see deposit ***1002*** as a fill of the re-cut. In either event, the feature is poorly defined and must be considered with some caution.

3.2.28 Discounting the possibility of a re-cut associated with the primary feature, the second feature in the possible sequence is represented by cut ***1005***. In section this cut measured approximately 2.80m wide and up to 0.36m deep representing the entire feature first viewed in plan (Fig 8). However, the cut is the least convincing in the sequence, with a wide irregular base rounding into sides varying between a shallow angle to the south, and near-vertical to the north. It contained two main fills (***1006*** and ***1007***), extending the full width of the feature, as well as a discrete layer or lens (***1009***). Fill ***1006*** comprised a dark greyish-brown silty clay up to 0.10m thick, ***1007*** a light yellowish-grey silty clay up to 0.20m thick, and lens ***1009*** a medium greyish-orange silty clay up to 0.56m wide and 0.10m thick.

3.2.29 Cut ***1003***, which was up to 0.4m wide and 0.30m deep with a U-shaped profile and concave base (Fig 8), represented a third possible feature. It was visible cutting into the top of deposit ***1006***, but may well have extended from the top of deposit ***1007***. It contained a single fill (***1004***) of medium grey sandy silt with organic inclusions that produced no finds. As a whole, this sequence of potential cuts and in-filling was difficult to interpret within the confines of the trench but was regarded as a potential ditch. The feature was sampled during the original evaluation trenching, but the bulk sample was found to be un-informative.

3.2.30 The feature was further exposed during the strip, map and record programme, and extended in plan roughly east-west through the centre of Area A (Fig 3). From the point where it had been examined in trench ATT010, it extended west for approximately 10m before encountering the edge of excavation. Immediately to the east of ATT010, the feature intersected the main palaeochannel, where no distinction between the upper fills of each feature was visible. It then continued for a further 50m or so before merging with a second palaeochannel migrating from the south. Between these two points of intersection, a further two slots were excavated across the feature and recorded as cut ***5075*** to the west and ***5066*** to the east (Fig 3). In section, cut ***5066*** appeared fairly convincing as a ditched feature, with a relatively well defined V-shaped profile up to 0.68m deep, containing a sequence of up to four fills (***5067-5070***; Plate 12). However, cut ***5075*** possessed a less well defined and slightly irregular profile, similar to the collective profile encountered in ATT010, up to 0.75m deep and containing a slightly different sequence of up to five fills (***5076-5080***: Plate 13).

*Plate 12. The west facing section of cut **5066**, featuring the merger with the palaeochannel approaching from the south (centre). Viewed facing east.*

*Plate 13. The east facing section of cut **5075**, featuring the point of intersection with the main north-east/south-west palaeochannel beyond. Viewed facing west.*

3.2.31 Further east, beyond the point at which it merged with the palaeochannel extending from the south, the linear continued for a further 20m after which it narrowed considerably and simultaneously curved towards the south, before intersecting the main south-west/north-east post medieval boundary feature (Fig 3: see *Section 3.2.106*). At this point a further slot was excavated across its width (Plate 14) and the feature was identified as cut ***5074***. Here the feature proved very shallow, up to 0.27m deep, and highly irregular in profile, with only a single peaty fill (***5073***), greatly resembling the palaeochannels examined elsewhere on site. It is possible that cut ***5074*** represents a continuation of the palaeochannel extending from the south, and that the east/ west linear feature terminated at some point to the east of where it was examined in the form of cut ***5066***. However, every effort was made to clean the feature in plan and a limited number of sondages were excavated to test potential axis or identify a terminal. At no point could a terminus to the feature be discerned and it appeared to merge seamlessly with the north/south palaeochannel. It is therefore determined that the east/west central linear also represents a further palaeochannel. As the feature was eventually interpreted as a further natural feature, no additional samples were retained.

3.2.32 Accepting that the two palaeochannels merge and collectively progress east, in plan they therefore curve to the south before intersecting the large post-medieval boundary feature (Fig 3). There is no clear continuation of this feature immediately to the east, but given the curvature, a further sinuous linear approximately 8m to the south, may represent a continuation of the channel. This feature was examined by a single slot excavated against the eastern limit of excavation for Area A, where it was recorded as cut ***5026*** (Plate 15). Here, the feature resembled other palaeochannels examined in

Area A, being relatively shallow, up to 0.16m deep, with an irregular profile and containing two deposits, a peaty secondary deposit (***5028***) and an orange sedimentary primary deposit of clay (***5027***).

*Plate 14. The west facing section of cut **5074**, featuring the arch and subsequent intersection with the post-medieval boundary ditch beyond. Viewed facing east.*

*Plate 15. The east facing section of cut **5026**, featuring its intersection with the post-medieval boundary ditch beyond. Viewed facing east.*

3.2.33 ***ATT011***: contained two features, initially interpreted as potential ditch terminals, located at either end of the trench and extending on the same north/south axis (Fig 9).

3.2.34 In plan, the western feature was located approximately 2m from the end of the trench. It extended from the southern trench edge and terminated in an irregular bulbous shape that came to a point just before reaching the opposite edge of the trench. At its widest point the feature measured approximately 1.50m, although in section it was interpreted as comprising three or more separate cut features (Fig 9; Plate 16).

Plate 16. The south-facing box section through the western possible ditch terminus in ATT011. Viewed facing north.

3.2.35 The primary feature was represented by cut ***1102***, which measured 0.40m wide and up to 0.30m deep, and appeared vaguely V-shaped with a rounded base. It contained a single firm greyish-brown silty clay fill (***1103***) that produced no finds.

3.2.36 This primary feature had apparently been truncated to the east by a more substantial V-shaped cut (***1104***) that measured up to 1.30m wide and 0.32m deep. It was thought to contain a sequence of up to three fills, a primary deposit (***1105***) of firm light grey/brown silty clay up to 0.12m thick, a secondary deposit (***1106***) of dark reddish-brown silty clay up to 0.20m thick with a peat component, and a tertiary fill (***1107***) of firm grey/brown silty clay up to 0.16m thick. No finds were recovered from any of the fills. In plan, the feature was associated with a bulbous projection of the potential ditch terminus, however, there was little evidence of the feature in the opposing section.

3.2.37 A third feature, interpreted as a possible posthole, was apparently cut into deposit ***1107*** and truncated the western edge of feature ***1104,*** as well as

underlying feature ***1102***. The cut (***1108***) measured approximately 0.25m in diameter and up to 0.22m deep with a V-shaped profile. It contained a single firm light grey clay fill (***1109***) that produced no finds.

3.2.38 Examination of an opposing section (Fig 9; Plate 17), within a box section cut against the trench edge, provided a slightly different sequence of deposition. There the remains of the primary cut (***1102***) and fill (***1103***) probably correspond with cut ***1110*** and fill ***1111***. However, this was truncated by a single cut feature, recorded as context ***1112***, which differed in form from cut ***1104***, being 1.05m wide and 0.45m deep, with a steep-sided U-shaped profile and containing a sequence of up to five fills. The primary fill (***1113***) comprised a firm greyish-brown silty clay less than 0.10m thick. This was overlain by deposit ***1114***, a dark reddish-brown silty clay up to 0.10m thick, with a peat component, followed by deposit ***1115***, a firm greyish-brown silty clay up to 0.18m thick. A final deposit (***1116***) of firm yellowish brown sandy clay up to 0.15m thick, capped the feature, although a further deposit (***1118***) of medium greyish-brown silty clay was also noted. This final deposit was interpreted as a backfill of topsoil indicating that cut ***1112*** extended through the topsoil deposit ***1117***, and was therefore probably modern. However, this upper deposit may reflect disturbance of context ***1116*** by the plough, and subsequent mixing with the topsoil horizon, prior to land use as pasture.

3.2.39 The other possible linear feature was located approximately 2.50m from the eastern end of the trench and, by comparison, was relatively simple. The cut (***1119***) extended from the southern edge of excavation for approximately 1.70m, gradually tapering towards the opposing trench edge and, therefore, forming a wedge shape up to 1.17m wide (Fig 9). In section it measured up to 0.28m deep and had a V-shaped profile with a wide, flat base stepped slightly towards the bottom along the eastern edge (Plate 18). It contained a sequence of up to three fills, including a primary deposit of firm yellowish-grey clay (***1120***) extending along the base of the eastern edge that was 0.32m wide and 0.10m thick. Above this was a secondary deposit of dark brown silty clay up to 0.20m thick with a peat component (***1121***) extending across the entire feature. A tertiary deposit of greyish-brown silty clay (***1122***) up to 0.22m thick capped it. No finds were recovered from any of the deposits.

*Plate 17. The north-facing section through the western feature **1102** in ATT011. Viewed facing south.*

*Plate 18. The north-facing section through the eastern ditch **1119** in ATT011. Viewed facing south.*

3.2.40 During the course of the strip, map and record programme, no corresponding linear features were observed within the former vicinity of trench ATT011. Instead, the recorded features were found to relate to one of several localised and irregular-shaped discrete features of natural origin.

3.2.41 ***ATT013***: contained a single sub-oval pit-like feature located approximately 1m from the western end of the trench and orientated on a north-west to south-east axis (Fig 10). The cut, ***1305***, measured 1.45m long, 1.10m wide

and up to 0.25m deep. In section it had an irregular profile and was filled by a single deposit (***1304***) of dark grey/brown silty clay with a peat component that produced no finds (Plate 19). The feature was interpreted as a possible pit of unknown function yet its irregular nature suggests it has a more natural origin, perhaps as a tree bowl.

3.2.42 Subsequent observation in Area B during the course of the strip, map and record programme, in the vicinity of former trench ATT013, revealed no additional discrete features. Given the relative isolation and irregular nature of cut ***1305***, it may be concluded that the feature was indeed natural in origin.

*Plate 19. The north-east-facing section of possible pit **1305** in ATT013. Viewed facing south-west.*

3.2.43 An additional gully was also recorded in the trench, but is of probable post-medieval or modern date and consequently discussed below in *Section 3.2.60*.

3.2.44 ***ATT015***: contained a single linear feature originally interpreted as a ditch. It entered the trench towards the centre of the northern limit of excavation and turned west, progressing for 6m before exiting the trench at that end (Fig 11). It was examined by one slot, excavated across its centre, where the cut was recorded as context ***1506***. The cut was 1.60m wide, and up to 0.36m deep, with a slightly irregular V-shaped profile and a rounded base (Fig 11; Plate 20). It contained a distinct primary fill of friable dark grey/brown clayey silt, up to 0.20m thick, containing fragments of wood and a peat component (***1505***). A secondary deposit of friable light brownish-grey clayey silt (***1504***), up to 0.18m thick, completed the fill sequence. A single fragment of burnt clay or ceramic building material (CBM) was recovered from near the top of this deposit. Its position near the top of the fill opens the possibility that this single find may be intrusive, even if it could be relied upon to provide adequate dating information.

3.2.45 Towards the western end of the trench the ditch widened in plan to a maximum of 2.40m. A further slot excavated at this point revealed that the probable ditch diverged into two separate channels, cut ***1508*** continuing west, and cut ***1507*** seemingly curving towards the north-west (Fig 11; Plate 21). Cut ***1507*** measured 0.94m wide, 0.32m deep and had an irregular profile containing a single fill of friable dark brown clayey silt (***1509***) that produced no finds. Cut ***1508*** measured 0.70m wide, 0.23m deep and contained a single fill of friable dark brown clayey silt (***1510***) that produced two sherds of post-medieval pottery. In addition to this small assemblage three more post-medieval pottery sherds were recovered from the topsoil (***1501***).

*Plate 20. The north-east-facing section of cut **1506** in ATT015. Viewed facing south-west.*

*Plate 21. The west-facing section across cuts **1508** and **1507**. Viewed facing east.*

3.2.46 Further exposure of the feature within Area A of the strip, map and record programme, indicated that it was in fact part of a substantial palaeochannel rather than a post-medieval ditch, as previously thought (Fig 3). From the vicinity of earlier trench ATT015, the feature continued west, but did not diverge as previously thought, cuts ***1507*** and ***1508*** therefore probably representing two channels within the same general feature. Further west it presumably joined with the main south-west/north-east palaeochannel (*Section 3.2.5*), just beyond the limit of excavation for Area A. To the east it meandered approximately north-east before merging with the central east-west aligned palaeochannel (see *Section 3.2.30-3.2.32*).

3.2.47 Between trench ATT015 and the point of merger with the east/west aligned central palaeochannel (*Section 3.2.30*), the linear was examined by two further slots excavated across its width during the strip, map and record programme, where it was identified as cut ***5042*** and ***5050*** (Fig 3). Between the two sections, the profile of the feature proved variable and irregular in form, and varied between 0.30m and 0.40m deep, but consistently contained two peat rich fills (***5040***-***5041*** and ***5048***-***5049*** respectively: Plates 22 and 23). Both of the upper fills (***5040*** and ***5048*** respectively), produced a small assemblage of post-medieval pottery, and a small number of ferrous metal finds also came from deposit ***5040***. The additional slots excavated through the feature confirmed the apparent natural origin of the linear as a palaeochannel, the late post-medieval finds likely becoming incorporated into upper sections of the fill sequence as the result of plough action or bioturbation.

Plate 22. The south-west facing section of cut ***5042***. Viewed facing north-east.

Plate 23. The south facing section of cut ***5050***. Viewed facing north.

3.2.48 ***ATT017***: contained a single poorly defined linear feature, extending east/west across the trench and located approximately 3m from the southern

end (Fig 12). The cut (***1704***) measured 1.28m wide, 0.36m deep and had a soft V-shaped profile with a rounded base. It contained a poorly defined possible primary fill of firm medium grey/brown silty clay, up to 0.23m thick (***1703***), which could not easily be distinguished from the surrounding natural, and a more easily distinguished secondary deposit of dark grey/brown silty clay with a slight peat component, up to 0.15m thick (***1702***) (Plate 24). No finds were recovered from either fill, and some doubt may exist in relation to the exact dimensions and composition of the feature in relation to the primary deposit.

3.2.49 The location of trench ATT017 was not included in either of the areas forming the focus of the strip, map and record programme. Consequently no further comment can be offered on the nature and likely origin of the feature, although based upon evidence elsewhere, it may be strongly assumed that it was natural in origin.

*Plate 24. The west-facing section of cut **1704** in ATT017. Viewed facing east.*

3.2.50 ***ATT020***: contained a single discrete feature, originally interpreted as a possible small pit or post hole, located towards the north-eastern end of the trench. In addition, a series of three linear features, one of which may be later in date than the others, were located towards the south-western end of the trench. A number of natural features and a single field drain, extending the full length of the trench, were also observed (Fig 13).

3.2.51 The possible pit or posthole was located approximately 6m from the north-eastern end of the trench. The cut (***2001***) was found to be sub-circular in shape with a diameter of 0.44m. In section it was concave, very shallow at 0.05m deep, and contained a single fill of dark grey/brown silty clay with a high peat component (***2002***) (Plate 25). It produced no finds.

3.2.52 Examination of the stripped surface of Area A, in the vicinity of trench ATT020, during the strip, map and record programme revealed a small number of discrete features (***5019*** and ***5029***) in the vicinity of the former trench and the possible post hole ***2001***. Both features were sub-oval in plan, with well defined, but slightly irregular edges, and contained a number of peaty fills (***5020***, ***5021*** and ***5022*** as well as ***5030*** and ***5031*** respectively), similar in nature to deposit ***2002***. These features were interpreted as probable tree throws and no discernible pattern, identifying a structure of any kind, was described by their relative spatial disposition. It is therefore highly likely, given its spatial isolation, that while slightly more uniform in nature, feature ***2001*** also represents a natural feature.

3.2.53 An ill-defined and irregular spread of material similar to the fill of feature ***2001***, occurred approximately 6m south of the possible pit, but upon examination proved natural in origin.

3.2.54 A well-defined ditch (***2005***) and a second, more equivocal linear (***2007***), were located approximately 8m from the south-western end of the trench. These features probably relate to Phase 2 activity and are therefore discussed in relation to *Section 3.2.67* below.

*Plate 25. The north-east-facing section of feature **2001**. Viewed facing south-west.*

3.2.55 Another, less well-defined, linear feature was evident in plan extending on a north/south axis, and potentially intersecting linear ***2007*** just beyond where it exited the southern edge of the trench. The cut (***2010***) appeared intermittent in plan and could not easily be discerned within a box section excavated across its potential line. In that section it potentially measured up to 0.95m wide, 0.29m deep and may have had a V-shaped profile (Fig 13; Plate 26). It potentially contained a poorly defined primary fill of dark grey/brown silty clay up to 0.21m thick (***2008***), which could not easily be distinguished from

the natural, and a more easily distinguished medium grey/brown silty clay secondary deposit (***2009***), up to 0.10m thick, with a slight peat component. No finds were recovered from either deposit.

3.2.56 Little trace of this equivocal linear was observed during the strip, map and record programme and it is likely, therefore, to represent vestiges of a natural channel or series of peat filled pockets relating to the marshland environment.

3.2.57 **ATT021**: contained a single linear feature located near the centre of the trench, extending on a north-west to south-east axis (Fig 14; Plate 27). The cut (***2105***) measured 0.85m wide, 0.20m deep and, in section, had a slightly uneven and shallow V-shaped profile (Fig 14). It contained a single medium brown silty clay fill deposit with a peat component (***2104***) that produced no finds.

*Plate 26: The south-facing section of cut **2010**. Viewed facing north.*

3.2.58 A further feature extended east from the western end of the trench for approximately 2.50m before ending with a rounded terminus. The cut (***2103***) varied in width from 0.60m to 1.10m and was found to be very shallow at 0.10m deep, with a concave profile. It contained a single fill (***2102***) identical to that of linear ***2105,*** which also produced no finds. The slightly irregular shape of the feature in plan may argue for a more natural origin compared to cut ***2105***.

3.2.59 A field drain extended through the length of the trench and an additional poorly defined layer of material, similar to the fill of the two features, was also identified. However, upon investigation the edge of this deposit proved highly irregular and is almost certainly natural in origin.

3.2.60 The position of former trench ATT021 relative to Area B of the strip, map and record programme, together with its combination of field drain, bisecting several irregular linear features, situates the features originally identified relative to several subsidiary palaeochannels exposed during the second phase of works. In specific terms the features relate directly to the series of curving channels adjoining the large subsidiary palaeochannel implicated as a continuation of that identified in ATT016 (see *Section 3.2.15*).

*Plate 27. General view of ATT021 showing natural features **2105**, extending north-west/south-east across the centre of the trench, and **2103** (foreground). A field drain extends east/west throughout the trench. Viewed facing east.*

3.2.61 ***ATT027***: contained a single discrete feature, interpreted as a possible pit, located approximately 5m from the eastern end of the trench (Fig 15). The cut (***2704***) was sub-rectangular in shape, orientated east/west, measuring 0.92m long, 0.59m wide and up to 0.14m deep. It contained a primary fill of medium grey/brown silty clay with orange mottling, up to 0.08m thick (***2703***), and a secondary fill of dark grey/brown silty clay (***2102***) up to 0.11m thick with a peat component (Plate 28). The fill produced no finds.

3.2.62 The trench was not encompassed within either of the areas exposed during the strip, map and record programme. No further comment can be made as to the validity of the feature, although the weight of interpretation, relating to similar discrete features elsewhere within the PDA, suggests a natural origin.

3.2.63 ***ATT029***: contained a single linear feature, located towards the western end of the trench, which meandered considerably over the course of approximately 11m on a north-east to south-west axis (Fig 16 and Plate 29). It was examined in two slots (cut ***2903*** and ***2905***) where it was found to be relatively shallow, extending to no more than 0.30m deep, and to have a fairly even concave profile. It contained a main deposit of friable medium reddish-brown silty clay with a peat component (contexts ***2904*** and ***2908***) and, in cut ***2905*** only, to have a primary fill of medium yellowish-grey silty clay (contexts ***2906*** and ***2907***). No finds were recovered from any of the fills.

*Plate 28. The north-facing section of cut **2704**. Viewed facing south*

3.2.64 While the feature was not further exposed during the strip, map and record programme, and presented a fairly regular and even profile, the considerable meander evident in plan would argue against an archaeological origin. This characteristic is, however, highly redolent of the various palaeochannels identified elsewhere within the PDA.

Plate 29. General shot of ATT029 showing the sinuous linear feature (background) and back-filled sondage (foreground). Viewed facing west.

3.2.65 ***ATT032***: contained a series of three linear features and two discrete features, although upon examination the majority were discounted as probably natural in origin (Fig 17).

3.2.66 A sub-rectangular feature was located approximately 3.75m from the eastern end of the trench. The cut (***3211***) measured 2.10m long, 0.70m wide and was orientated east/west with both ends tapering towards a point. In section it measured up to 0.18m deep and had a slightly irregular steep sided U-shaped profile and contained a single fill of medium brown silty clay (***3210***) that produced no finds (Plate 30).

3.2.67 Approximately 1m west of feature ***3211***, a narrow linear feature extended for 2m from the northern limit of excavation, on a north-east/south-west axis, before ending in a rounded terminus. The cut (***3209***) measured 0.35m wide and only 0.06m deep with a concave profile, and contained a single fill of medium greyish-brown sandy clay (***3208***) that contained large pieces of wood (Plate 31).

3.2.68 Approximately 13m west of feature ***3209*** a similar linear feature extended on the same north-east/south-west axis for 1.50m before ending in a rounded terminus. When examined, the base of this feature was highly irregular and, consequently, it was interpreted as natural. Within the confines of the trench the presence of this similar, but ostensibly natural, feature casts doubt upon the archaeological origin of linear ***3209***.

3.2.69 Approximately 8m from the western end of the trench, a second discrete feature was identified and, in plan, appeared a good candidate for a pit (***3203***). The upper fill of this feature was distinguished from the natural by the presence of a dark peaty deposit (***3202***), identical to that encountered

elsewhere on the site. However, upon examination, this deposit proved very shallow and to possess a very irregular base and was, therefore, interpreted as natural.

3.2.70 A small section towards the eastern end of trench ATT032 was encompassed by Area A of the strip, map and record programme, although the majority lay west beyond its limits. However, the former trench was located in the vicinity of several palaeochannels observed in Area A (Fig 3) and the linear features identified within the trench probably relate to one or more of the natural channels. The discrete features, by virtue of the weight of evidence across the PDA, are also probably natural in origin, either representing tree throws, or else troughs within the former marshland environment.

*Plate 30. The west-facing section of possible pit **3211**. Viewed facing east.*

*Plate 31. The south-west-facing section of linear **3209** with the wood in fill **3208** evident in the foreground. Viewed facing north-east.*

3.2.71 ***ATT036***: contained a single linear feature extending across the centre of the trench on an east/west axis (Fig 18; Plate 32). The cut (***3601***) measured 0.80m wide but was very shallow at 0.05m deep and contained a single fill of medium grey/brown silty sand (***3602***) with small angular stone inclusions that reflect the change in geology, which occurs in the vicinity of the trench, towards the south-east corner of the PDA. No finds were recovered from the fill, and on the whole it was felt that its anthropogenic origin is questionable.

*Plate 32. General shot of ATT036 with the linear feature **3601** (background) and the natural feature (foreground). Viewed facing north-west.*

3.2.72 An additional discrete feature was identified towards the south-eastern end of the trench, but, upon examination, proved natural in origin and probably a tree throw.

3.2.73 The trench lay outside of the excavation areas established during the strip, map and record programme, but, given that similar features were identified during the more detailed exercise, it seems likely that those found within ATT036 were of natural origin.

3.2.74 ***ATT038***: contained numerous field drains as well as a single discrete feature located 4m from the north-eastern end of the trench, interpreted as a probable posthole (Fig 19). The cut of this feature (***3803***) measured approximately 0.20m in diameter, 0.12m deep and had a U-shaped profile with a rounded base (Plate 33). It contained a single fill of dark brown sandy clay (***3804***) that produced no finds. No further discrete features were identified in the vicinity of the trench during the subsequent strip, map and record phase of work. The isolated nature of this feature, therefore, makes it difficult to interpret in terms of archaeological validity or subsequent function, and it is most likely to be of natural origin.

3.2.75 A large linear feature was also observed extending east/west near the centre of the trench, but, upon examination, proved to be natural in origin.

*Plate 33. The north-east-facing section of possible posthole **3803**. Viewed facing south-west.*

3.2.76 ***ATT044***: contained a single possible pit located approximately 1.75m from the southern end of the trench (Fig 20). The cut (***4402***) was sub-circular in shape, measuring 0.88m long, 0.80m wide and 0.26m deep. In section it had a concave base rounding imperceptibly into the sides and contained a single fill of dark brown silty clay with a strong peat component (***4401***; Plate 34). No finds were recovered from the feature.

3.2.77 Several other discrete features were examined within the trench but were found to be highly irregular in profile and deemed to be natural in origin. A series of field drains were also highly prominent. The southern end of the trench was incorporated within Area A of the strip, map and record phase of work, but no additional features, of an archaeological nature, were identified within its vicinity.

*Plate 34. The west-facing section of cut **4402** in ATT044. Viewed facing east.*

3.2.78 ***Additional features exposed during the strip, map and record programme***: the additional works exposed further elements of the features recorded during the initial evaluation programme, as well as a series of additional, and hitherto unidentified, ditched features and natural palaeochannels within both Areas A and B (Fig 3).

3.2.79 Two such palaeochannels were clearly visible within the north-eastern corner of Area A (Fig 3), although only the largest of the two was examined by excavation during the strip, map and record programme. Two initial slots were excavated across the part of the channel exposed to the east of the main post-medieval boundary feature. Here the 10m section of channel appeared very straight and regular in plan and to have a relatively clear terminus (cut ***5023***), located just short of the eastern edge of excavation. In plan the terminus tapered towards a point while the profile was clear and V-shaped, up to 0.30m deep, and contained two distinct peat rich fill deposits (***5024*** and ***5025***; Plate 35). A second slot examined the feature further to the west, before it reached the post-medieval boundary ditch, and revealed a regular V-shaped profile (***5006***; Plate 35), up to 0.22m deep, containing a single peat rich fill (***5007***).

3.2.80 On the basis of the first two slots, the feature appeared to be confirmed as a ditch, however, further exposure of the linear, to the west, beyond the post-medieval boundary ditch, revealed that it meandered considerably heading

due north, varying greatly in width along its length. A further two slots were excavated across the feature in this section (cut ***5061*** and ***5063***) and revealed a well-defined but variable profile up to 0.60m deep (Plate 36), containing two or more fills (***5059***-***5060*** and ***5061***-***5062*** respectively), including re-deposited natural clay (***5062***). No finds were recovered from any of the fills. The variability of the feature within this western section confirmed that it did indeed represent a further palaeochannel.

Plate 35. The east-facing section of ***5023*** (foreground) and ***5006*** (background). Viewed facing west.

Plate 36. The south-facing section of cut ***5061***. Viewed facing north.

3.2.81 An additional palaeochannel was also examined towards the south-eastern corner of Area A, immediately west of the main post-medieval boundary (Fig 3). In plan the channel formed an irregular circle with a central island of natural. It was examined quickly in one slot where the cut (***5036***) was found to be very shallow, less than 0.05m deep, with a slightly irregular V-shaped profile (Plate 37). It contained a single peat rich fill (***5035***) that produced no finds. The circular nature of the feature stands in contrast to the linear, all be it meandering nature of the other palaeochannels, and it may be that it represents a lesser, and perhaps more stagnant channel within a marshland environment rather than a free-flowing channel. Given the proximity of the features, this channel may be a continuation of that examined as ***5016*** and, in ATT020, as ***2007***, where it was provisionally, and perhaps erroneously, identified as a possible ditch.

Plate 37. The south-facing section of cut ***5035***. Viewed facing north.

3.2.82 Additional linear palaeochannels were also recorded in the north-western half of Area A (Fig 3). While none were examined by excavation, their variable and meandering nature in plan, identical to those already excavated, offered confirmation of their natural origin. All appeared to feed into the main north-east/south-west aligned palaeochannel and, like the other features of Phase 1a, are most likely contemporary with it.

3.2.83 ***Phase 2: Post-medieval or Modern Features***: a series of quite well-defined features were encountered across the site, mainly comprising ditches or gullies, but also including several discrete pit features. These probably relate to late post-medieval or early modern activity, as identified by the nature of the backfill, their alignment relative to modern drainage features or the recovery of dateable finds from their fill contexts. They are discussed below first in relation to the numerical trench sequence and then those subsequently identified during the strip, map and record programme.

3.2.84 ***ATT013***: in addition to the undated feature (***1305***) the trench also contained a single well-defined gully or shallow ditch extending across the centre of the trench on an east/west axis (Fig 10). The cut (***1303***) measured 0.60m wide, 0.25m deep and had a clear V-shaped profile with a flat base (Plate 38). It contained a single medium orange/brown silty clay fill (***1302***) that produced no finds. Whilst the feature cannot actually be dated, it shares an identical orientation with several post-medieval or early modern ceramic field drains located further to the east. The feature has, therefore, been classified within this phase of activity.

*Plate 38. The east-facing section of ditch **1303**. Viewed facing west.*

3.2.85 During the strip, map and record programme, a linear feature was identified extending on an east/west axis towards the southern end of Area B (Fig 3). While this was not examined, due to the early curtailment of the project, this feature almost certainly relates to gully ***1303***, and shares an identical alignment with field boundaries identified on the 1848 First Edition OS map relating to the area of the PDA (Fig 21), but is not otherwise depicted on the map. On this basis, while the feature cannot be related to an actual boundary, it is almost certainly late post-medieval in origin and probably relates an episode in which efforts were made to claim, partition and expand cultivation into previous wetland.

3.2.86 ***ATT019***: contained an array of features throughout the trench, the majority of which were almost certainly modern in date (Fig 22). Moving from east to west, the first features to be encountered were two probable pits of unknown date and function. The first, cut ***1919***, was recorded approximately 3m from the eastern end of the trench and was sub-circular in shape with a diameter of approximately 0.70m. In profile the feature was 0.20m deep, with steep

edges and a concave base (Plate 39). It had a single fill of dark brown silty clay (***1920***) that produced no finds and consequently cannot be dated. The second pit was partially exposed extending from the southern limit of excavation approximately 2.50m west of the first. As far as the feature could be exposed, the cut (***1921***) was ovoid in shape and measured approximately 1.35m long and 0.60m wide orientated east/west. In section it was 0.25m deep and had a slightly uneven concave profile (Plate 40). It contained a single homogenous fill of dark reddish-brown silty clay (***1922***) that produced no finds.

3.2.87 Approximately 8.50m west of the two discrete features described above, a large spread of material (***1923***) extended further west for approximately 5m. This deposit comprised a mixture of topsoil, natural clays and a dark brown silty clay up to 0.30m thick, with an irregular undulating base, and was interpreted as a dump deposit or made ground, probably relating to relatively recent activity.

*Plate 39. The south-facing section of possible pit **1919**. Viewed facing north.*

*Plate 40. The north-facing section of possible pit **1921**. Viewed facing south.*

3.2.88 Approximately 18m further west than spread ***1923***, after a series of field drains set at different angles and numerous irregular-shaped pockets of natural dark brown soil, a linear feature extended from the northern limit of excavation. This curved westward for approximately 4.60m before re-entering the northern edge of the trench. The cut of the feature was identified in three sections as context ***1903***, ***1908***, and ***1910***, where it was found to be up to 0.80m wide and 0.14m deep, with a slightly irregular concave profile (Fig 22). It contained a single homogenous fill (***1904***, ***1909*** and ***1911***) comprising a medium greyish-brown silty clay that produced no finds and cannot, therefore, be dated. A small number of post-medieval pottery sherds was recovered from fill ***1904*** of the linear feature.

3.2.89 At its most easterly point, just before it exited the trench, an ovoid pit ***1918*** had truncated linear feature ***1910***. This pit measured approximately 0.95m long, 0.85m wide, and up to 0.30m deep, with a U-shaped profile. It was found to contain a mixture of dark grey/brown silty clay and a very compact layer of reddish-grey fired clay (Plate 41) that sealed an assemblage of plastic and metal debris and wire that was obviously modern in origin.

*Plate 41. The east-facing section of the burnt clay capping deposit in pit **1918**, truncating linear **1910**, prior to removal and exposure of the modern materials. Viewed facing west.*

3.2.90 Towards the western end of the linear, where it curved north once again, the feature had been cut by a possible sequence of two further pits, cut ***1915*** to the east and ***1912*** to the west. Both pits appeared sub-ovoid in shape, with a slightly irregular profile and a sequence of at least two fills each (***1913*** and ***1914*** relating to cut ***1905***, and ***1916*** and ***1917*** relating to cut ***1912***; Fig 22). These fills comprised a primary deposit of dark reddish-brown silty clay with a peat component (***1913*** and ***1916***), with a small amount of wood recovered from ***1913***, and an upper fill of dark grey/brown silty clay that produced no finds. The fills of the proposed pits could not easily be distinguished. Any stratigraphic sequence of cuts could not therefore be established. Similarly, no dating evidence for the features was obtained.

3.2.91 Where linear feature ***1910*** continued into the northern edge of excavation, it was also found to have been cut into by a further discrete feature interpreted as a possible posthole (cut ***1905***). It measured approximately 0.30m in diameter and 0.28m deep (Plate 42). In section it had a steep V-shaped profile and contained a single fill deposit of dark grey silty clay (***1906***). A number of angular stones within the base were interpreted as possible packing stones. A further layer of dark brown silty clay (Fig 22) sealed this deposit. No finds were recovered from the fill, and the feature cannot be dated.

*Plate 42. The south-facing section of ditch **1910** and possible post hole **1905**. Viewed facing north.*

3.2.92 A large linear feature extended north/south across the trench 2.50m west of the curvilinear feature ***1910***, but on examination was found to contain a large ceramic land drain relating to the system of modern king drains.

3.2.93 ***ATT020***: a clearly defined ditch extended on an east/west axis approximately 6.5m from the south-western end of the trench. The cut (***2004***) measured approximately 1.15m wide, 0.42m deep and, in section, had a clear V-shaped profile with a flat base and a limited step towards the top of the southern edge (Fig 13; Plate 43). It contained a single mixed dark grey/brown and medium orange/brown firm silty clay (***2003***) that gave the appearance of having been rapidly back-filled into the feature. The fill produced no finds, but the clarity of its edge and nature of the fill may suggest it have a more recent and potentially post-medieval or modern origin.

3.2.94 The same ditch was examined during the course of the strip, map and record programme, as cut ***5008***, and revealed a similar V-shaped, flat bottomed profile, up to 1.35m wide and 0.56m deep (Fig 23; Plate 44). It contained a primary fill of re-deposited clay (***5009***) and a secondary silting deposit (***5010***), producing no finds. The ditch could be traced extending east from the large post-medieval boundary (*Section 3.2.106*) for approximately 15m, before continuing beyond the limit of excavation. No dating evidence was recovered from the feature, but it has been assigned to Phase 2 activity, given the weight of dating evidence relating to the other features across the site.

*Plate 43. The west-facing section of cut **2003.** Viewed facing east.*

*Plate 44. The east-facing section of cut **5008**. Viewed facing west.*

3.2.95 Approximately 2m to the north-east of ditch ***2003,*** a second probable ditch also extended on an east/west axis across the trench (Fig 13). The cut (***2007***) measured 1.74m wide, up to 0.42m deep and in section had an uneven V-shaped profile with a short and steep northern edge and a wider, more shallow southern edge (Plate 45). It had a poorly defined possible primary fill of medium orange/brown silty clay up to 0.29m thick (***2006***), which could not easily be distinguished from the natural, and a clear secondary fill of dark

grey/brown silty clay, up to 0.18m thick, with a peat component (***2005***). No finds were recovered from either fill.

*Plate 45. The west-facing section of cut **2007**. Viewed facing east.*

3.2.96 This feature was also examined during the strip, map and record programme as cut ***5016*** (Fig 24: Plate 46), where it was found in profile to be V-shaped with a flat bottom, up to 1.09m wide and 0.34m deep, similar to cut ***2003***/***5008***. In addition it contained a primary (***5017***) and secondary fill (***5018***), both identified as naturally occurring silting of the feature. In plan the feature extended east, for approximately 10m, on a near parallel axis to cut ***2003***/***5008,*** after which no trace of the feature was observed. However, no clear terminus was also located and it was unclear if the feature progressed further east, and was potentially masked, or not. No finds were recovered from the ditch, but given the shared axis with cut ***2003***/***5008,*** it is possibly of a similar date. No clear function for the parallel ditches could be discerned, although they may be associated with a third linear feature (***5011***; *Section 3.2.114*), as well as the main boundary to the west. Alternatively, the feature may be associated with a natural channel recorded to the south-west as ***5036*** (*Section 3.2.81*).

*Plate 46. The east facing section of cut **5016**. Viewed facing west.*

3.2.97 ***ATT024***: an additional feature was initially recorded in ATT024 as a probable ditch, which measured approximately 2.10m wide and extended east/west. However, after excavation, interpretation favoured another probable, though slightly smaller, palaeochannel. This interpretation has since been amended again after examination of the First and Second Edition Ordnance Survey (OS) Map of the area (Fig 21 and 25), which indicates a clear field boundary located in the same position and on the same alignment as the linear identified in ATT024. In profile the feature appeared to be cut from just below the topsoil layer (***2401***), extending through a subsoil or upper natural clay layer (***2402***) and terminating within the upper section of the alluvial clay deposits (***2403***). The cut (***2406***) appeared V-shaped in profile, with a wide, slightly irregular and convex base, extending to a slightly greater depth along the southern edge (Fig 26 and Plate 47). In a reversal of the depositional sequence characterising most features across the site, the primary basal fill of the feature (**2405**) consisted of a dark brown firm clay deposit up to 0.40m thick, containing numerous sequential thin layers of peat. A variable light grey or orange/brown clay secondary deposit, up to 0.36m thick, overlay this deposit. Neither fill produced any archaeological finds. Two monolith samples were taken from the feature, under the advice of the attending palaeoenvironmentalist, and the results are summarised in *Section 3.4* below.

*Plate 47. The east-facing section of palaeochannel/ditch **2406** in ATT024. Viewed facing west.*

3.2.98 Radiocarbon assay of the peat recorded at the base of the feature (***2405***), returned two near identical dates attributable to the Bronze Age (SUERC-57522 (GU36145): 3488 ± 28 BP: 1891-1741 cal BC: and SUERC-57523 (GU36146): 3529 ± 29 BP: 1941-1763 cal BC at 95% confidence). This date is obviously at odds with the post-medieval phasing of the feature. However, it is unlikely that the boundary ditch exactly overlays a much earlier ditched feature, or, given the length of chronological separation and dearth of additional evidence, that such a feature was in some way visibly preserved and therefore continued as the focus for later land divisions. It is arguably most likely, given the radiocarbon date was derived from humic acid associated with peat material, that it relates to the formation of the peat, rather than the ditch cut, and that the material has, at some point, been re-deposited into a later feature. The two identical dates therefore more readily provide some indication of a period of marshland development across the site rather than activity associated with its subsequent drainage and division during the post-medieval period.

3.2.99 The ditch was further exposed, but not excavated, during the course of the strip, map and record programme, and clearly extended on an east/west axis across the northern end of Area B (Fig 3). Here it can quite clearly be matched with the line of the field boundary depicted on the First Edition OS map (Fig 21).

3.2.100 ***ATT039***: contained a single linear feature extending north-east/south-west, approximately 6m from the north-east end of the trench and along the top of the slope that rises towards the south-east corner of the PDA (Fig 27). The cut (***3903***) measured 0.80m wide, 0.20m deep and, in section, had a concave profile (Fig 27; Plate 48). It contained a sequence of up to three fills. The

primary deposit was a medium brown sandy silty clay with occasional angular small stone inclusions (***3904***), reflecting the change in geology in this area. A thin secondary layer of medium brown sandy silty clay contained frequent inclusions of coal (***3905***), whilst a tertiary deposit was a medium brown sandy silty clay with rare angular stone inclusions (***3906***). The presence of coal inclusions in deposit ***3905*** would suggest this is a deliberate dumping deposit, and probably relates to a late phase of activity at the site. This was confirmed by the recovery of a small number of post-medieval ceramic sherds from the top fill ***3906***.

3.2.101 Trench ATT039 was located beyond the areas of investigation during the course of the strip, map and record programme. However, the projected line of ditch ***3903***, together with the dating evidence recovered, might suggest that it related to a post-medieval field boundary shown in the vicinity on historic maps (OS 1891).

*Plate 48. The south-west-facing section of cut **3903** in ATT039. Viewed facing north-east*

3.2.102 ***ATT041***: contained a single linear feature extending across the centre of the trench on a north-east to south-west axis. It also contained an irregular discrete feature interpreted as a probable natural tree bowl towards the south-western end of the trench, and a peaty deposit forming at the base of the slope similar to that recorded in ATT037 (see *Appendix 3*; Fig 28).

3.2.103 The linear feature measured up to 0.85m wide and up to 0.36m deep, but upon excavation, was interpreted as having a sequence of two cuts and associated fills (Fig 28; Plate 49). The earliest feature was represented by cut ***4103*** that measured up to 0.85m wide and had a steep sided, slightly irregular, U-shaped profile. It contained a sequence of up to three fills,

including a primary deposit of yellowish-grey sandy clay up to 0.08m thick (***4104***), and two secondary deposits, ***4105*** a light grey silty clay deposit up to 0.10m thick extending up the north-western side of the feature, and ***4106***, a light brown silty clay, restricted to the upper section of the south-eastern side. A second re-cut (***4107***) had apparently been excavated just off centre of the first, removing large sections of deposit ***4106*** and ***4105*** and obscuring their exact stratigraphic relationship. This second cut measured up to 0.60m wide and 0.30m deep, with a slightly irregular steep-sided U-shaped profile (Fig 28). It contained two fills, a primary deposit of dark grey silty clay (***4108***) that made up the bulk of the fill, and a deposit of light grey sandy clay that was restricted to upper parts along the north-western edge, measuring 0.20m wide and 0.10m deep.

3.2.104 No finds were recovered from any of the fills but their general character suggested the rapid back-filling of the cuts and a relatively recent phase of activity.

*Plate 49. The south-west facing-section of cut **4104/4107** in ATT041. Viewed facing north-east*

3.2.105 ***Additional Phase 2 features identified during the strip, map and record programme***: a limited number of additional features, clearly relating to Phase 2 activity were identified during the open area excavations only. These comprised a substantial field boundary and later additions, the majority of which extended roughly south-west/north-east within the eastern half of Area A, and an additional, much smaller ditch or gully within the south-eastern corner of the same area.

3.2.106 The main boundary feature extended the entire length of Area A, running approximately parallel to and 12m west of the eastern edge of excavation

(Fig 3). An additional shorter linear feature extended south-east, from a point slightly to the south of the centre of the main boundary, and continued to the limit of excavation in this direction. Both linears were distinguished from surrounding features by the frequent occurrence of a reddish brown stony and gravely upper fill, which had numerous pieces of obviously modern metal, plastic and CBM littering protruding from its exposed surface. Despite such an obviously modern upper fill, the linears were examined within a number of excavated slots, in an effort to sufficiently characterise their nature and composition. This, together with cartographic evidence, suggests that they probably comprised at least two phases of active use, the first possibly relating to late medieval or early post-medieval activity, a possible second phase of late-post medieval activity, and a modern phase in which they were substantially modified to provide the modern drainage feature identified during current works.

3.2.107 A single section was excavated across the main boundary line, south of the junction with the appended linear (Fig 29). Here the cut (***5037***) was found to be nearly 4m wide and up to 0.50m deep, with an irregular undulating profile and bottom (Plate 50), probably indicative of the remains of a hedgerow. It contained a sequence of two fills, ***5039***, a deposit of re-deposited natural restricted to the south-eastern edge of the feature, and ***5038***, forming the main bulk of the fill. Modern contamination mixed with the reddish brown stony material was visible to approximately half the depth of the feature.

*Plate 50. The south-west facing section of cut **5037**. Viewed facing north-east.*

3.2.108 A second slot was excavated towards the northern end of the main boundary (Fig 30). This revealed a very regular cut (***5043***) that was 2.60m wide and up to 1m deep with a distinct V-shaped profile (Plate 51). It contained a sequence of four fill deposits (***5044***-***5047***), the primary of which (***5044***)

consisted of re-deposited natural and contained a single large plastic field drain as well as fragments of CBM, while modern CBM and elements of the reddish brown stony material was also recovered from the main secondary deposit (***5046***).

*Plate 51. The north-east facing section of cut **5043**. Viewed facing south-west.*

3.2.109 The profile and content of the second slot was obviously quite distinct from that of the first, raising the possibility that the main course of the boundary line comprised at least two distinct components and probable phases of activity. In this light the appended linear, extending on a south-eastern axis, was highlighted as a probable component of one or other of the features. A third slot was therefore excavated across the width of the appended linear and against the eastern limit of excavation for Area A (Fig 31). This revealed a V-shaped cut (***5055***), up to 2m wide and 0.85m deep, containing a sequence of three fills (***5056***-***5058***), the lowest of which (***5056***) comprised re-deposited natural and contained a small diameter plastic field drain (Plate 52). The feature was, therefore, near identical to that identified as cut ***5043*** in the second slot, and indicates that it almost certainly represents a continuation of the main boundary ditch recorded to the north and extending on a south-west/north-east axis.

3.2.110 While modern material quite obviously indicates that the features had been in-filled during the twentieth century, the V-shaped profile of the ditch in particular, suggests an earlier origin. The feature may, however, have been re-used, with the field drain inserted to maintain drainage, while the remainder of the ditch was back-filled to prevent any impediment and allow consolidation of the field into a larger plot of land more conducive to modern farming equipment and techniques. This is supported by cartographic evidence in which the main south-west/north-east axis of the linear is

depicted, probably as a municipal boundary, on the First Edition OS Map (Fig 21). The boundary was therefore established, probably as a hedgerow given the evidence of cut ***5037***, by 1848. Having said this, if the boundary represents a municipal division this may have been established, if not formalised, much earlier, possibly during the early post-medieval or even late-medieval period.

*Plate 52. The south-east facing section of cut **5055**. Viewed facing north-west.*

3.2.111 By the time of the Second Edition OS Map of 1891 (Fig 25), the boundary line is still represented, but this time with a second linear appended, extending south-east. This second linear clearly relates to that recorded as cut ***5055*** and indicates that the northern half of the main boundary line, as recorded as cut ***5043***, was probably redefined with the insertion of a ditch forming a continuation of the south-eastern appended linear.

3.2.112 In summary, the archaeological and cartographic evidence suggest a sequence of development relating to the large linear feature identified in Area A, as first appearing sometime before the early 19th-century. Given the evidence of cut ***5037***, this was probably initially established as a hedgerow and formalised a probable municipal boundary, potentially demarcating parish boundaries established along the edge of the former marshland at a much earlier point in time. During the second half of the 19th-century the various parcels of land depicted on the First Edition OS Map, were partially re-defined, although the municipal boundary itself was retained, and a substantial ditch was inserted along part of its course. This ditch appears to partially define Field 7 depicted on the Second Edition OS Map. However, both the boundary features of hedgerow and ditch, were subsequently removed and in-filled during the 20th-century, probably in an effort to remove their impediment and consolidate multiple parcels of land into one

large field forming the current PDA. While this was established by infilling the ditch, the drainage of the area was maintained by inserting the field drains.

3.2.113 The only other feature, of probable archaeological origin, identified during the strip, map and record programme, was a short section of a linear feature, up to 7m in length, extending north from the southern limit of excavation in the south-eastern corner of Area A (Fig 32). This feature was examined via a single slot and revealed a shallow vaguely U-shaped cut (***5011***), up to 0.50m wide and 0.10m deep (Plate 53). It contained a single fill (***5012***) that produced no finds. Towards its northern end the feature became quite indistinct but was thought to intersect, but not progress beyond, the east/west aligned ditch recorded as cut ***2004***/***5008*** (*Section 3.2.93-94*). Given this potential association, the feature is presumed to also relate to Phase 2 activity, although no clear dating evidence is associated with either feature.

*Plate 53. The south facing section of cut **5011**. Viewed facing north.*

3.3 FINDS

3.3.1 The finds assemblage from the site was small, consisting of post-medieval pottery, metal work and ceramic building materials of little interpretative significance. A small number of pieces of wood were recovered from various features (***1105, 1913, 1915, 3208*** and ***3209***) but were un-worked and in a poor condition. Together with the large tree trunk identified in the top of the

alluvial flood deposits in ATT023, they probably represent the remnants of fallen trees preserved within a marshland environment.

Context	Finds
1201	1x Brown glazed earthenware base sherd. 18th C - m 19th C
1501	1x Dark glazed red earthenware body sherd. 18th C - m 19th C 1x Brown glazed earthenware body sherd. 18th C - m 19th C 3x Yellow ware body sherds. M 17th C - e 18th C 1x CBM fragment. Not closely datable
1504	1x CBM fragment, possibly daub.- Not closely datable
1903	1x ceramic land drain fragment 1x unglazed earthenware. L 18th C plus 1x nail shank. Not closely datable
2201	1x iron horse shoe, post-medieval
3003	1x iron chain link. Not closely datable
5040	2x Iron object. Not closely dateable. 2x White glazed earthenware 18th C-19th C
5048	1x white glazed ware, 1x brown glazed ware, 1x brown glazed external surface, cream glazed inner
5070	1x brown glazed vessel lid, 1x iron object

Table 1: Summary of artefacts from the site

3.3.2 A small number of heavily corroded indistinct metallic objects were recovered, including a horseshoe from topsoil deposits in ATT022, a probable chain link from a natural feature in ATT030. In addition metallic objects were recovered from context ***5040*** and ***5070*** during the strip, map and record phase, but are equally uninformative. All of the material probably relates to agricultural activity across the site since its reclamation during the later nineteenth century. A small assemblage of post-medieval pottery was recovered in a few features, but mainly from the topsoil in ATT012 and ATT015, of which the latter produced several sherds of mid-seventeenth to early eighteenth-century date. A small number of sherds were recovered from contexts associated with the fill of the post-medieval boundary feature in Area A (fills ***5040***, ***5048*** and ***5070***). The pottery from the features contributes a little towards the chronological phasing of the activity, but as a whole the material lacks any great significance.

3.4 PALAEOENVIRONMENTAL RESULTS

3.4.1 ***Introduction***: all palaeoenvironmental results featured in this section derive from the initial evaluation phase of trial trenching. This is because no additional sampling was undertaken during the strip, map and record stage of the investigation once it was apparent that the features revealed were either natural in origin, or had been adequately sampled during the trial trenching.

3.4.2 Previous studies (QUEST 2014) revealed the presence of peat deposits overlying gravels and sands and overlain by thick deposits of clays and silts, at the proposed site of Walney Sub-station. Two boreholes (Fig 2, BH9, BH10), drilled for the current study, penetrated a full stratigraphic sequence, confirming the presence of deep peat, at approximately 6.9m bgl. The sediment sequences are described below, and an assessment is made of potential for palaeoenvironmental work. Evaluation trenches across the site encountered evidence for palaeochannel deposits, and monolith samples

through organic and alluvial deposits from four trenches have also been described and appraised for palaeoenvironmental potential.

3.4.3 ***Previous palaeoenvironmental work***: nearby the Walney Sub-station site, Heysham Moss occupies a shallow depression on the northern side of the Lune Estuary, on the south-east side of Morecambe Bay. Heysham Moss is believed to contain peat deposits overlying marine deposits comprising silts and clays (Middleton 1995, 119). A stratigraphic transect across relict peat deposits at Heysham Moss, showed that peats up to 3.25m deep occur above clay deposits and limited palynological evidence suggests that the interface between the clay and peat may date to the late Mesolithic/early Neolithic transition (Tooley 1969; Langridge 1969). Buried peat deposits have also been recorded at the base of marine deposits to the east of Heysham (Crofts 1992).

3.4.4 ***Stratigraphic Results***: stratigraphic logs (*Appendix 4*) show details of the sediments encountered in the two boreholes and from monolith samples taken from four of the trenches. The borehole data penetrated 10m of sediment, whereas the monolith data sampled sediments up to 1.4m thick. At the base of the boreholes, coarse gravels and sands, probably representing glacial deposits, were encountered. Overlying these, sticky grey silts and clays up to approximately 1m thick were deposited prior to the onset of organic sedimentation. The organic sediments, comprising dry, crumbly peat, woody in places, were identified interspersed with layers of siltier material, and lay at depths between c 6.9 and 8.9m bgl, albeit being somewhat compressed. Overlying the peat, a thick deposit (approximately 6m) of silts and clays, was overlain by sandy clay and topsoil.

3.4.5 The stratigraphic sections sampled by monolith show a sequence of blue/grey clays overlain by grey clays with iron staining, succeeded by clearly defined organic peaty deposits. In one of the trenches, ATT024, the organic deposits are overlain by stiff dark grey clay. Elsewhere the organic deposits were overlain by variably disturbed clay deposits and topsoil.

3.5 INSECTS

3.5.1 ***Introduction***: two samples from peat deposits recovered during borehole sampling (sample BH9a, representing the top and bottom of the peat deposits), were assessed for their insect content and potential to produce environmental data.

3.5.2 ***Method:*** the samples were both small (<150ml). Since they consisted of peat which can prove difficult to disaggregate, the material was frozen and thawed out twice before processing to minimise damage to delicate organic remains (Vandorpe and Jacomet 2007). After thawing, the samples were subjected to paraffin flotation to extract insect remains following the methods of Kenward *et al*. (1980).

3.5.3 The paraffin flots were scanned in industrial methylated spirits (IMS) for the presence of insects and other invertebrates using a low-power binocular microscope (x10 – x45). The abundance of identifiable beetles (Coleoptera)

and bugs (Hemiptera) was estimated, the state of preservation of remains recorded, and the potential to provide environmental data assessed. Nomenclature for Coleoptera follows Duff (2012). The flots are currently stored in IMS in glass jars.

3.5.4 ***Results of the assessment:*** *BH9a 7.98 – 8m (from base core).* The sample had a volume of ~100ml and a paraffin flot with a volume of 10ml was produced. Single individuals of four beetle and bug taxa were represented in the paraffin flot. Two of the taxa were aquatic beetles. A few unidentifiable scraps of insect cuticle were also noted. *Ochthebius minimus* (identified from a well-preserved pronotum) is typical of shallow rather muddy water, most commonly (but not always) in stagnant water bodies. The remaining taxa were represented by fragmentary sclerites that could not be identified closely enough to provide further indications of habitat type.

3.5.5 *BH9a 6.98-7m (top of peat).* The sample had a volume of ~140ml and a paraffin flot with a volume of 10ml was produced. Insect remains were a little more common than in the lower deposit but the material was highly fragmented. Some taxa were represented only by small elytral fragments which could not be confidently identified beyond family level (e.g. ground beetles (Carabidae) and click beetles (Elateridae)). In all, 14 beetle and bug taxa were probably represented including a hydroporine water beetle, a small *Pterostichus* species, *Cercyon*, *Dryops*, *Lesteva* and two species of planthoppers (Auchenorhyncha spp.). *Dryops* and *Lesteva* are suggestive of wet waterside mud and generally damp, marshy conditions.

Insecta		**Arachnida**
Hemiptera (true bugs)	?Lygaeidae sp. [oa-p]	Acarina sp. (mites)
	Delphacidae spp. [oa-p]	
	Auchenorhyncha sp. [oa-p]	
Diptera (flies)	Diptera sp. puparia	
Coleoptera (beetles)	Hydroporinae sp. [oa-w]	
	Pterostichus sp. [oa]	
	Carabidae sp(p). indeterminate [ob]	
	Anacaena sp. [oa-w]	
	Cercyon sp. [u]	
	Ochthebius minimus (Fabricius) [oa-w]	
	Lesteva sp. [oa-d]	
	Mycetoporinae sp. [u]	
	Dryops sp. [oa-d]	
	Elateridae spp. indeterminate [ob]	
	Coleoptera spp. indeterminate fragments [u]	
Insecta spp. indeterminate larval fragments		

Table 2: List of insects and other invertebrates recorded from the samples during scanning

Identifications should be regarded as provisional. Nomenclature for Coleoptera follows Duff (2012). Ecological codes shown in square brackets are as follows: d – damp ground/waterside taxa, oa – certain outdoor taxa , ob – probable outdoor taxa, p – strongly plant-associated taxa, w – aquatics, u – uncoded

3.5.6 The insect fauna suggest that the base of the peat may have been characterised by shallow water, muddy palaeoenvironments, possibly indicative of stagnant water. The upper peat fauna suggest possible muddy wet waterside, marshy conditions. As the samples stand, no further

information can be gained from insect remains within them, other than the results reported here. The remains appear to be rather variably preserved from good to poor, the latter largely because of high fragmentation although some sclerites fragments were also seen to be thinned by erosion. No further work is recommended.

3.6 POLLEN

3.6.1 ***Introduction***: previous studies (OA North 2014, QUEST 2014) revealed the presence of peat deposits overlying gravels and sands and overlain by thick deposits of clays and silts, at the site of Walney substation. Two boreholes (Fig. 2, BH9, BH10) penetrated a full stratigraphic sequence, confirming the presence of deep peat, at approximately 6.9m bgl. The sediment sequence from one of these boreholes (BH10) was assessed for palynological potential, with a focus on the organic rich peat interval. Evaluation trenches ATT016, and ATT024 encountered evidence for palaeochannel deposits, and monolith samples through the organic and alluvial deposits in these trenches were also assessed for palynological potential.

3.6.2 ***Methodology***: volumetric samples were taken from twenty five sub-samples and one tablet containing a known number of *Lycopodium* spores was added so that pollen concentrations could be calculated (Stockmarr 1972). The samples were prepared using a standard chemical procedure (method B of Berglund and Ralska-Jasiewiczowa 1986), using HCl, NaOH, sieving, HF, and Erdtman's acetolysis, to remove carbonates, humic acids, particles > 170 microns, silicates, and cellulose, respectively. The samples were then stained with safranin, dehydrated in tertiary butyl alcohol, and the residues mounted in 2000cs silicone oil. Slides were examined at a magnification of 400x by ten equally-spaced traverses across at least two slides to reduce the possible effects of differential dispersal on the slides (Brooks and Thomas 1967) or at least until 100 total land pollen grains were counted. Pollen identification was made following the keys of Moore *et al* (1991), Faegri and Iversen (1989), and a small modern reference collections. Plant nomenclature follows Stace (2010). The preservation of the pollen was noted and an assessment was made of the potential for further analysis.

3.6.3 ***Background***: a stratigraphic transect across relict peat deposits at Heysham Moss, showed that peats up to 3.25m deep occur above clay deposits and limited palynological evidence suggests that the interface between the clay and peat may date to the late Mesolithic / early Neolithic boundary (Tooley 1969). Buried peat deposits have also been recorded at the base of marine deposits to the east of Heysham (Crofts 1992). Holocene sea-level changes in north-west England, between Cumbria and the Mersey, have been documented by Zong (1998) and Zong and Tooley (1996, 1999). Marine transgressions are known from the Morecambe Bay area, from as early as c 8300 BC (Zong and Tooley 1996), and relative sea level rose rapidly around 6870-6510 BC, which may have resulted in deposition of marine clays and silts across the area (Zong and Tooley 1996). During the period c 6510-1500 BC (c cal 7000 – 3500 BP) (late Mesolithic – middle Bronze Age), relative sea-level rose at rates between -8mm per year and 12mm per year; a rise of

sea-level at a rate of over 4mm per year may have resulted in extensive inundation over the coastal lowlands. Tooley (1987) identified a regressive sea-level index point from Heysham Moss, dated to the early Bronze Age (2330-3110 cal BC (4190 ± 150 BP; Hv.2920).

3.6.4 Within the context of the Heysham sub-station sediments, following deglaciation and sea level rise during the early Holocene, represented by gravels/sands and silts, subsequent deposition of organic rich silts and peats (recovered from boreholes BH9 and BH10) may represent the initial development of vegetation as sea levels fell. The overlying silts and clays within the borehole deposits may provide evidence of possible phases of sea level transgression. Due to the thickness of the overlying wet silts and clays, probable caving downhole during coring, resulted in the presence of peat units separated by silts/clays. It is estimated that the overall peat thickness in BH10 is represented by 0.54m. Duplicated cores were taken to test the stratigraphy and to ensure collection of as much peat as possible.

3.6.5 The organic sediments present within the trench evaluation sites, may represent peaty deposits from an area where these deposits merged into estuarine and marine deposits, or may represent the remnants of hollows or depressions that became filled with organic sediments prior to subsequent inundation by marine, estuarine or freshwater sediments. The lithological descriptions for the borehole and trench sequences are available *Appendix 5*.

3.6.6 ***Radiocarbon dates***: in the absence of suitable plant macrofossils, woody material was obtained from the deposits from BH10, which has permitted the lower organic rich and upper peat sequences to be dated. No suitable plant macrofossils were present in sediments from trench ATT024, so a humin/humic acid date was obtained from the organic sediments from the trench site. The radiocarbon dates are presented in *Section 3.11* below:

3.6.7 ***Assessment Results***: the assessment results are presented in the table accompanying this report (*Appendix 5*). The palynological sample from Trenches ATT016 (1601b), ATT024 (2401a) and borehole 10, are initially described and then interpreted.

3.6.8 ***Sample 1601b*** (ATT016): nine sub-samples from this palaeochannel feature were assessed for palynological potential, two from context ***(1603)***, a blue-grey clay, three from the overlying grey clay ***(1604)*** and four from the upper crumbly peaty deposit ***(1605***). Pollen was present in all the sub-samples, with rich, well preserved pollen assemblages present in the upper peaty deposits and generally good assemblages, but mixed preservation, present in the clays.

3.6.9 Pollen from contexts ***(1603)*** and ***(1604)***: Tree pollen accounts for between 75% and 94% of the assemblage, the dominant taxa being hazel-type (*Corylus avellana*-type) and oak (*Quercus*). Pollen of pine (*Pinus*), birch (*Betula*), elm (*Ulmus*) and alder (*Alnus*) is also present, with sporadic occurrences of ash (*Fraxinus*) at 0.890m and 0.40m (bgl), willow (*Salix*) and lime (*Tilia*) at 1.20m (bgl). Herb pollen is represented by grasses (Poaceae), sedges (Cyperaceae), pollen of the goosefoot family (Chenopodiaceae, now Amaranthaceae (Stace 2010)), sea plantain (*Plantago maritima*) at 1.20m and

0.80m (bgl), mugworts (*Artemisia*) at 1.20m and 0.40m (bgl) and docks/sorrels at 1.20m and 0.80m (bgl). Fern spores are present in low numbers and include spores of common polypody (*Polypodium vulgaris*), bracken (*Pteridium*) and monolete ferns (Pteropsida). Freshwater algae include occurrences of *Pediastrum* (HdV-760) and *Botryococcus* (HdV-766). Fragments, and some complete specimens of dinoflagellate cysts, of marine affinity, are present in most of the samples from the lower clay deposit, and foram test linings are recorded at 1.20m and 1.00m (bgl). Moderate amounts of microcharcoal are present.

3.6.10 The four remaining sub-samples from peaty deposit ***(1605)*** appear to show a trend from a dominantly grassy palaeoenvironment with less than 50% tree and shrub cover to alder carr with greater than 85% tree and shrub cover. There is evidence for freshwater depositional environments and also some evidence for proximity to the sea, based on the presence of salt tolerant plants such as sea lavender (*Limonium vulgare*), at 0.30m (bgl), known to grow on muddy saltmarshes (Stace 2010).

3.6.11 Arboreal pollen, from the clay lithologies (***1603***, ***1604***), is probably derived from regional woodlands. The sparse herb pollen includes taxa that are salt tolerant, for example, sea plantain, which grows in coastal locations and around salt-marshes (Stace 2010) and pollen of the goosefoot family, a large group inclusive of plants such as saltmarsh goosefoot. Grasses also may occupy coastal habitats. The best indicators for marine conditions though, are the dinoflagellate cysts and foram test linings (see also Whittaker, *Section 3.10*). Sources of fresh or brackish water may be inferred from records of the algal types *Botryococcus* (HdV-766) and *Pediastrum* (HdV-760). Occurrences of these algae in marine deposits are usually interpreted as indicating transport from freshwater habitats, for example, rivers (Batten 1996).

3.6.12 The clay lithology and palynomorphs contained within it suggest possible mud-flat palaeoenvironments, open to tidal influence, receiving local pollen from adjacent saltmarshes and hinterland pollen from regional woodlands. The upper, peaty lithology (***1605***) yields abundant pollen of grasses, suggesting open areas, possibly saltmarsh, that appear to become encroached upon by alder carr within the upper 0.20m of sediment. Alder carr occurs commonly on floodplains and in estuarine settings (Brown 1988). Microcharcoal particles are particularly common in the clay lithologies, and may be derived from woodland hinterland which has been subjected to burning.

3.6.13 ***Sample 2401a*** (ATT024): the deepest sub-samples from this ditch, from clay and mixed clay/peaty deposits, (***2403***) and lower (***2305***), respectively, yielded low frequencies of tree/shrub pollen, including pine, oak, hazel-type, alder, birch, lime and elm. Also represented are very rare herbs including grasses, pollen of the goosefoot family and daisy-type (Asteraceae, a large group including plants such as sea aster, ragworts and daisies). Fern spores are present including spores of monolete ferns, common polypody and bracken. Dinocyst fragments occur at 0.70m and 0.50m, with foram test linings and *Pediastrum* (HdV-760) also recorded at 0.70m.

3.6.14 A sharp lithological break separates the lower grey clays from the upper peaty context (***2404***), which yields a rich pollen assemblage, dominated by alder, between 0.40m and 0.10m (bgl). Pollen of hazel-type and oak are commonly recorded, with fluctuating counts for pollen of birch and low numbers of ash, pine, lime, heather (*Calluna*), hawthorn (*Crataegus*) and willow. Herb pollen is present, but poorly diverse, comprising predominantly grass pollen and sedges at 0.40m and 0.30m (bgl). A slightly more diverse herb pollen assemblage is recorded at 0.20m and 0.10m (bgl), including pollen of ribwort plantain (*Plantago lanceolata*), cinquefoils (*Potentilla*-type), pollen of bedstraws (Rubiaceae) and of the carrot family (Apiaceae, a large group including plants such as sweet cicely, sea holly and chervils). Fern spores including polypody ferns and monolete ferns are present and *Sphagnum* moss spores occur in small numbers throughout. Microcharcoal is most commonly recorded in the deepest sub-sample assessed, at 0.70m (bgl).

3.6.15 The pollen profiles suggest similar palaeoenvironmental conditions to those described above for sample 1601b, with development of possible saltmarsh or mudflat environments in context ***2403***, receiving pollen from regional woodlands. The saltmarsh / mudflat envrionments appear to be subsequently encroached upon by alder carr. Pollen from the clay lithologies (***2403***) is, however, quite sparse, although the count for microcharcoal is relatively high. The occurrence of several dinoflagellate cysts within this context, suggests the area may have been subjected to tidal inundation, which would be consistent with a possible saltmarsh environment. The occurrence of the fungal spore *Gelasinospora* (HdV-1), in association with high counts for microcharcoal, suggest burning; the microcharcoal may have been derived locally (from burning of saltmarsh plants, for example members of the goosefoot family, the pollen of which is present within an overall low pollen count) or from regional sources (via freshwater transport). The development of alder carr (context ***2404***) signals the establishment of freshwater conditions at the site. This may correspond with a fall in relative sea-level, or regression, and a humic acid sample from this context has been dated to the early Bronze Age, 1891-1700 cal BC (see *Section 3.11*).

3.6.16 ***Borehole 10****:* ten sub-samples were assessed and while pollen was present in all the sub-samples, none yielded a rich assemblage. The assessment focused on sub-samples from silts just beneath the peat at 9.0m, through the peat, and into silts overlying the peat at 6.80m (bgl). The deepest sub-sample (9.00m bgl) is dominated by pollen of sedges. Rare tree/shrub pollen includes occurrences of hazel-type and pine. *Sphagnum* moss spores are present in abundance. Spores of Carboniferous age are reworked in the pollen assemblages.

3.6.17 Within the lower part of the peat deposit, sub-samples at depths of 8.90m (bgl) and 8.80m (bgl) yield poor and reasonable assemblages, respectively. At 8.80m (bgl), tree and shrub pollen dominate the pollen spectrum, in particular pollen of hazel-type, which together with birch and pine and lesser quantities of willow and elm, account for more than 80% of the total land pollen counted. Pollen of herbs includes commonly occurring sedges and grasses as well as single occurrences of cinquefoils and campions (*Silene*-

type). Pollen of aquatic plants includes occurrences of lesser bulrush (*Typha angustifolia*) at 8.90m (bgl) and 8.80m (bgl). Sparse pollen assemblages, comprising similar taxa to those already described, occur at 8.70m (bgl), 8.60m (bgl) and 8.50m (bgl), and the sub-samples at 8.70m (bgl) and 8.60m (bgl) also contain records for pollen of alder. Hazel-type, birch, pine, oak, willow and sedge pollen occur in low overall pollen counts in the peat sub-samples between 7.90m (bgl) and 6.95m (bgl). Within the silt layer overlying the peat, at 6.80m (bgl), sparse pollen assemblages are recorded, including tree/shrub pollen (birch, pine, hazel-type, oak), grass pollen and fern spores. The presence of rare dinoflagellate cysts and pollen of the goosefoot family is noted also at this depth. Microcharcoal counts fluctuate from moderate to low through the peat and clay layers.

3.6.18 Low counts for pollen were obtained from the silty clays, silts and peaty sediments assessed from the core. Pollen counts of less than 100 grains provide assemblages that are considered insufficiently robust to suggest possible interpretations. If fern spores and moss spores are included in the pollen count, then two of the levels assessed may allow a partial interpretation. The deepest sub-sample, at 9.00m (bgl), yielded a pollen assemblage rich in sedges and *Sphagnum* moss spores, suggesting possible wet, open areas. In waterloggegd basins, sedge swamps may become sufficiently acid for *Sphagnum* mosses to begin colonisation, as has been recorded from the North Cumbrian Plain, where such an event has been dated to the opening of the Holocene (c. 10,000 – 7800BC) (Hodgkinson *et al* 2000). Wood from BH10, at 9.00m (bgl), has produced a radiocarbon date of 8288-8243 cal BC (9055±30 BP; see *Section 3.11*), and supports the pollen interpretation. In BH10, at 8.80m (bgl) and 7.90m (bgl) within the peat, the apparent expansion of hazel-type scrub, although present in assemblages with low overall pollen counts, may possibly correlate with similar trends in pollen profiles described and dated, for example, from Scaleby Moss in Cumbria, to 8425-7576 cal BC (9009±194 BP; Q-161) (Walker 1966, Hodgkinson *et al* 2000). A radiocarbon date, obtained from sapwood from the upper peat in BH10, of 8186-7738 cal BC (8798±29 BP; see *Section 3.11*), would agree broadly with this interpretation. At 6.80m (bgl), the proximity of marine influence is noted from the occurrence of dinoflagellate cysts and pollen of the goosefoot family, possibly suggesting a return to saltmarsh conditions, but the pollen counts are too low to provide more than a hint of such conditions.

3.6.19 ***Discussion and Conclusion***: the deep sequence assessed for pollen, from BH10, suggests that initial organic sedimentation developed during the early Holocene, 8288-8243 cal BC (9055±30 BP; GU36144, SUERC-57521). The limited recovery of palynomorphs suggests development of possible sedge swamps, which later became colonised by hazel-type scrub. Radiocarbon data from the upper part of the peat deposit in the present study, suggest that deposition of clays and silts (probably representing a marine transgression) occurred at this site, sometime after 8165-7738 cal BC (8798±29 BP; GU36143, SUERC-57520). There is published data from the greater Morecambe Bay area for sea level rises from c 8300 - 6510 cal BC, with a rapid rise in sea level between 6870-6510 cal BC (Zong and Tooley 1996).

3.6.20 The potential palaeochannel and ditch sequences assessed for pollen (*ATT016, ATT024*) show similar trends in palaeoenvironmental data to each other, from saltmarsh or possible mudflat habitats to freshwater habitats dominated by alder carr, represented in the stratigraphy as a shift from deposition of silts and clays to one of organic deposits. A radiocarbon date obtained from organic deposits from the base of the ditch in *ATT024*, suggests the wetland habitats were developed during the early Bronze Age (1891-1700 cal BC (3488±28 BP, GU36145, SUERC-57522), although a note of caution should be appended given the probable level of disturbance associated with these deposits. However, this accords well with a previous early Bronze Age date for sea level regression from Heysham Moss (Tooley 1987, Zong and Tooley, 1996).

3.6.21 The pollen data from BH10 suggest a palaeoenvironmental record beginning as early as the opening of the Holocene, following deposition of sands and gravels as deglaciation progressed. An early Holocene organic silt and peat deposit suggests a probable drop in sea level, resulting in development of sedge swamps and subsequent hazel-type scrub, as organic sedimentation accumulated, beginning around 8288-8243 cal BC (9055±30 BP; GU36144, SUERC-57521). This wetland palaeoenvironment was transgressed by the sea at some point after 8165-7738 cal BC (8798±29 BP; GU36143, SUERC-57520). Marine and brackish conditions appear to have persisted for some time, with evidence for the establishment of further wetland habitats during the early Bronze Age, based on palynomorph assemblages present in the possible palaeochannel deposits (*ATT016),* and sediments re-deposited in the post-medieval ditch *(ATT024*).

3.7 SOILS

3.7.1 ***Introduction***: two monoliths and five borehole cores, all from Borehole BH10, were assessed in order to more securely situate the stratigraphic sequence at Heysham within its wider geological developmental setting.

3.7.2 ***Methods and approach***: the sedimentary micromorphology of the samples were briefly described and assessed employing background Soil Survey of England and Wales information (Jarvis *et al*., 1983) and standard methods (Goldberg and Macphail, 2006; Hodgson, 1997). A number of soil/geoarchaeological themes were tentatively recognised during the monolith assessment to support a possible post-excavation study programme. These are:

- Minerogenic and organic intertidal soil-sediment accumulation associated with fluctuating and steadily rising Holocene sea levels, and:
- Coastal/intertidal land use and management.

3.7.3 ***Results***: the PDA is mapped as having a Humic alluvial gley soil cover formed in marine alluvium (Downholland 2 soil association; Jarvis *et al*., 1983); also present locally are typical sand para-rendzinas formed on dune sands and marine shingle, which may also be relevant to the borehole study.

The Downholland soil differs from others formed in marine alluvium by having a humose or peaty topsoil, and their location has been associated with "riverine backswamps, minor valley bottoms and former lake beds" (Avery, 1990, 310-311). They often have a silty clay loam grain size.

3.7.4 ***Section 1601, trench ATT016, Monolith 1601b***: examination of the sediments indicate an essentially natural intertidal coastal marsh soil formed in marine alluvium. It shows soil formation/sediment ripening due to modern drainage and influence of freshwater from inland sources, generally accepted as evidence for water levels managed by "ditches and pumps" (Jarvis *et al*., 1983). There is also evidence of strong humification, associated with root concentrations.

3.7.5 ***Section 2402, Monolith 2401b***; both the section drawing and the monolith itself suggest that this feature is unlikely simply to be a natural channel fill formed by dendritic drainage etc, of the salt marsh, if only because of the concentrations of fine and coarse charred organic matter present. Such charred material may be indicative of activity associated with the management of salt marsh vegetation by fire, for example, coastal marsh grazing. This burned material may also record other coastal activities; salt making produces much burned fuel although only very small quantities of possible burned mineral material were seen. Lastly, animal management in coastal marsh areas are recorded from prehistoric to modern times with, for example, probable cattle trampled stock routes at Iron Age Goldcliff (Bell *et al*., 2000; Wilkinson and Murphy, 1995; Wilkinson *et al*., 2012); and the local vegetation may have been managed by fire.

3.7.6 ***Borehole 10***: exact recording of stratigraphic depths was difficult due to compression and consequent sample loss (M. Rutherford, *pers comm.*). Nevertheless, the cores seem to be recording organic and minerogenic sedimentation influenced by a fluctuating, but steadily rising sea levels/base levels. No obvious weathered surfaces were identified with onset of peat formation, but these peats likely record stasis episodes of waterlogging and organic matter accumulation, possibly with base level fluctuations causing contemporary humification (as in recent coastal peats; Bouma *et al*., 1990; Dinç *et al*., 1976), before rising sea level and/or landmass depression led to renewed marine alluviation. Such marine alluvium-peat interfaces could yield information, along with palynology, on coastal environmental change through time.

3.7.7 ***Conclusion***: the results of the sedimentary assessment broadly confirm the general results of the other palaeoenvironmental lines of enquiry, indicating deposition of marine alluvium within a probable saltmarsh environment subject to episodic marine inundation as the result of fluctuating sea levels. This appears to be interspersed with periods of relative stasis resulting in the formation of freshwater marshland environments accompanied by peat formation.

3.8 PLANT REMAINS AND CHARCOAL

3.8.1 ***Introduction:*** eighteen bulk samples taken during the excavation were processed for the assessment of palaeoenvironmental remains. Samples were taken from ten putative and relatively shallow gullies/ditches (***503, 1001, 1303, 1505, 2004, 2006, 2010, 2105, 3209***, ***4107***), six putative pits or postholes (***1104, 1921, 2001, 2704, 3211, 4402***), and two palaeochannels, cuts ***2903*** and ***3106***; the latter reaching depths of up to 1.5m in places. The purpose of the assessment was to check for the survival of palaeobotanical material, such as charred and waterlogged plant remains, wood, and charcoal, in order to provide information on the local environment and associated land use. Palaeobotanical information from all periods is still poorly documented in the Lancashire area (see Hall and Huntley 2007, Huntley 2010), which means that the recovery and assessment of any surviving palaeobotanical material from the site is of high priority.

3.8.2 ***Quantification:*** eighteen palaeoenvironmental samples were taken during the excavations, each bulk sample comprising a minimum of 40 litres, or, if less, the entirety of the deposits, in order to comply with accepted professional guidelines (Campbell *et al* 2011).

3.8.3 ***Methodology:*** as part of the assessment, 10 to 30 litres of each sample were processed using hand flotation, where the flots were collected on a 250µm mesh, and air-dried if no waterlogged remains were apparent. Any waterlogged or charred organic material still retained in the residue was also extracted and kept with the flot. Each flot was examined using a binocular microscope during which any surviving charred plant remains (cpr) and waterlogged plant remains (wpr) were quantified, as was other material such as charcoal, coal, heat affected vesicular material (havm), bone, mortar, and ceramic building material (cbm). Preliminary seed/fruit identifications were made with the aid of standard texts (Cappers *et al* 2006, Stace 2010) and a reference collection. The presence of modern contaminants, such as roots, insect eggs and modern seeds was also noted. Material was quantified on a scale of + to ++++ where + is rare (one to five items); ++ is frequent (less than 50 items); +++ is common (51–100 items); and ++++ is abundant (greater than 100 items).

3.8.4 The diversity and type of charcoal was also recorded, and if warranted, a number of fragments from the charcoal-rich samples were radially split for preliminary identification. Identifications were made with the aid of standard texts (Schweingruber 1990, Hather 2000) and a small reference collection. The suitability of any of the plant remains or charcoal for providing radiocarbon dating material was also assessed.

3.8.5 ***Assessment Results***: the results of the palaeobotanical assessment are summarised in *Appendix 7*. Although many of the features contained waterlogged deposits, including peaty organic material, very little identifiable waterlogged seeds or wood were preserved. Given that the tops of many of the features were also relatively near the modern ground surface, containing abundant modern roots, many of the waterlogged seeds that were recovered, such as fat-hen (*Chenopodium album*), blackberry (*Rubus*

fruticosus), hemp-agrimony (*Eupatorium cannabinum*), sedges (*Carex* sp) and rushes (*Juncus* sp) may originate from present day or recent vegetation. All of these taxa can grow in damp conditions and on rough/open ground, typical of the area today.

3.8.6 Plant remains preserved through charring were recorded in three of the features, and included rare to common grass (Poaceae) stem and stem base fragments in putative gully ditch ***503***, putative palaeochannel ***2903***, and putative pit ***4402***. The putative palaeochannel (***2903***) was the only feature containing cereal remains in the form of a single oat (*Avena* sp) grain and a culm node. This same feature also contained rare glass, calcined bone, and abundant havm (heat affected vesicular material), which is likely to represent discarded refuse.

3.8.7 Charcoal was the most commonly recorded palaeoenvironmental material, being recovered from 10 of the 18 bulk samples. Charcoal was particularly abundant in putative gully/ditch ***503***, putative pit ***1921***, putative palaeochannel ***2903***, putative gully/ditch recut ***4107***, and putative pit ***4402***. Provisional identifications of a number of the larger, >2mm, fragments indicates that the charcoal primarily consists of oak (*Quercus* sp) and alder/hazel (*Alnus glutinosa/Corylus avellana*).

3.8.8 ***Discussion***: although many of the negative features excavated at Walney were obviously waterlogged in nature, the general paucity of plant remains preserved through waterlogging, and the presence of highly decomposed wood suggests that the deposits have been subjected to some degree of drying out. Indeed, the extensive network of land drains currently at the site may have facilitated this process. Charred plant remains were similarly scarce, however charcoal was commonly recorded in the features. The charred plant remains and charcoal from the site is likely to represent burnt vegetation and/or the waste from nearby activity.

3.8.9 ***Conclusion:*** given the limited nature of the palaeoenvironmental evidence from the site, further work would add very little to the existing data provided by the assessment.

3.9 DIATOM ANALYSIS

3.9.1 ***Introduction***: thirty-one sediment sub-samples from the site at Walney sub-station, Heysham, were prepared and assessed for diatoms. The samples for diatom evaluation were taken from three sediment sequences. The purpose of carrying out the diatom assessment was to test for the presence or absence of diatoms and the potential of the sediments for further analysis. The diatom assessment of each sample takes into account the numbers of diatoms, the state of preservation of the assemblages, species diversity and diatom species environmental preferences.

3.9.2 The first batch of sixteen samples were taken from two monoliths, 1601b from the palaeochannel in trench *ATT016*, and 2401a from the putative palaeochannel/ditch in trench *ATT024*. The second batch of fifteen samples derives from a borehole (BH10). They were taken using a terrier-type rig; the

aim being to recover deposits associated with a peat layer occurring c 7m (bgl) (Mairead Rutherford pers. comm.). Of particular interest in the diatom assessment is the salinity regime indicated by the diatom assemblages. Radiocarbon ages for the borehole and trench features are discussed in *Section 3.11*.

3.9.3 ***Methodology***: diatom preparation followed standard techniques (Battarbee *et al.* 2001). Two coverslips were made from each sample and fixed in Naphrax for diatom microscopy. A large area of the coverslips on each slide was scanned for diatoms at magnifications of x400 and x1000 under phase contrast illumination.

3.9.4 Diatom floras and taxonomic publications were consulted to assist with diatom identification; these include Hendey (1964), Werff & Huls (1957-1974), Hartley et al. (1996), Krammer & Lange-Bertalot (1986-1991) and Witkowski *et al.* (2000). Diatom species' salinity preferences are indicated using the halobian groups of Hustedt (1953, 1957: 199), these salinity groups are summarised as follows:

- Polyhalobian: >30 g l-1;
- Mesohalobian: 0.2-30 g l-1;
- Oligohalobian - Halophilous: optimum in slightly brackish water;
- Oligohalobian - Indifferent: optimum in freshwater but tolerant of slightly brackish water;
- Halophobous: exclusively freshwater;
- Unknown: taxa of unknown salinity preference.

3.9.5 ***Results and Discussion***: the results of the diatom evaluation are summarised in Table 3 and diatom species data for each sample are presented in *Appendix 8*.

Diatom Sample No.	Diatoms	Diatom Numbers	Quality of Preservation	Diversity	Assemblage type	Potential for % count
D1	+	ex low	ex poor	v low	mar fw	none
D2	+	low	poor	mod	bk mar	mod
D3	+	low	poor	low	mar bk	some
D4	+	v low	v poor	low	mar bk	some
D5	+	mod	poor to mod	low	mar bk	some
D6	+	mod	poor to mod	mod	mar bk	some
D7	+	mod	poor to mod	mod	mar bk	some
D8	+	ex low	v poor	low	mar hal fw	none
D9	+	high	mod	mod	fw halophobe	mod
D10	+	low	poor	mod	fw aero	low
D11	+	v low	poor	low	fw aero	v low
D12	+	ex low	v poor	low	fw aero	none
D13	+	v low	v poor	low	bk	none
D14	+	ex low	v poor	v low	bk	none
D15	+	ex low	v poor	v low	mar bk aero	none

Diatom Sample No.	Diatoms	Diatom Numbers	Quality of Preservation	Diversity	Assemblage type	Potential for % count
D16	+	ex low	ex poor	ex low	mar	none
D17	+	ex low	poor	low	mar bk fw	none
D18	+	ex low	ex poor	v low	mar bk	none
D19	-	-	-	-	-	none
D20	+	ex low	v poor	v low	bk mar	none
D21	+	ex low	v poor	v low	bk mar	none
D22	-	-	-	-	-	none
D23	+	ex low	v poor	v low	bk	none
D24	+	ex low	v poor	v low	bk mar	none
D25	+	ex low	v poor	v low	bk mar	none
D26	+	ex low	v poor	v low	mar bk	none
D27	+	ex low	v poor	v low	bk mar	none
D28	+	ex low	v poor	v low	bk mar	none
D29	+	ex low	v poor	v low	bk mar	none
D30	+	ex low	v poor	v low	bk mar	none
D31	+	ex low	v poor	v low	bk mar	none

Table 3. Summary of diatom evaluation reslts for Heysham (+ present; - absent; mod = moderate; ex = extremely; bk = brackish; mar = marine; fw = freshwater; aero = aerophilous; hal = halophilous)

3.9.6 ***Monolith 1601b (samples D1-D7)***: diatoms are present in all seven samples assessed from the Monolith 1601b sequence, taken from between 0.30m and 1.20 m (bgl). The number of diatoms (Table 3) varies from, low or very low in the top part of the sequence to moderately high in the bottom three samples. The quality of diatom valve preservation is also poor or very poor in the top four samples whilst diatom preservation varies from poor to moderate in all three of the bottom samples. Species diversity varies from low to moderately high, except in the top sample where it is very low. There is some potential for diatom counting in samples D3 to D7 and moderately good potential for percentage analysis of sample D2. However, as a result of the poor quality of diatom preservation, the top sample D1 has no potential for further diatom analysis.

3.9.7 All seven samples from Monolith 1601b show the influence of marine conditions. Samples D3 to D7 are dominated by marine and brackish water taxa. Sample D2 has a greater number of benthic, brackish water diatoms; and in the top sample, although poorly preserved, both freshwater and marine diatoms are present.

3.9.8 The diatom assemblages of samples D7 to D3 have relatively high numbers of marine diatoms. In particular the planktonic coastal species *Paralia sulcata* is abundant, but in addition polyhalobous diatoms such as *Cymatosira belgica, Podosira stelligera, Rhaphoneis* spp. and *Actinoptychus undulatus* are present or common in these samples. In addition mesohalobous, brackish-marine diatoms such as the benthic diatom *Nitzschia navicularis*, which is typical of mudflat and tidal creek habitats, are common or present in four of these samples. Other mesohalobous or mesohalobous to halophilous diatoms include *Bacillaria paradoxa, Diploneis aestuari, Navicula peregrina, Nitzschia hungarica, Nitzschia levidensis* and *Nitzschia tryblionella*. The planktonic brackish water diatom *Cyclotella striata* is

present in three samples. Freshwater and halophilous diatoms are almost completely absent from this section of the sequence.

3.9.9 In sample D2 at 0.35m depth (bgl) *Paralia sulcata* remains common along with other polyhalobous taxa such as *Cymatosira belgica, Podosira stelligera, Rhaphoneis surirella* and *Actinoptychus undulatus*. However, the benthic, mud-surface epipelon becomes more common or abundant; in particular *Navicula peregrina* and *Nitzschia navicularis*. Other benthic, brackish water diatoms in this sample are *Scolipleura tumida* and *Diploneis interrupta*.

3.9.10 The quality of preservation is very poor and the number of diatoms is extremely low in the top sample D1. However, poorly-preserved valve fragments of the marine species *Paralia sulcata* and *Podosira stelligera*; along with the freshwater taxa *Gomphonema angustatum* and *Pinnularia* cf. *major* (a desiccation tolerant species) were identified in this sample.

3.9.11 ***Monolith 2401 A (samples D8-D16)***: nine samples from Monolith 2401a were assessed for diatoms. With the exception of sample D9 from 0.20m depth (bgl), the number of diatoms in the samples varies from extremely low to low. The quality of diatom preservation is also poor or very poor in all but sample D9. Diatom species diversity is low or very low in seven of these samples. There are greater numbers of diatom taxa in samples D9 and D10.

3.9.12 The diatom assessment shows that there are changes in the salinity conditions and tidal influence during the period represented by the Monolith 2410a sequence. One sample (D9) has moderate potential for percentage diatom analysis. Samples D10 and D11 respectively have low and very low potential for further diatom analysis; whilst six samples (D8 and D12-D16) have no further potential for diatom analysis.

3.9.13 The bottom two samples D16 and D15 (0.90m and 0.80m depth bgl) have poorly preserved diatom assemblages which include the marine planktonic species *Podosira stelligera*. Benthic mesohalobous diatoms (*Nitzschia navicularis* and *Diploneis didyma*) are also present in D15 along with a fragment of *Pinnularia* cf. *borealis*, an aerophilous (semi-terrestrial) freshwater diatom.

3.9.14 The mesohalobous benthic species *Nitzschia navicularis* is relatively common in samples D14 and D13, along with *Diploneis didyma* and *Diploneis interrupta* in D13. These benthic brackish-marine taxa are derived from shallow water tidal habitats such as mud-flats.

3.9.15 Samples D12 to D10 (0.50m to 0.30m depth bgl) have freshwater and freshwater aerophilous diatom assemblages with no polyhalobous diatoms present and only traces of mesohalobous taxa (*Synedra pulchella* and *Cyclotella striata*). The oligohalobous indifferent, freshwater, diatoms include *Gomphonema parvulum, Achnanthes hungarica* and *Pinnularia viridis*. The aerophilous diatom *Pinnularia borealis* is common or present in D10 and D11.

3.9.16 Sample D9 contains high numbers of halophobous taxa that are associated with acidic, nutrient-poor freshwater habitats, for example peatland pools. Marine diatoms are absent and the only mesohalobous diatom present is *Synedra pulchella*, which can also be found in non-marine waters of high conductivity. The halophobous taxa are represented by *Eunotia* spp. including *Eunotia pectinalis* var. *minor*, *Eunotia curvata*, *Eunotia naegelii* and *Eunotia tenella*. These are non-planktonic, shallow water diatoms.

3.9.17 Sample D8 has a very poorly-preserved, mixed diatom assemblage including marine (*Podosira stelligera*), halophilous/aerophilous (*Navicula cincta*) and freshwater (*Frustulia vulgaris*) diatoms.

3.9.18 Some caution must be exercised in the assessment of the results from sample 2401a, as the radiocarbon evidence deriving from the basal fill of this post-medieval ditched feature is associated with a Bronze Age date and, therefore, is obviously redeposited.

3.9.19 ***BH10 (Samples D17-D31)***: diatoms are present in thirteen of the fifteen samples assessed from BH10. The diatom assemblages are very poorly preserved throughout the sequence, with extremely low numbers of diatoms in each sample and very low diatom species diversity. None of the diatom samples in BH10 has further potential for diatom analysis, however, the diatom assemblages of these samples are nevertheless informative and the diatom assemblages present reflect tidal, brackish and marine conditions.

3.9.20 Diatoms are absent from samples D19 and D22, both samples taken from peat. The diatom assessment does not show any clear changes in the diatom assemblages through the BH10 sequence. All of the diatomaceous samples contain polyhalobous, planktonic diatoms, notably *Paralia sulcata* and *Podosira stelligera*. Benthic, mesohalobous diatoms such as *Nitzschia navicularis, Caloneis westii, Diploneis interrupta, Diploneis didyma, Nitzschia punctata* and *Diploneis smithii* indicate shallow water, mud or sand surface habitats. Halophilous and freshwater diatoms are absent except for the halophobous species, *Tabellaria flocculosa*, in D17 (at 9.5m depth bgl) which is likely to be an allochthonous component of the diatom assemblage.

3.9.21 The poor preservation or absence of diatom remains in this sequence can be attributed to taphonomic processes (Flower 1993, Ryves et al. 2001). This may be the result of diatom silica dissolution and breakage caused by factors such as extremes of sediment alkalinity or acidity, the under-saturation of sediment pore water with dissolved silica, cycles of prolonged drying and rehydration, or physical damage to diatom valves from abrasion or wave action.

3.9.22 ***Conclusions***: diatoms were assessed from thirty-one samples taken from three sediment sequences from the Heysham site. In the Monolith 1601b sequence diatoms are present in all seven samples with some or moderate potential for diatom analysis of six of these samples. Coastal marine or brackish-marine diatoms that reflect tidal influence are present throughout the sediment sequence. Open water, planktonic marine diatoms are most common in the bottom five samples. Benthic, brackish-marine diatoms, that

are associated with mudflats or tidal creeks are more common in sample D2 at 0.35m depth (bgl). However, diatoms from both habitats are present throughout the sequence. A very poorly-preserved diatom assemblage occuring at 0.30m depth (bgl) has a mixed marine and freshwater diatom taxa.

3.9.23 In the Monolith 2401a sediment sequence diatoms are present in all nine samples. However, only one sample (D9) has moderate potential for percentage diatom analysis. Samples D10 and D11 respectively have low and very low potential for further diatom analysis. Six samples (D8 and D12-D16) have no further potential for diatom analysis. The diatom assessment indicates that there is variation in salinity conditions and tidal influence through the sequence. Marine planktonic diatoms are present in the bottom two samples. In samples D15 to D13 (0.80m to 0.60m depth bgl) brackish water benthic diatoms are more common. Samples D12 to D10 (0.50m to 0.30m depth bgl) have freshwater and freshwater aerophilous diatom assemblages with no polyhalobous diatoms present and only traces of mesohalobous taxa. Sample D9 (0.20m depth bgl) is dominated by halophobous taxa that are associated with acidic, nutrient-poor freshwater habitats, for example peatland pools. The top sample D8 has a very poorly-preserved diatom assemblage from a mixture of habitats.

3.9.24 Diatoms are present in thirteen of the fifteen samples assessed from BH10. The diatom assemblages are very poorly preserved throughout the sequence. There are extremely low numbers of diatoms and very low diatom species diversity throughout and, therefore, none of the diatom samples have further potential for diatom analysis. The diatom assemblages assessed nevertheless indicate tidal, brackish and marine conditions. All of the diatomaceous samples contain polyhalobous, planktonic diatoms; and benthic, mesohalobous diatoms indicate shallow water, mud or sand surface habitats. Halophilous and freshwater diatom assemblages are absent. The poor preservation or absence of diatom remains in this sequence can be attributed to taphonomic processes that have resulted in diatom valve breakage and silica dissolution.

3.10 FORAM ANALYSIS

3.10.1 ***Introduction***: a total of 31 samples were assessed for the presence and diversity of Foraminifera (forams) as an indicator of environmental context and potential sequences of change.

3.10.2 Two samples, 1601b from the palaeochannel in trench ATT016 and sample 2401a from the putative ditch in trench ATT024, yielding a total of seven and nine sub-samples respectively. In addition, a borehole (BH10) was sunk to a depth of 10m below ground level (bgl) and generated a total of fifteen sub-samples. These are summarised in Table 4 according to weight, context and depth.

Sample 1601b		**Sample 2401a**		**Bore Hole 10**	
Depth (bgl)	**Weight (g) processed**	**Depth (bgl)**	**Weight (g) processed**	**Depth (bgl)**	**Weight (g) processed**
0.27-0.30m	10g	0.08-0.10m	20g	1.50m	70g
0.37-0.40cm	40g	0.18-0.20m	25g	2.50m	75g
0.47-0.50m	40g	0.25-0.27m	40g	3.50m	45g
0.57-0.60m	40g	0.55-0.57m	50g	4.50m	50g
0.77-0.80m	50g	0.65-0.67m	50g	5.50m	45g
0.97-1m	25g	0.73-0.75m	50g	6.50m	40g
1.17-1.20m	25g	0.78-0.80m	45g	6.80m	35g
-	-	0.87-0.90m	50g	6.95m	10g
-	-	-	-	7.48-7.50m	55g
				7.90m	5g
-	-	-	-	8.48-8.50m	45g
-	-	-	-	8.60m	10g
-	-	-	-	8.80m	10g
-	-	-	-	9m	45g
-	-	-	-	9.48-9.50m	40g

Table 4. Summary by volume, context and depth of the sub-samples assessed for foram analysis

3.10.3 ***Methodology***: the samples were broken up by hand into small pieces, put in ceramic bowls and thoroughly dried in an oven. A small amount of sodium carbonate was subsequently added to each (to help remove the clay fraction) and hot water poured over them. They were left to soak. Good breakdown was achieved by washing through a 75 micron sieve with hand-hot water. Each residue was then decanted back into a bowl and returned to the oven to dry. Samples were stored in labelled plastic bags and analysed by placing each sample into a nest of sieves and examining each of the fractions on a tray under a binocular microscope. The faunas were noted and representative microfossils picked out and put into 3" x 1" slides for archive purposes. The results of the semi-quantitative analysis are shown in Figures 1-3. "Organic remains" are also shown on these figures, but on a presence/absence basis only.

3.10.4 ***Results***: the results of the microfaunal assessment are summarised in Figures 1-3. In the uppermost table are listed the "organic remains" on a presence/absence basis while in the two tables below are the foraminifera and ostracods encountered, indicated semi-quantitively.

3.10.5 ***Sample 1601b***: the results of the microfaunal assessment for this sample are summarised in *Appendix 10* plant debris and seeds were elements of charcoal or burnt vegetation, probably the latter, and thus from natural fire. Cladocera (water-fleas) and their egg cases (ephippia) occur in two of the upper samples. Iron mineral and/or iron tubes are present in the interval 0.57-0.80m and are said (by Candy, *in* Ashton *et al.*, 2005) to be associated with weathering or near-surface groundwaters, formed prior to the onset of fully terrestrial conditions, or pedogenic activity.

3.10.6 Overall the ecological developmental sequence for sample 1601b is quite clear (*Appendix 10*). The lower five samples from the interval 0.25-0.75m blg (+3.63m – +2.90m O.D.) contain brackish foraminifera, the lowest two samples, in addition, also contain brackish ostracods. The colour coding in

Appendix 10 illustrates their ecological signature, this being given in more detail, species by species, in Appendix 9. Initially, there is a brackish mudflat (indicating the presence of a tidal channel) which becomes silted up and gives way ultimately to saltmarsh. After this the foraminifera die out completely and it must be assumed that the site becomes a freshwater wetland, ending with waterlogging and subsequent peat formation.

3.10.7 ***Sample 2401a***: the findings of the microfaunal assessment for this sample are shown in *Appendix 10*. Again the environmental reconstruction indicates brackish saltmarsh occurred in the lower part of the sedimentary sequence covering the interval 0.65-0.90m bgl (+3.41m - +3.06m O.D.), with freshwater wetland above. Here, the brackish component comprises exclusively agglutinating foraminifera of mid-high saltmarsh; on the evidence of a total lack of calcareous foraminifera or ostracods and, unlike ATT016, there is no mudflat present here whatsoever. It would thus appear that ATT024 lies at the fringes of tidal access.

3.10.8 There is then a change between 0.47-0.55m bgl (+3.55m - +3.41m O.D.), at almost an identical depth (bgl) to that recorded in trench ATT016, which witnesses a relatively sudden end to foraminifera presence (colour-coded turquoise). The sample from 0.45-0.47m (bgl) is composed of peat and probably indicates a total severance of tidal access, to be succeeded by (freshwater) waterlogging. The occurrence of *Cypris ophtalmica*. a freshwater ostracod which will survive in the most inhospitable of places, as well as cladocera, serve to reinforce that this is now a totally freshwater environment.

3.10.9 Assessment of the microfauna represented in this sample must be tempered by the fact that the peat deposits, dated to the Bronze Age (*Section 3.11*), occur in the base of a post-medieval feature, and are therefore displaced. However, they seem to confirm the sequence identified in earlier features of marine inundation of the area and the presence of a saltmarsh environment followed by a severance of marine influence and the subsequent development of freshwater marshland accompanied by peat formation.

3.10.10 ***Borehole 10***: the borehole penetrated some 9.50m of sediment (down to -5.20m O.D.), and the results of the microfaunal survey are summarised in *Appendix 10*. If the results from the two trenches described above showed a relatively simple sedimentary sequence indicative of saltmarsh below freshwater wetland (with peats), here the picture is much more complicated with brackish saltmarsh and tidal mudflats, interspersed at several intervals between 6.95m bgl (-2.65m O.D.) and 8.80m bgl (-4.50m O.D.) by peats. These latter deposits, albeit on mainly negative evidence, would indicate periods of (freshwater) waterlogging. If this is the case, then the mechanism for this curiously oscillating environmental occurrence must be sought.

3.10.11 The brackish foraminifera seen in *Appendix 10* always have low diversity, but often occur in very large numbers. They comprise agglutinating foraminifera (colour-coded turquoise) of mid-high saltmarsh (they are herbivores and detrivores, *Jadammina macrescens* in particular living on decaying vegetation) and calcareous foraminifera (colour-coded grey) of

tidal mudflats and low-mid saltmarsh. *Appendix 9* gives more information on the individual species. Brackish ostracods, in contrast to the foraminifera, are very rare and perhaps the result of some decalcification, as ostracod carapaces and valves are much more prone to this than the foraminiferal test.

3.10.12 The lowest sample submitted (at 9.48-9.50m bgl or -5.18/-5.20m O.D.) is a sand/fine gravel, the sedimentary grains, it appears, coming from a glacial till. Nevertheless, tidal access is apparent and saltmarsh is already established (*Appendix 10*). The sequence is subject to three distinct breaks characterised by peat formation, with mid-high saltmarsh conditions and associated mudflats continuing almost to the top of the sequence - until 2.60m bgl (+1.80m O.D.) to be precise, after which the final sample contains only agglutinating foraminifera (yet in superabundant numbers). The sediments are indeed all silts/clays.

3.10.13 A palynological analysis and examination of the macro plants and seeds can only add to the reconstruction presented here, as well as providing much further useful information on the changing environment. Obtaining an age framework to the sediments, through radiocarbon dating, is also absolutely vital – potentially enabling a comparison to be made against recognised sea-level changes in the area and give an idea of the geographical changes that must have taken place.

3.11 RADIOCARBON DATING

3.11.1 In the absence of suitable plant macrofossils, woody material was obtained from the deposits from BH10, which has permitted the lower organic rich and upper peat sequences to be dated. No suitable plant macrofossils were present in sediments from trench ATT024, so a humin/humic acid date was obtained from the organic sediments from the trench site. The radiocarbon dates are presented in Table 5 below:

SUERC reference	GU lab code	Sample	Depths (m)	Calibrated age (BC)	Date (BP)	Period
57521	36144	BH10, wood	9.0	8297-8243	9055±30	Early Mesolithic
57520	36143	BH10, sapwood	7.9	8165-7738	8798±29	Early Mesolithic
57522	36145	2401A, humic acid	0.32-0.33	1891-1700	3488±28	Early Bronze Age
57523	36146	2401A, humin	0.32-0.33	1941-1763	3529±29	Early Bronze Age

Table 5: Radiocarbon dates for the Walney substation, Heysham

3.11.2 The results obtained from BH10 are relatively secure and indicate a period of peat formation some time during the Mesolithic period subsequent to deglaciation. This is in turn followed by a sequence of marine alluvial deposits that probably derive from marine inundation of the area associated with rising sea levels.

3.11.3 The radiocarbon dates deriving from sample 2401a must be treated as deriving from re-deposited material within a much later feature. The Bronze Age date they encapsulate does not, therefore, date the feature, but, with some reservation given the reworked nature of the material, may generally

indicate a period of peat formation and the development of a freshwater marshland environment during this period.

3.12 PALAEOENVIRONMENTAL OVERVIEW

3.12.1 In total, 31 environmental samples were taken, these comprised 18 bulk samples from 18 trenches. Two monolith samples which represent the fills of a palaeochannel (ATT016) and a further potential palaeochannel/disturbance feature (ATT024), were sub-sampled for palaeoenvironmental assessment. Boreholes from two locations penetrated 10m of sediment and sub-samples were selected from BH10 for assessment. The peat deposit from BH10 was scanned for suitable plant macrofossils for radiocarbon dating. The number of bulk and monolith samples taken, and the various palaeoenvironmental proxies assessed from them, is shown in Table 6. Samples with potential for analysis are summarised in Table 7.

	Number of samples assessed	Number of sub-samples assessed	Sample type
Microfauna (Foraminifera/ Ostracoda)	3	31	Monolith and borehole BH10
Diatoms	3	31	Monolith and borehole BH10
Pollen	3	25	Monolith and borehole BH10
Insect	1	2	Borehole BH9
Plant macrofossils	18	18 (bulk)	Bulk
Soil micro-morphology	3	7	Monolith and borehole

Table 6: Quantification of environmental samples assessed from Walney sub-station, Heysham

3.12.2 ***Microfauna***: the foraminiferal and ostracod fauna from the palaeochannel in trench ATT016 are indicative of a brackish mudflat associated with the presence of a tidal channel ***(1603)***, which becomes silted up, and develops into a saltmarsh ***(1604)***. The establishment of a freshwater wetland ***(1605)*** is inferred from the absence of foraminifera and brackish water ostracods. From putative palaeochannel ATT024, the microfaunal evidence is for a brackish saltmarsh ***(2403)***, developing into a freshwater peat ***(2404)*** containing freshwater ostracods. The deep borehole, BH10, records microfauna that suggest the inception of saltmarsh (with tidal access) at the base of the borehole, followed by a wetland sequence, ultimately overlain by a thick sequence of silts and clays of mid-high saltmarsh palaeoenvironments and associated mudflats.

3.12.3 ***Diatoms***: coastal marine or brackish-marine diatoms that reflect tidal influence are present throughout the sediment sequence in the palaeochannel identified in trench ATT016. A poorly-preserved diatom assemblage within the upper context ***(1605)*** has a mixed marine and freshwater diatom assemblage. Diatom assessment from trench ATT024 indicates that there is variation in salinity conditions and tidal influence through the sequence. The sub-sample from upper context ***(2404)*** is dominated by halophobous taxa that are associated with acidic, nutrient-poor freshwater habitats, for example peatland pools or drainage ditches. From BH10, the sparse and poorly preserved diatom assemblages assessed indicate tidal, brackish and marine

conditions. Mesohalobous diatoms present in the sediments indicate shallow water, mud or sand surface habitats.

3.12.4 ***Pollen***: the pollen data from the palaeochannel in trench ATT016 suggest possible mudflat palaeoenvironments, open to tidal influence, possibly receiving local pollen from adjacent saltmarshes, and hinterland pollen from regional woodlands ***(1603, 1604)***. The upper peaty lithology ***(1605)*** yields abundant pollen of grasses, suggesting open areas, possibly saltmarsh, that appear to become encroached upon by alder carr, within the uppermost part of the sample. The pollen sequence from putative trench ATT024 suggests a similar sequence of palaeoenvironments to those described from trench ***1601***. From BH10, the pollen data suggest probable sedge swamp conditions at the bottom of the borehole, with some evidence for the possible expansion of hazel-type in the overlying peaty sediments, which is subsequently overlain by silts and clays, potentially of saltmarsh palaeoenvironments. Recovery of pollen is generally sparse within the borehole sediments.

3.12.5 ***Insects***: samples from the base and top of the peat in BH9 were assessed for insect remains. A fauna from the base of the core suggests the presence of shallow, possibly stagnant, rather muddy water. Faunal assemblages from the top of the peat suggest wet, waterside mud and generally damp, marshy conditions.

3.12.6 ***Plant macrofossils***: from BH10, a fragment of alder /hazel wood in the lower organics and sapwood from the upper part of the peat, permitted radiocarbon dates to be obtained. Among the other (bulk) samples assessed, plant macrofossils were recorded in 7 deposits, ranging from gully/ditch fills, to ditch fills and pit fills. The most abundant but poorly diverse assemblages are from ditch fill **2002/(*2003*)** and pit fill **2701/(*2702*)**. These fills recorded abundant rushes (*Juncus*) seeds, suggesting proximity to aquatic or wet areas (Stace, 2010).

3.12.7 ***Soil micro-morphology***: assessment of sediments from trench ATT016, suggests a natural intertidal coastal marsh formed in marine alluvium. The presence of charred organic matter in the sample from trench ATT024 may suggest the sedimentary sequence here may represent some form of disturbance, a possible trackway with fills recording local activities associated with burning, rather than being an accumulation of sediments resulting from purely natural processes. These sediments have subsequently been re-interpreted as representing displaced deposits of Bronze Age date within a post-medieval ditch feature. The sediments in BH10 were assessed as recording organic and minerogenic sedimentation influenced by a possibly fluctuating, but steadily rising sea level / base levels. The peats likely record stasis episodes of waterlogging and organic matter accumulation, prior to rising sea level and/or landmass depression, leading to renewed marine alluviation.

3.12.8 ***Palaeoenvironmental history and dating***: interpretation of the combined palaeoenvironmental proxies suggests a palaeoenvironmental record beginning as early as the opening of the Holocene, following deposition of sands and gravels, as deglaciation progressed. Microfauna of brackish marine

affinity and pollen indicative of freshwater palaeoenvironments, suggest a mosaic of habitats, typical of coastal lowlands, the onset of organic deposition dated to the early Holocene, 8288-8243 cal BC (9055±30 BP; GU36144, SUERC-57521). The development of peat suggests a probable drop in sea level, resulting in establishment of freshwater palaeoenvironments, perhaps characterised by hazel-type scrub. The wetland palaeoenvironment was transgressed by the sea at some point after 8165-7738 cal BC (8798±29 BP; GU36143, SUERC-57520). Published data from the greater Morecambe Bay area interprets sea level rise from c 8300 - 6510 cal BC, with a rapid rise in sea level between 6870-6510 cal BC (Zong and Tooley 1996). Palaeoenvironmental conditions of mid-high saltmarsh and associated mudflat conditions appear to have persisted for some time, with evidence for the establishment of further wetland habitats during the early Bronze Age (1891-1700 cal BC (3488±28 BP, GU36145, SUERC-57522).

3.12.9 ***Potential***: the palaeoenvironmental data recovered from sediments from a deep borehole, and two palaeochannel features at Walney sub-station, Heysham, have been assessed. The entire palaeoenvironmental history, available from the sediments recovered, spans the time period from the early Holocene to the Bronze Age. Pollen and diatom recovery was poor from the deep borehole sediments, but these data together with the microfaunal assemblages and radiocarbon dating have permitted interpretation of an outline vegetational reconstruction. The best recovery for all palaeoenvironmental disciplines is from the palaeochannel sequences. Both sequences show a trend from saltmarshes with tidal access to freshwater wetland habitats, signifying a major change in palaeoenvironments, resulting in a severance of tidal access.

Feature	Fill	Sample	Microfauna	Diatoms	Pollen	Soil	C14
ATT016	***1603***	1601b	Yes	Yes	Yes	Yes	-
	1604	1601b	Yes	Yes	Yes	Yes	-
	1605	1601b	No	Yes	Yes	Yes	Yes

Table 7: Summary of samples suitable for analysis according to data type/technique

4. CONCLUSION

4.1 DISCUSSION

4.1.1 ***The palaeochannel and alluvial deposits***: the presence of the main palaeochannel was confirmed in all four trenches deliberately targeting the feature, although in the majority of cases, its position varied slightly from the proposed alignment based upon known aerial photographs of the area. In all instances where it was examined, the palaeochannel was found to be entirely sterile, in terms of cultural material. It was also identified as having been cut through material that can be associated with marine alluvial deposits sealing a layer of peat, as originally determined by geo-technical investigations (QUEST 2014) and confirmed by the limited program of borehole sampling (*Section 3.4* above). In addition, several other probable palaeochannels were also identified in ATT016 and ATT029 and may represent tributaries of the main channel. In the majority of cases, the channels had undergone a process of natural silting followed by a period of peat development. The peat development probably represents part of the wider Heysham Moss, located to the north of the PDA, which has been suggested to date from the Flandrian II/III Transition onwards (essentially the Mesolithic to Neolithic transition, *c* 4000 cal BC). The exception to this sequence was the peat, thought to be re-deposited in the post-medieval ditch, identified in ATT024, which produced two radiocarbon dates indicative of peat formation during the Bronze Age.

4.1.2 In addition to the main sequence of the palaeochannels, the machine sondages, excavated in various trenches, each demonstrated the same stratigraphic sequence of alluvial flood deposits. At no point was a buried soil horizon identified, although an example of bog wood was identified and sampled in the top of the alluvial clays revealed within ATT023.

4.1.3 The line of the main palaeochannel was subsequently exposed and recorded extending on a south-west/north-east axis through Area A during the strip, map and record programme, but no further investigation of the feature was required during this phase of works.

4.1.4 A number of subsidiary palaeochannels were also identified within the context of the strip, map and record programme and confirmed by limited investigation. In a number of instances the palaeochannels can be directly linked to many of the linear features recorded during the earlier evaluation phase, some of which had already been interpreted as probably natural in origin, while others had previously been highlighted as potentially archaeological in nature. The later group included a curvilinear feature postulated as a possible prehistoric ring ditch or drip gully (ATT005) as well as probable post-medieval ditch features (ATT015). In addition, a number of discrete features were potentially interpreted as possible pits or post holes, but after exposure within the wider areas of the strip, map and record programme, appear in relative isolation or formed part of a wider irregular spread of natural material, probably forming remnants of dips and hollows within the former wetland environment and peat beds of Heysham Moss. While these features have been assigned to a separate phase (Phase 1a), to

that of the main palaeochannel (Phase 1), they are probably contemporary with some aspects of the channel sequence, for example, formation of the peat deposits marking the upper fill.

4.1.5 ***Archaeological remains***: an array of discrete and linear features were identified as potentially archaeological within various trenches during the initial evaluation phase of work. These features were originally sorted according to two broad provisional phases of activity, a potential, but more ambiguous, prehistoric phase (Bronze Age to Roman) and a later post-medieval to modern phase. However, subsequent exposure of many of these features and their wider physical context during the strip, map and record programme, established that many were actually natural in origin, relating to various palaeochannels and marshland features of Phase1-Phase1a. Consequently, the earliest phase of potential prehistoric activity can be entirely refuted on the basis of these additional results. This is supported to some extent by the fact that little development of the PDA can be identified until the late nineteenth century. The Ordnance Survey map of 1848, for example, depicts the area as relatively un-enclosed land, the northern extent of which is identified as Brown Moss, probably a local name for the marshland forming part of the wider Heysham Moss (*ibid*). The general area of the PDA, therefore, probably also marshland until the later post-medieval period. Based upon the palaeoenvironmental results and radiocarbon assay, these conditions were probably established, albeit on a fluctuating basis, from as early as the Holocene period.

4.1.6 With this said, a probable municipal boundary is depicted extending through the site, together with a number of other field boundaries located to its west, and consequently some attempts to drain and reclaim the land may have begun during the post-medieval period, if not before. In this regard, the municipal boundary in particular, may have been established during the medieval or early post-medieval period. This initially may have simply related to the edge of the former marshland, although at some point it was formalised. This appears to have been in the form of a probable hedgerow and later, at least partially, as a substantial V-shaped ditch, as demonstrated by the large linear feature recorded during the strip, map and record programme, extending south-west/north-east across Area A and associated features.

4.1.7 Evidence of this post-medieval phase of enclosure and reclamation was also demonstrated in the form of a large linear feature, initially recorded in Trench ATT024 and further exposed in Area B of the strip, map and record programme. This feature was initially identified and sampled as a probable palaeochannel, but, despite returning radiocarbon dates deriving from a peaty basal fill associated with the Bronze Age, quite clearly aligns with a field boundary depicted on the OS map of 1848 extending on an east/west axis. The Bronze Age date almost certainly relates to the formation of the peat material it was derived from, that was presumably subsequently re-deposited within the later feature. The Bronze Age date therefore has little interpretative value with regard to the feature but does probably indicate that

a marshland environment had been established by and persisted during this period.

4.1.8 The feature in trench ATT024 also clearly interfaced with a second linear, partially exposed but not examined in the north-east corner of Area B, that clearly relates to an associated boundary line extending north/south depicted on the OS map of 1848. A further boundary line depicted on the map can also be related to an additional linear feature exposed but not examined towards the centre of this area. An additional gully, initially exposed in the context of trench ATT013, does not feature on the map, but clearly shares a parallel alignment to the field system established by this point around it and probably relates to attempts to drain the land.

4.1.9 A small cluster of short but relatively well defined linear features were also identified, initially within ATT020, and subsequently within the south-east corner of Area A. These features are probably contemporary but did not produce any dateable evidence and cannot be related to any significant boundary features depicted on early OS mapping. Their purpose and date are therefore unclear, but, given the overwhelming emphasis of other archaeological features relating to post-medieval activity, they have been assigned to the same phase.

4.1.10 A series of linear and discrete (pit) features producing post-medieval or modern material were also identified within ATT019, ATT039, ATT041 and potentially ATT036. This late activity demonstrates a focus upon the periphery of the site, particularly towards the south-eastern corner of the PDA, although there is no clear pattern or function to their distribution. These features were not included in the subsequent phase of mitigation.

4.1.11 Despite the potential for prehistoric activity highlighted at the site, ultimately the area of development has yielded very little of archaeological significance. Those features unequivocally attributed to human activity have proven almost entirely to be of post-medieval or modern origin and of little import, other than demonstrating that the area remained relatively undeveloped until its reclamation during recent centuries. The palaeoenvironmental sequence has, however, yielded slightly more interesting results relating to the specific historical environmental development of the site, which, in turn, may contribute to an understanding of the development and use of the wider area.

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6. ILLUSTRATIONS

6.1 FIGURES

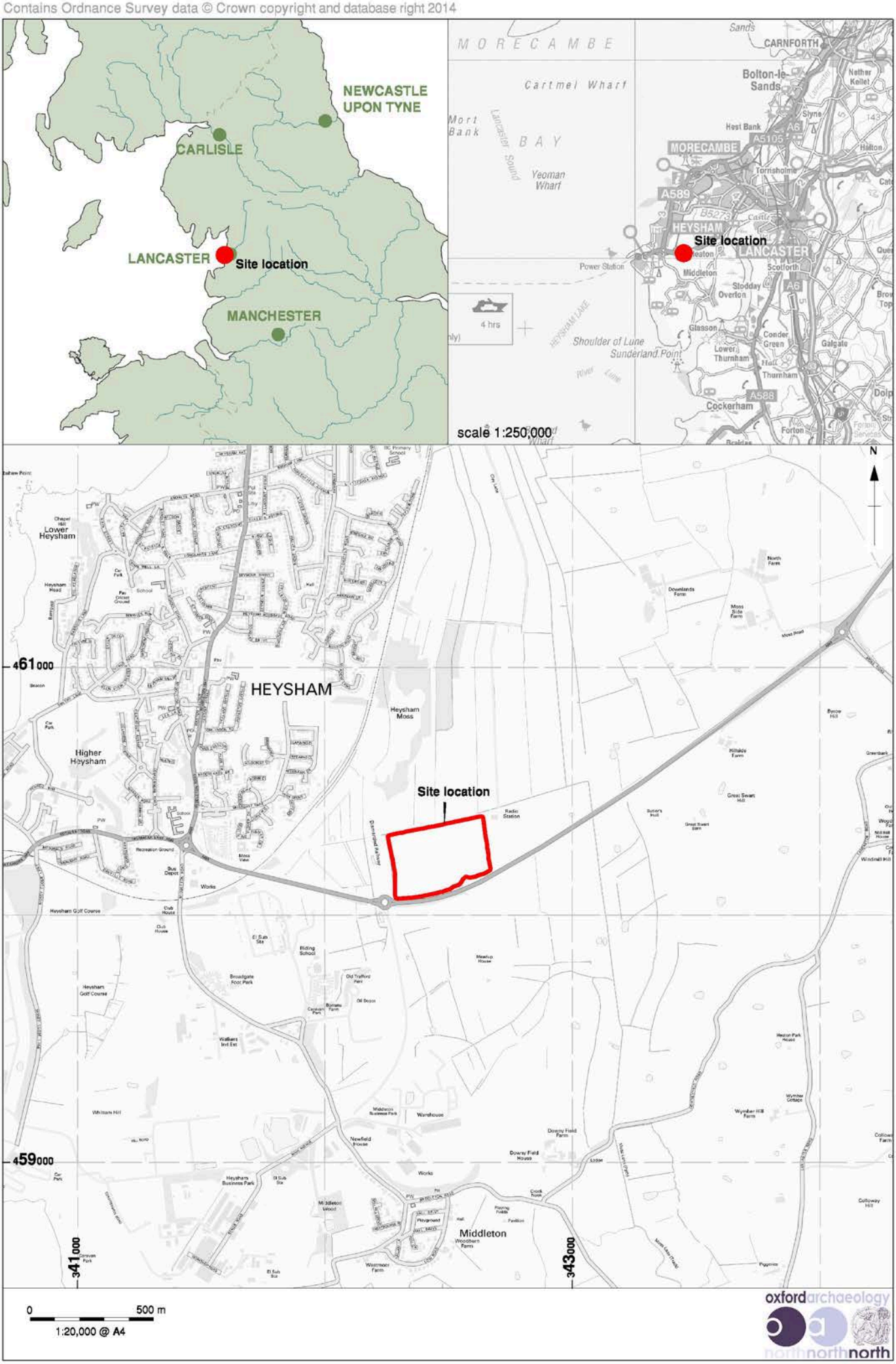

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Figure 1: Site location

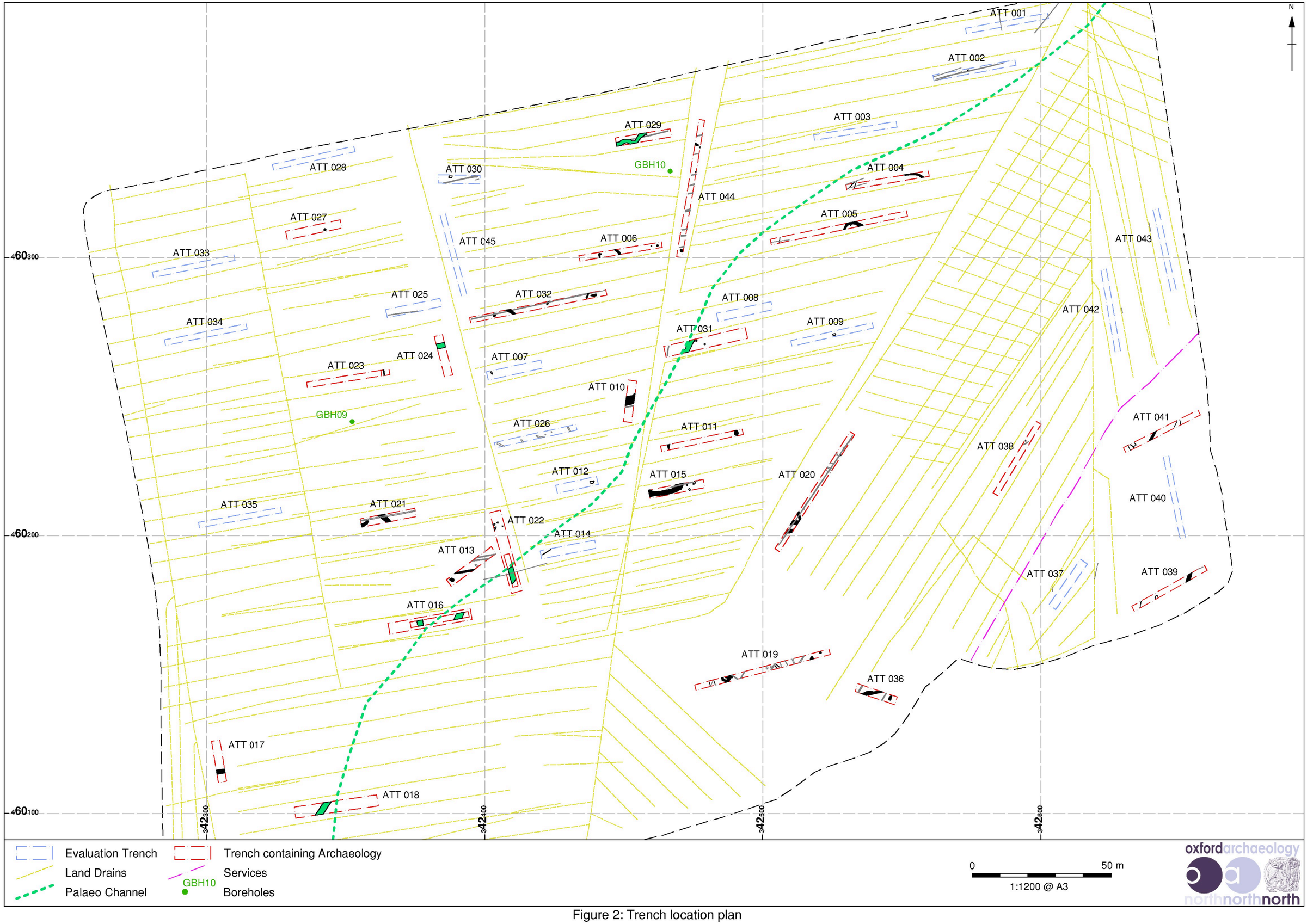

Figure 2: Trench location plan

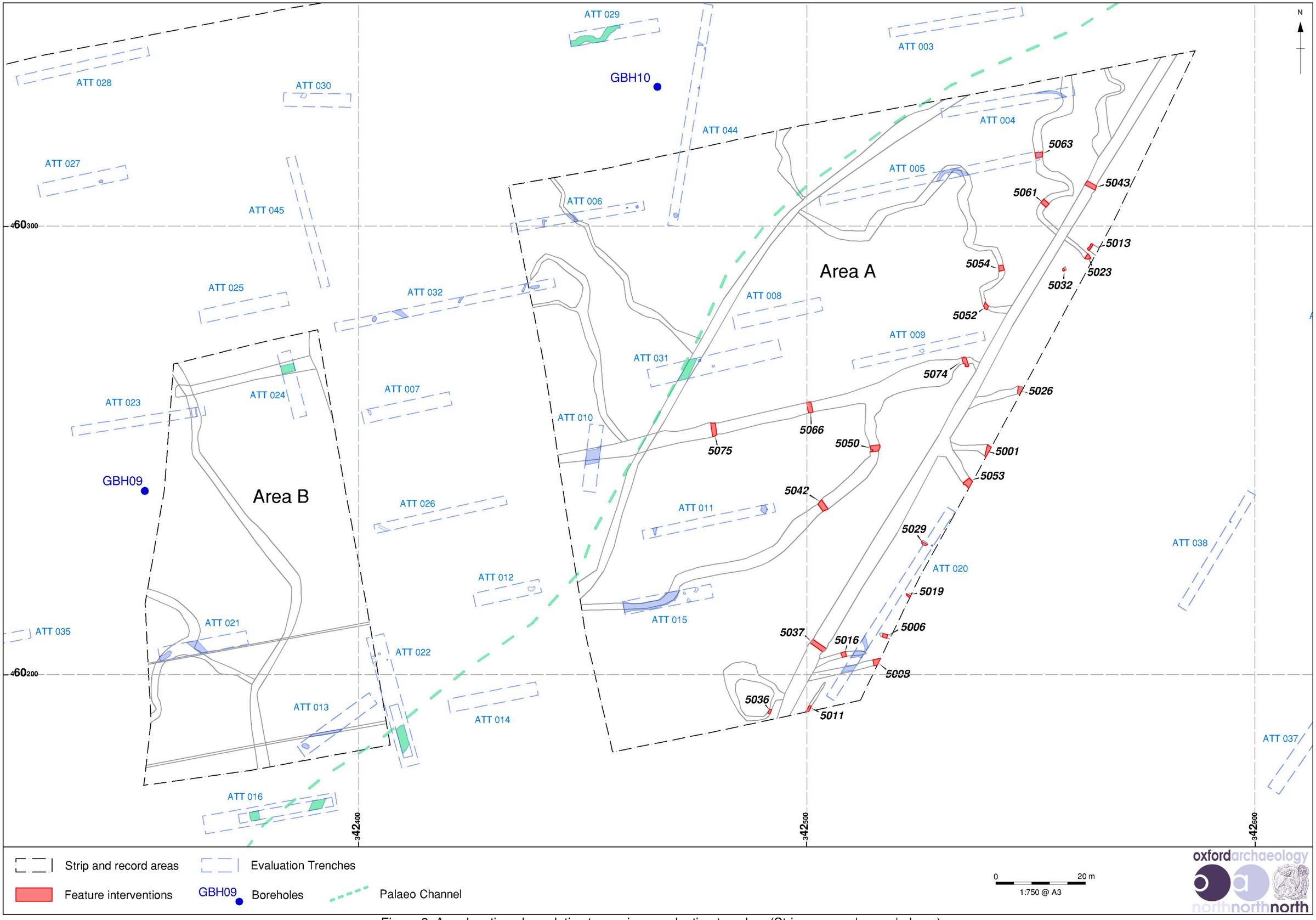

Figure 3: Area location plan relative to previous evaluation trenches (Strip, map and record phase)

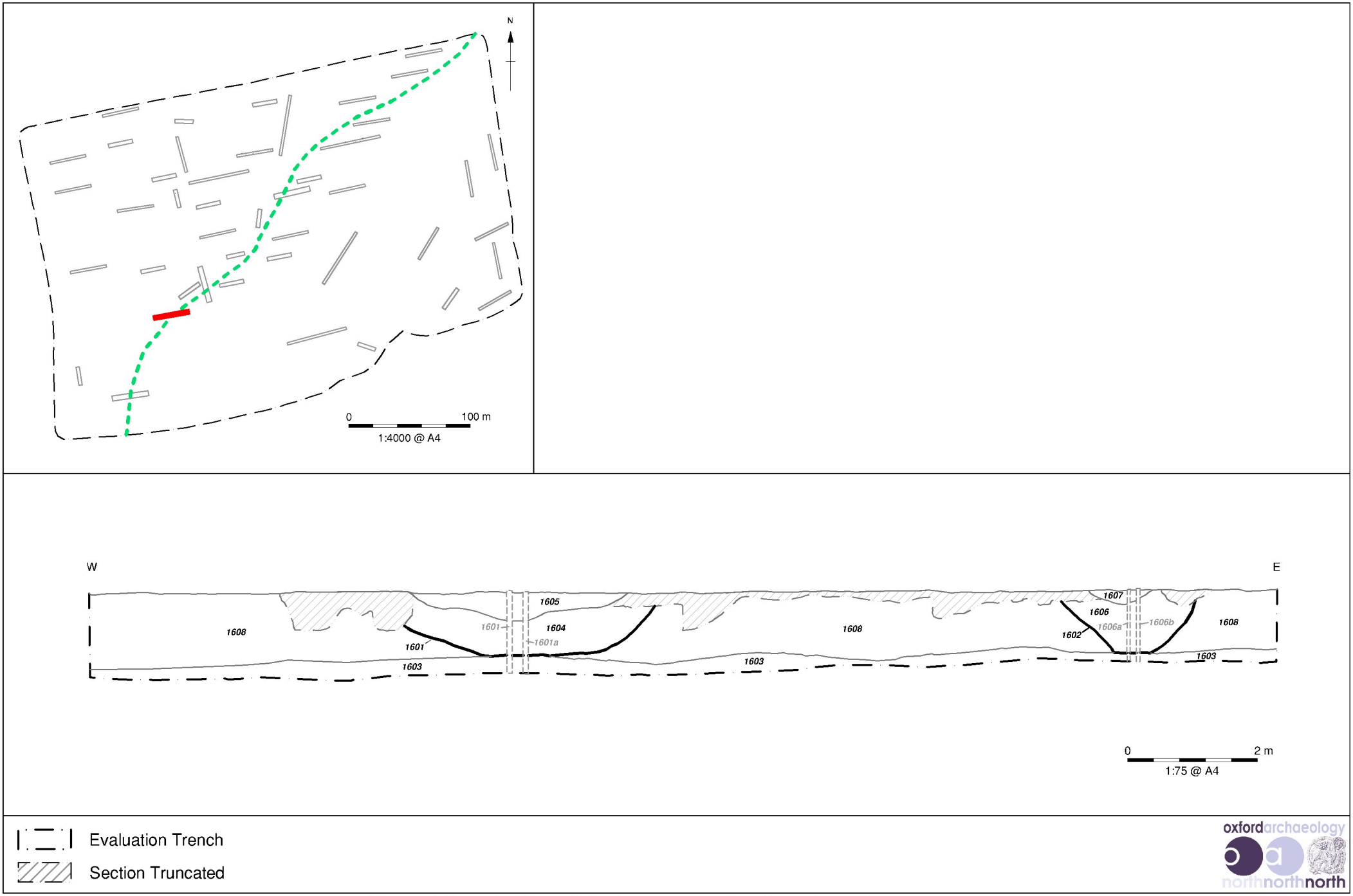

Figure 4: Trench 16, north-facing cross-section through sondage

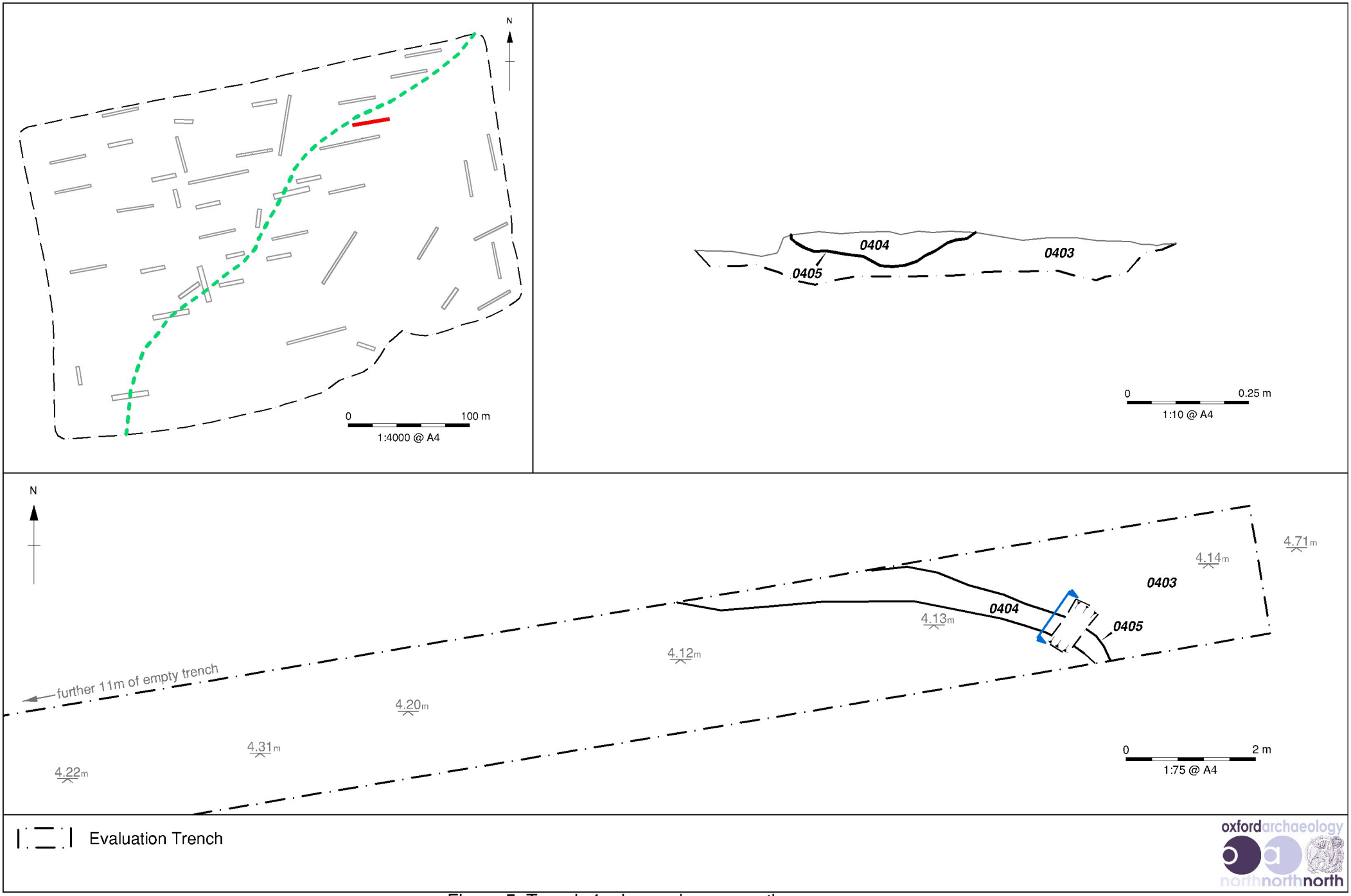

Figure 5: Trench 4, plan and cross-section

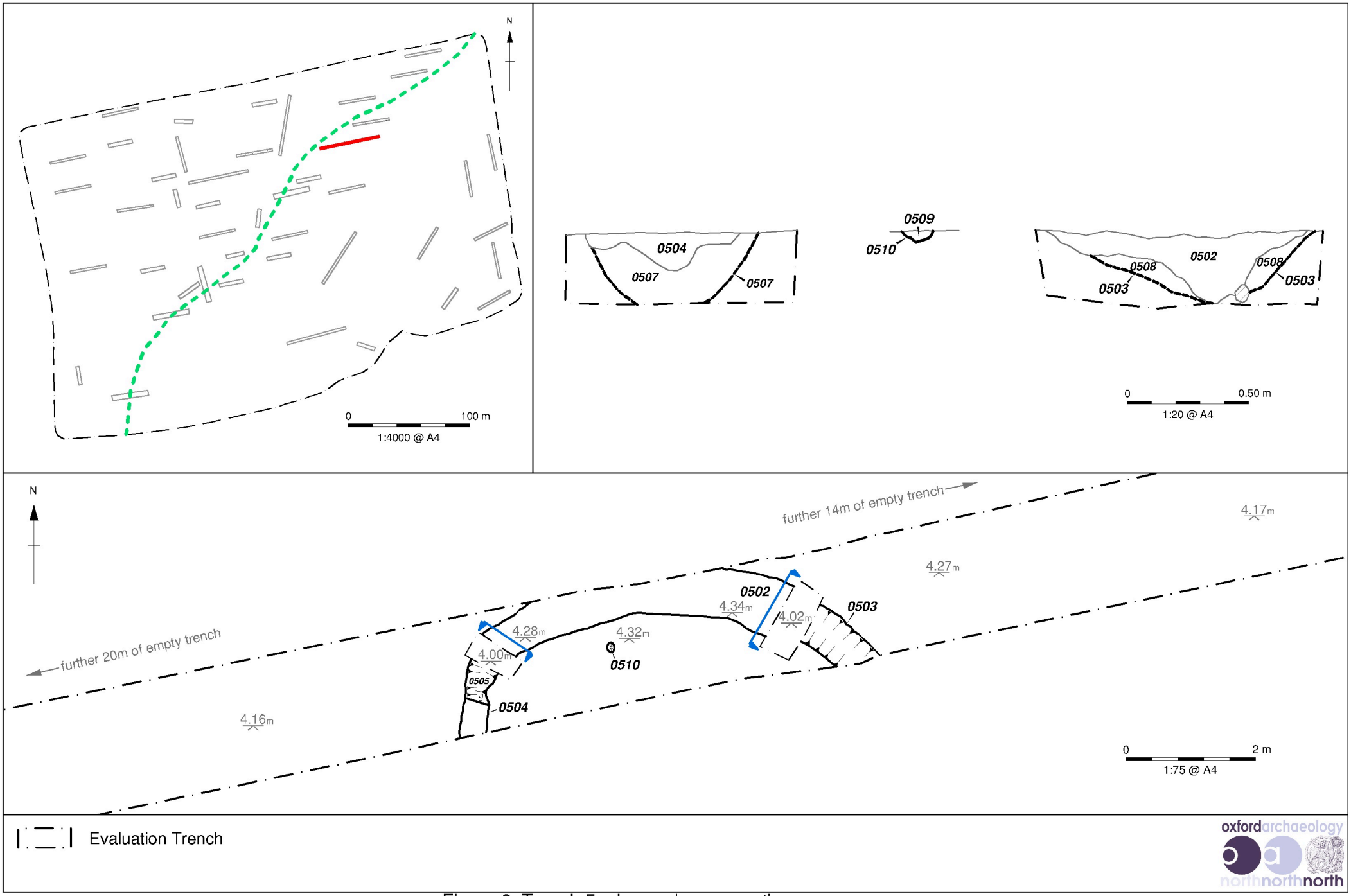

Figure 6: Trench 5, plan and cross-sections

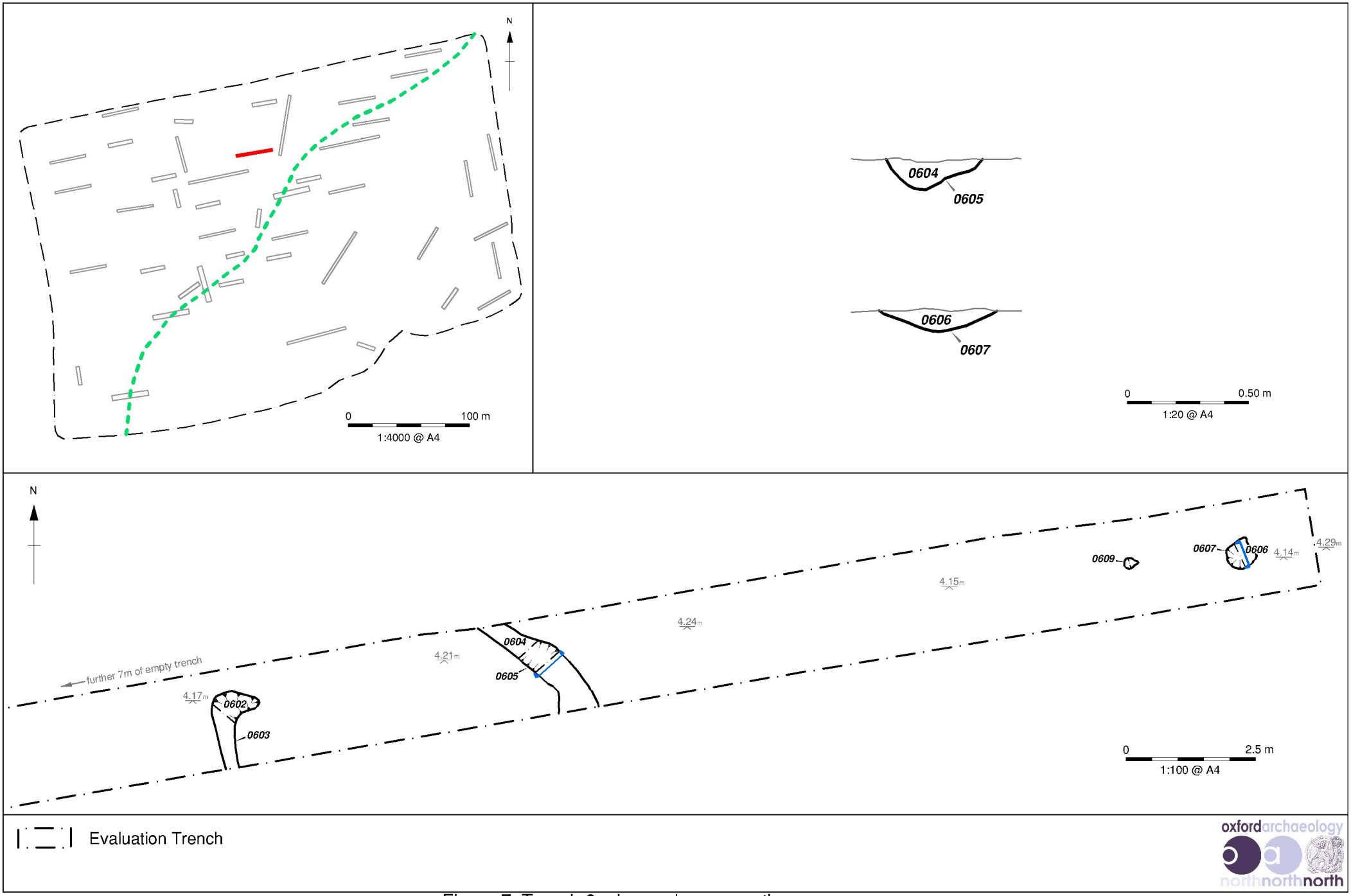

Figure 7: Trench 6, plan and cross-sections

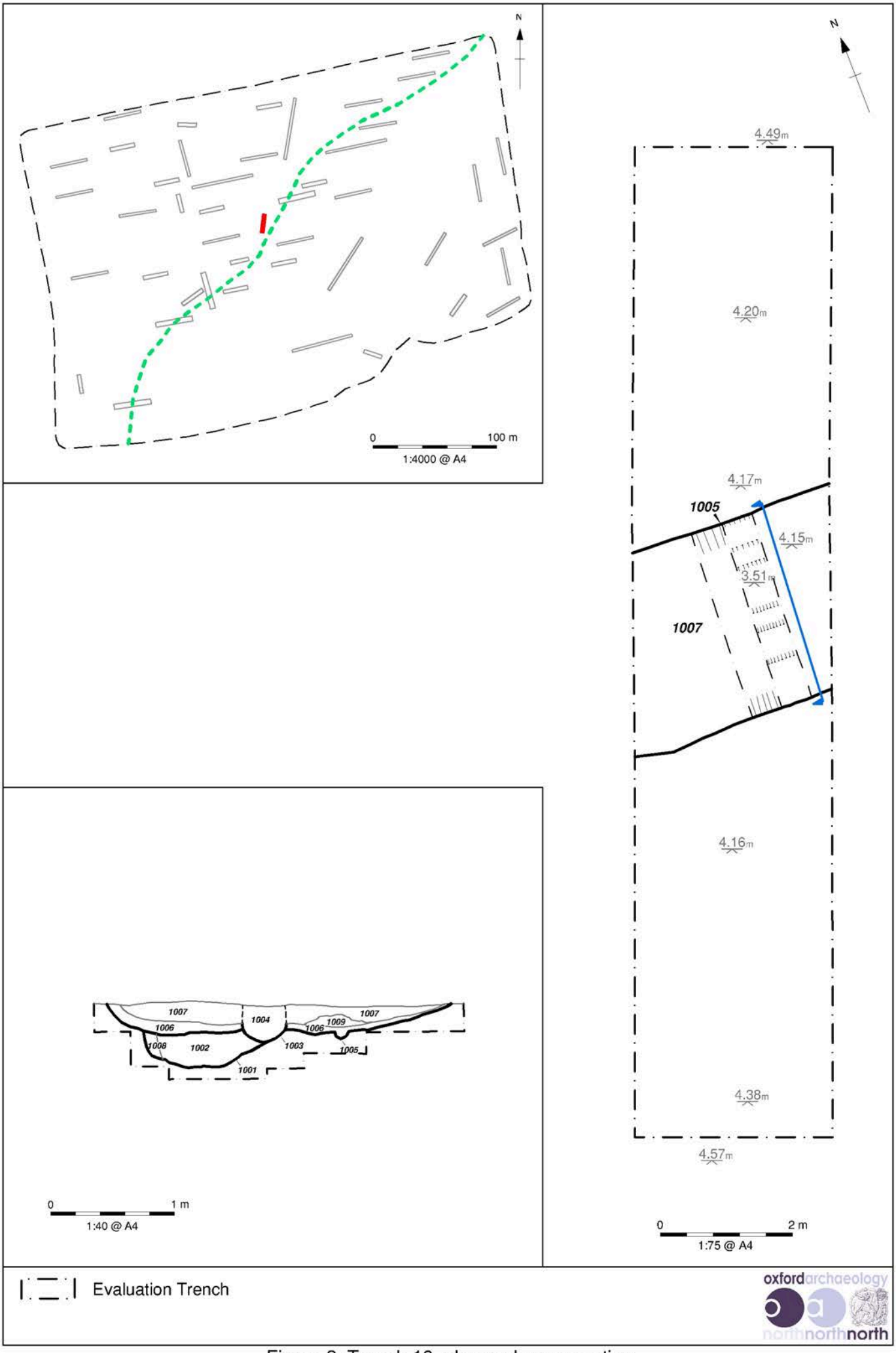

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Figure 8: Trench 10, plan and cross-section

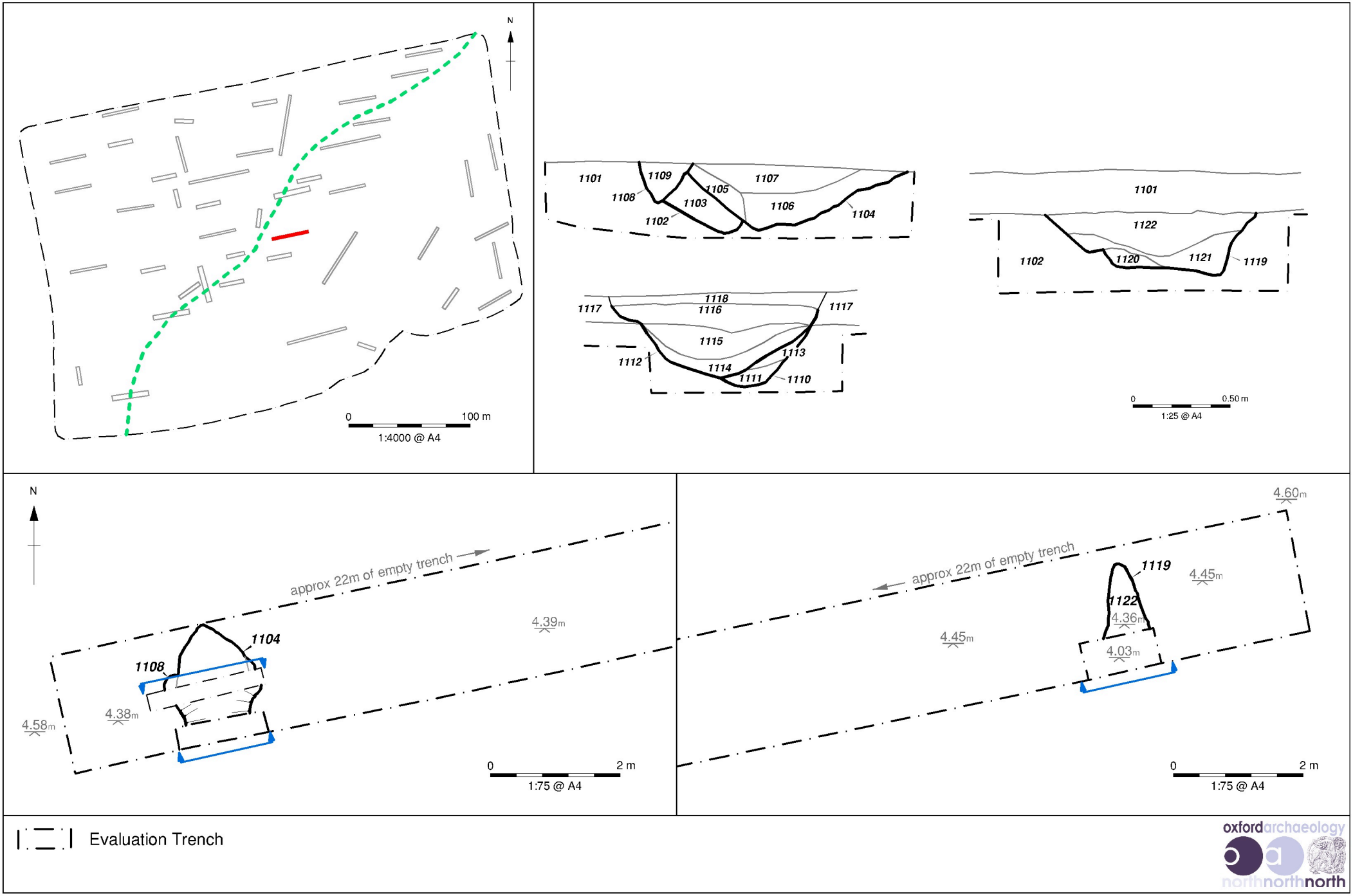

Figure 9: Trench 11, plan and cross-sections

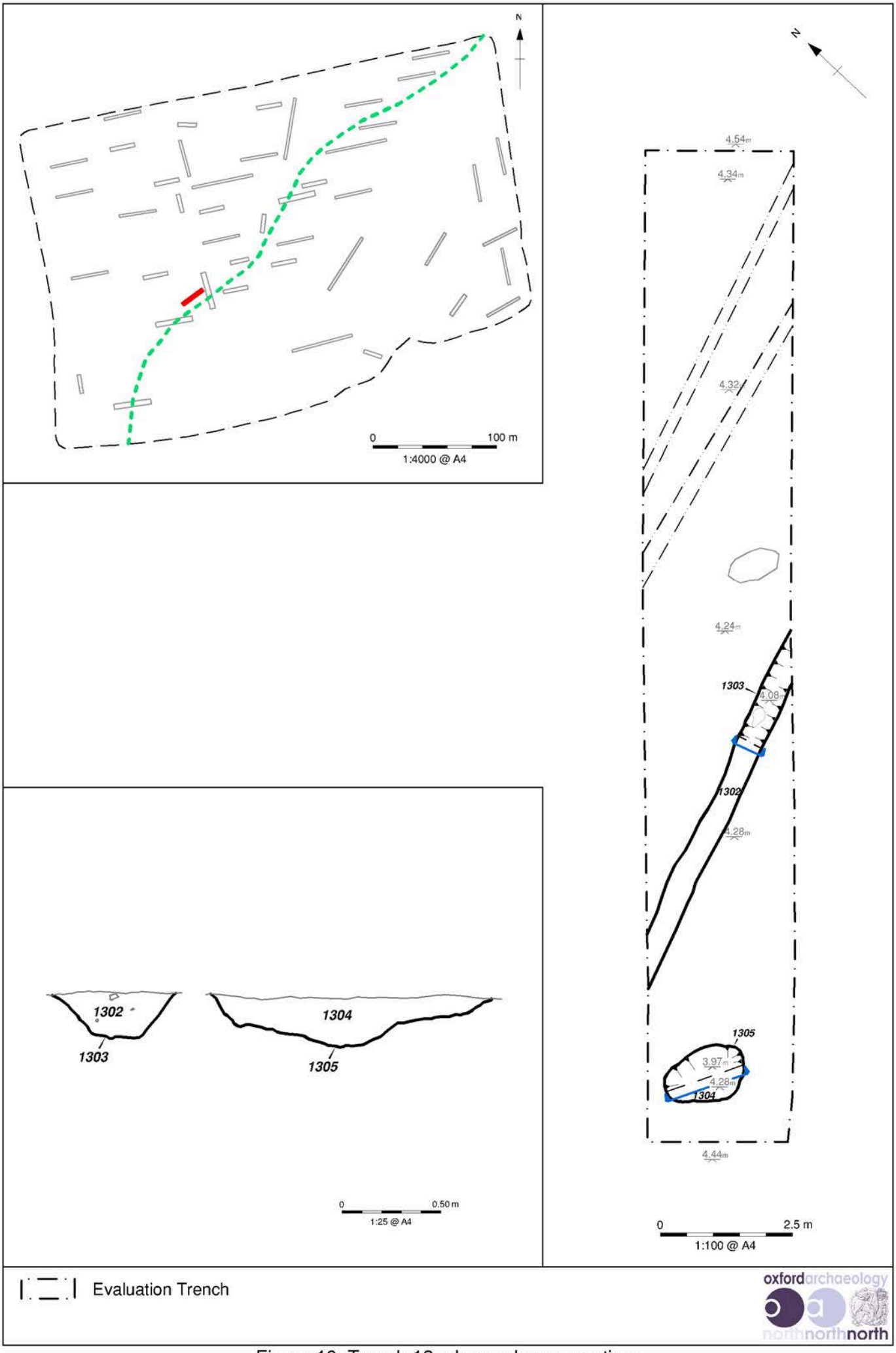

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Figure 10: Trench 13, plan and cross-sections

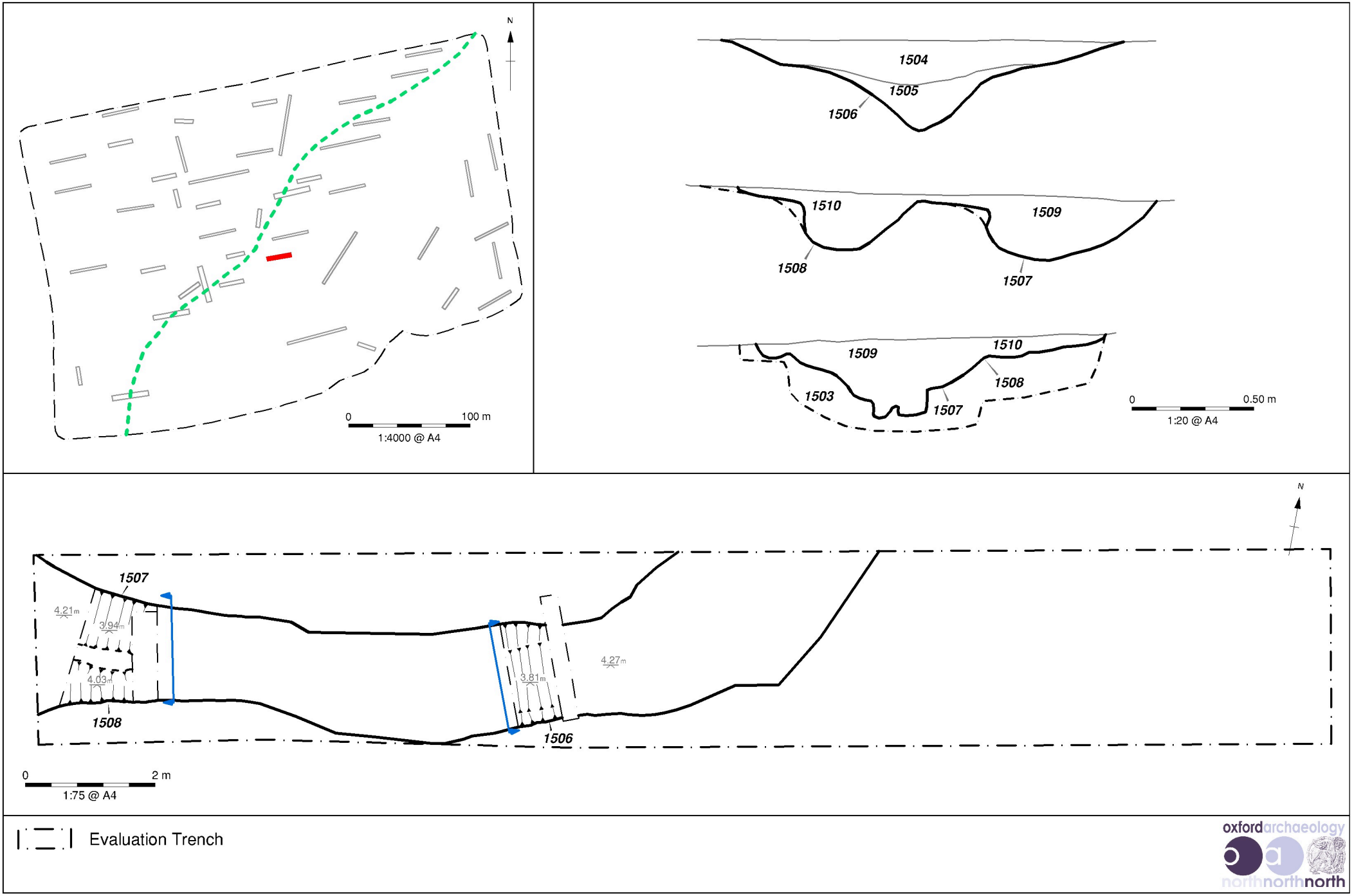

Figure 11: Trench 15, plan and cross-sections

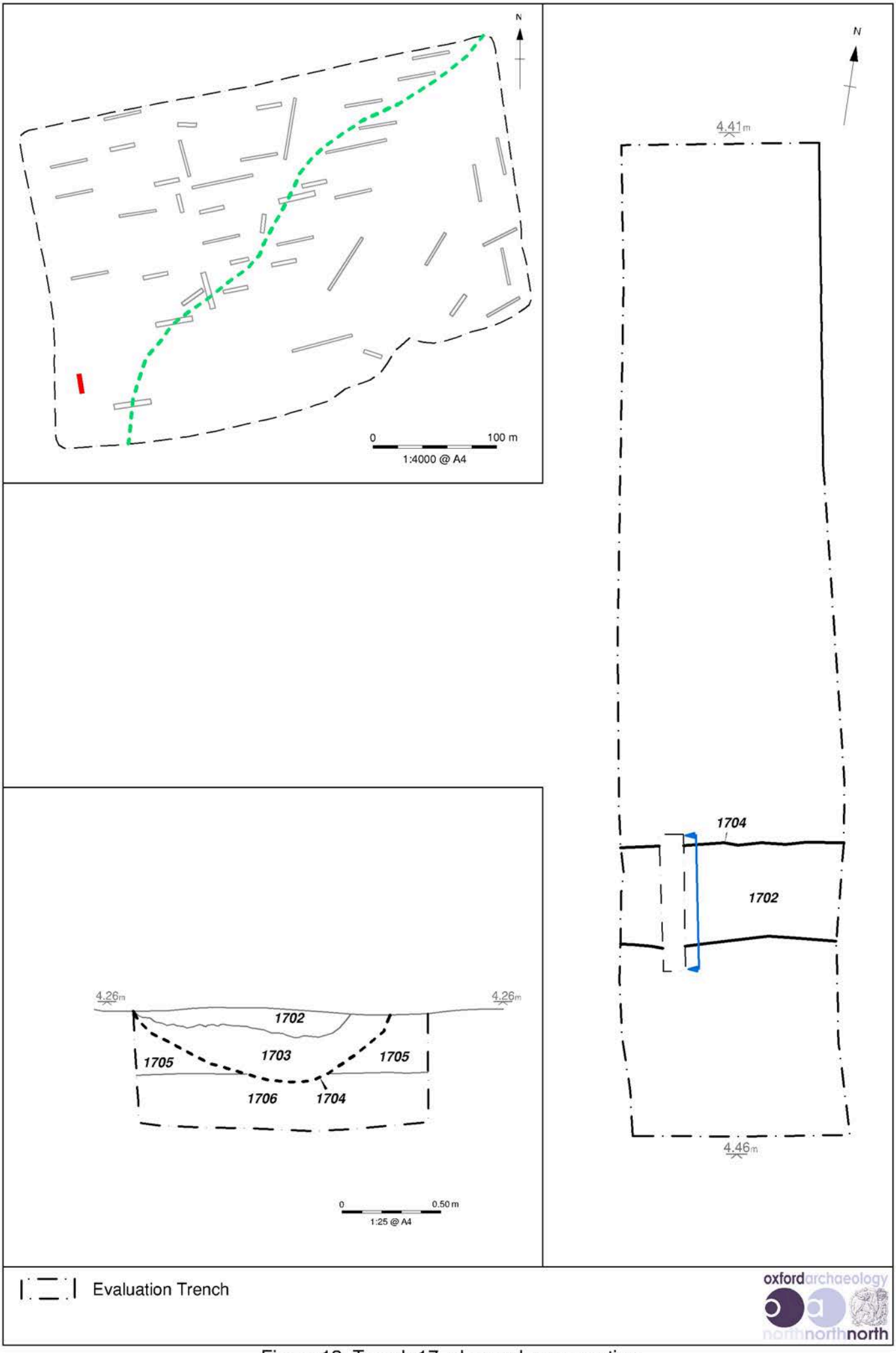

Figure 12: Trench 17, plan and cross-section

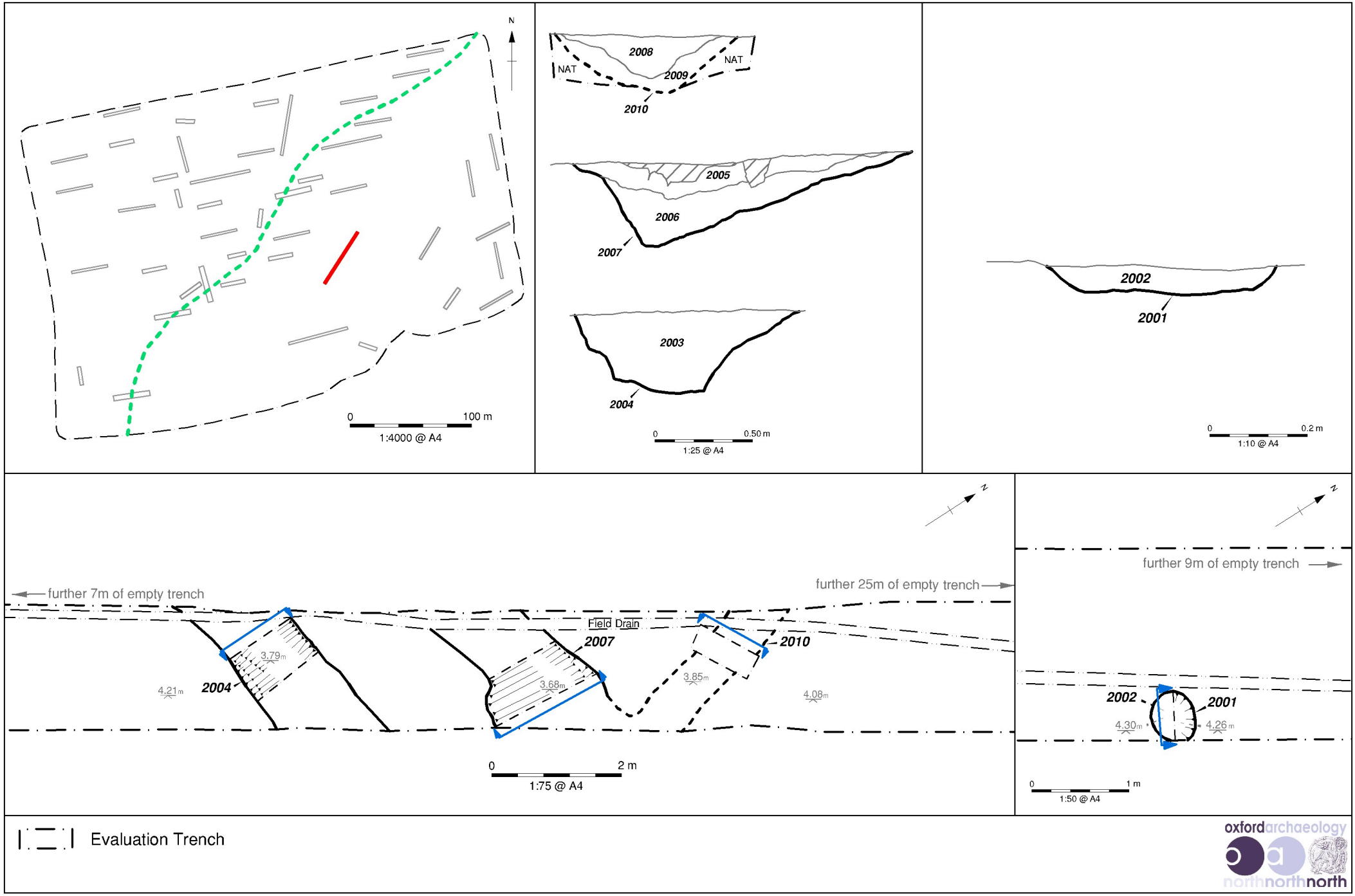

Figure 13: Trench 20, plan and cross-sections

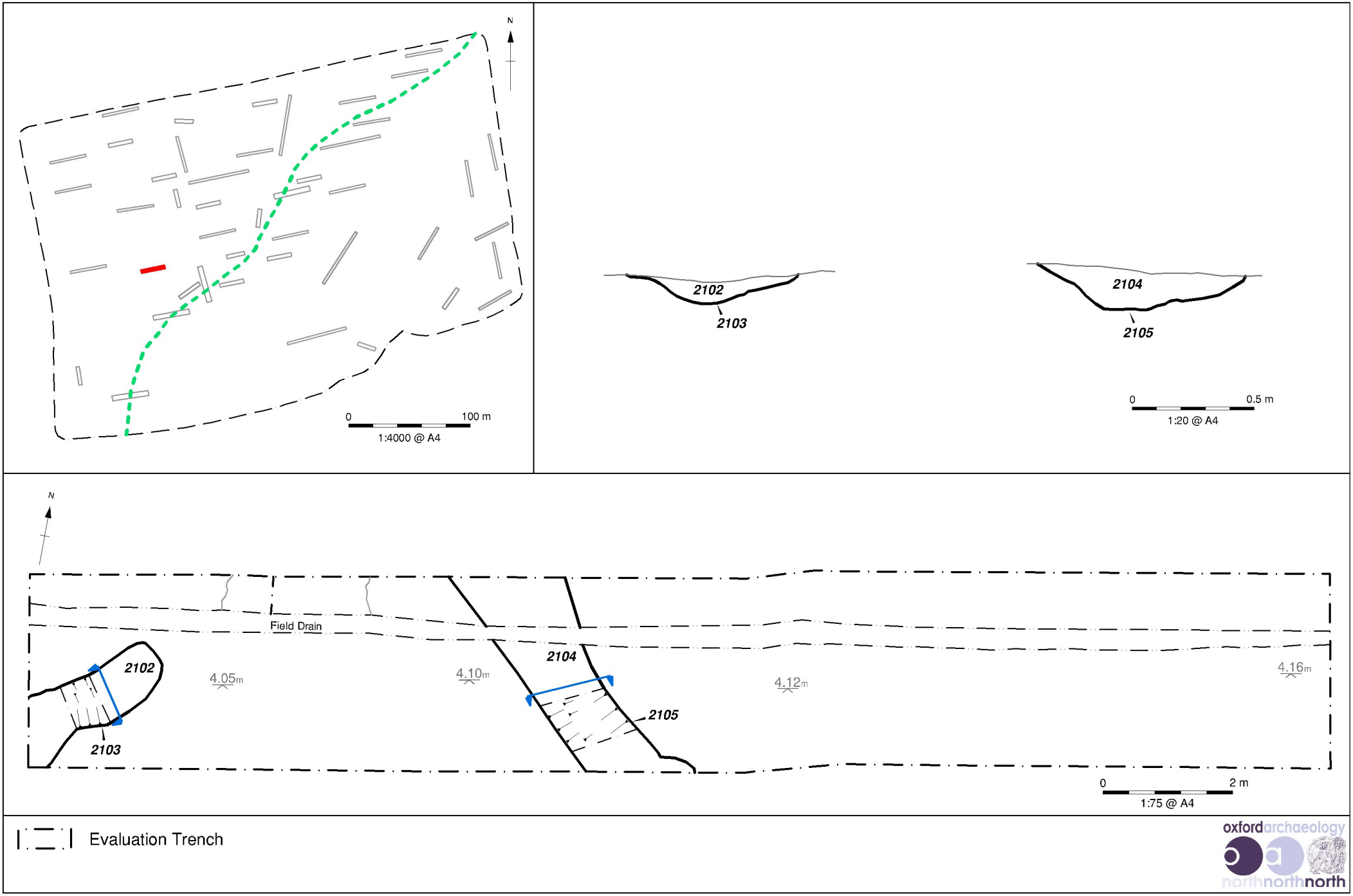

Figure 14: Trench 21, plan and cross-sections

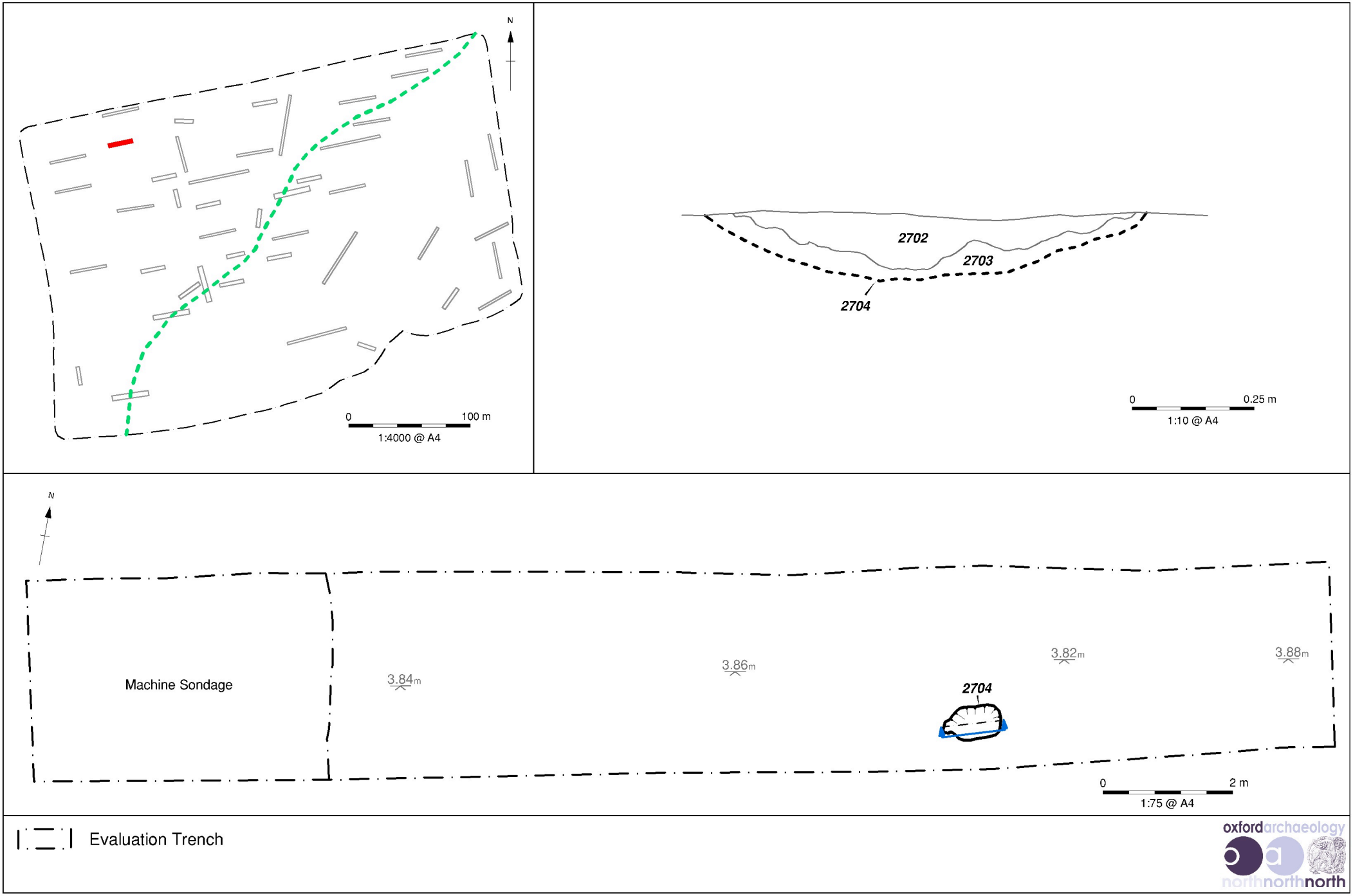

Figure 15: Trench 27, plan and cross-section

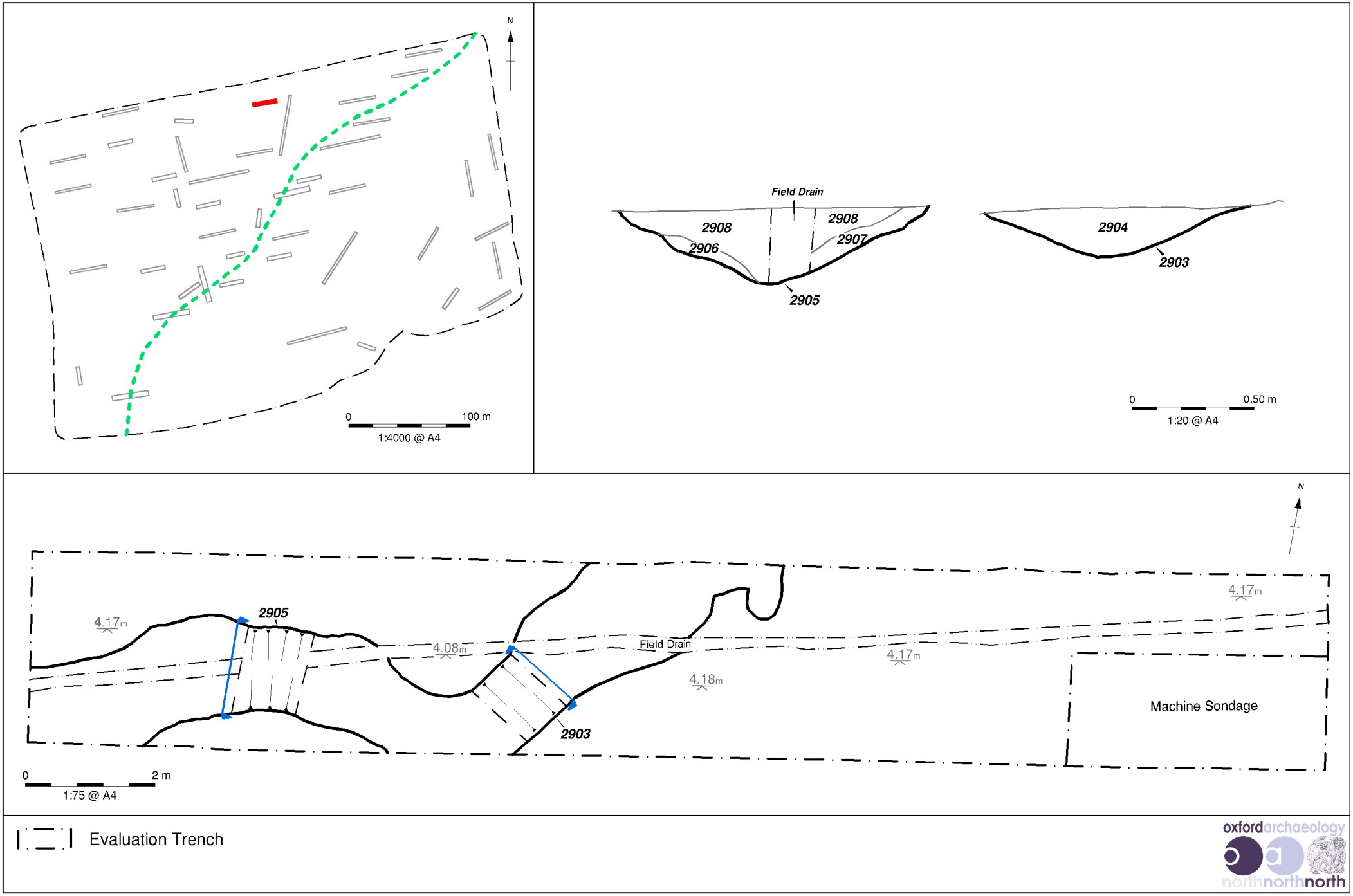

Figure 16: Trench 29, plan and cross-sections

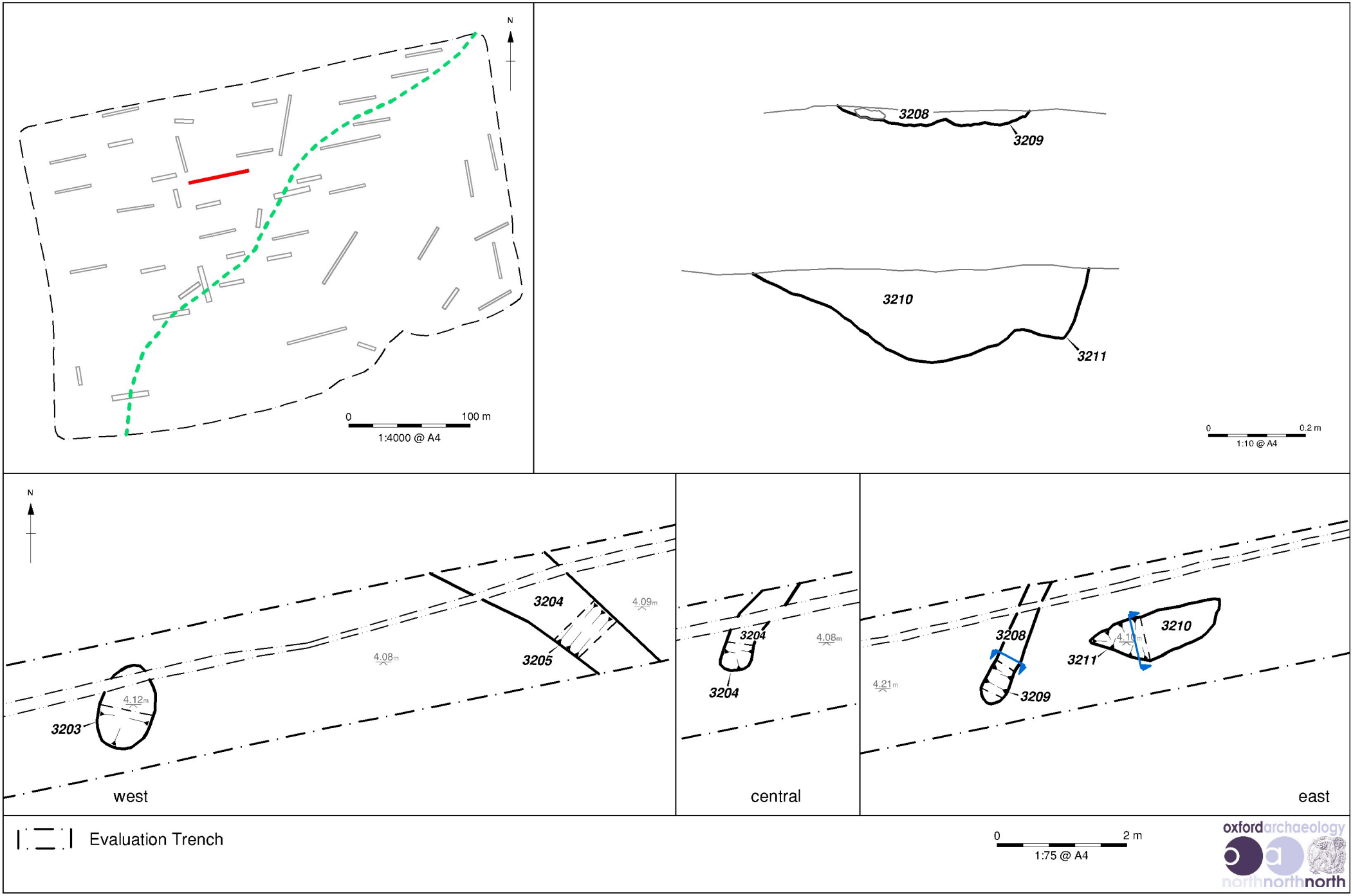

Figure 17: Trench 32, plan and cross-sections

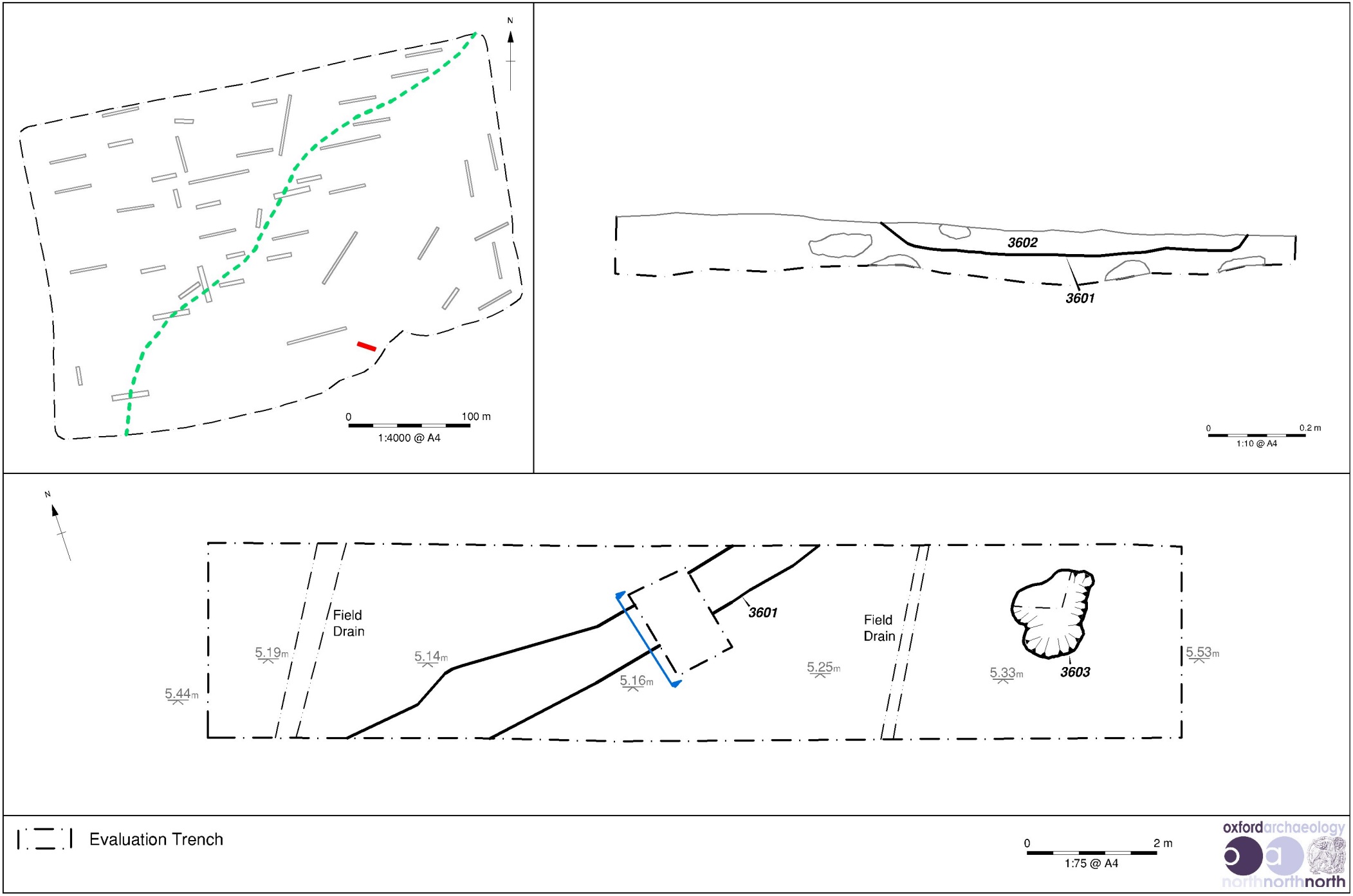

Figure 18: Trench 36, plan and cross-section

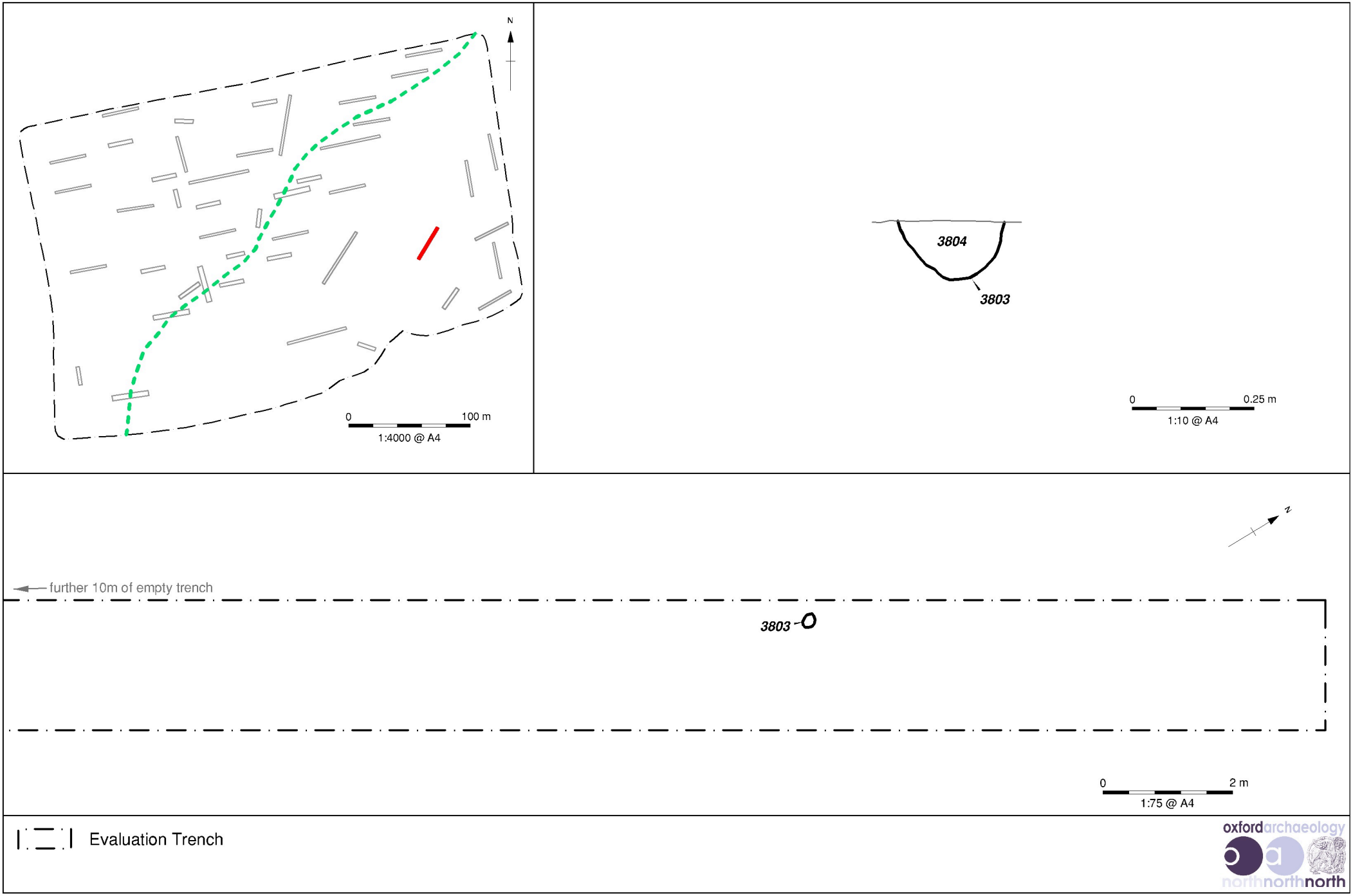

Figure 19: Trench 38, plan and cross-section

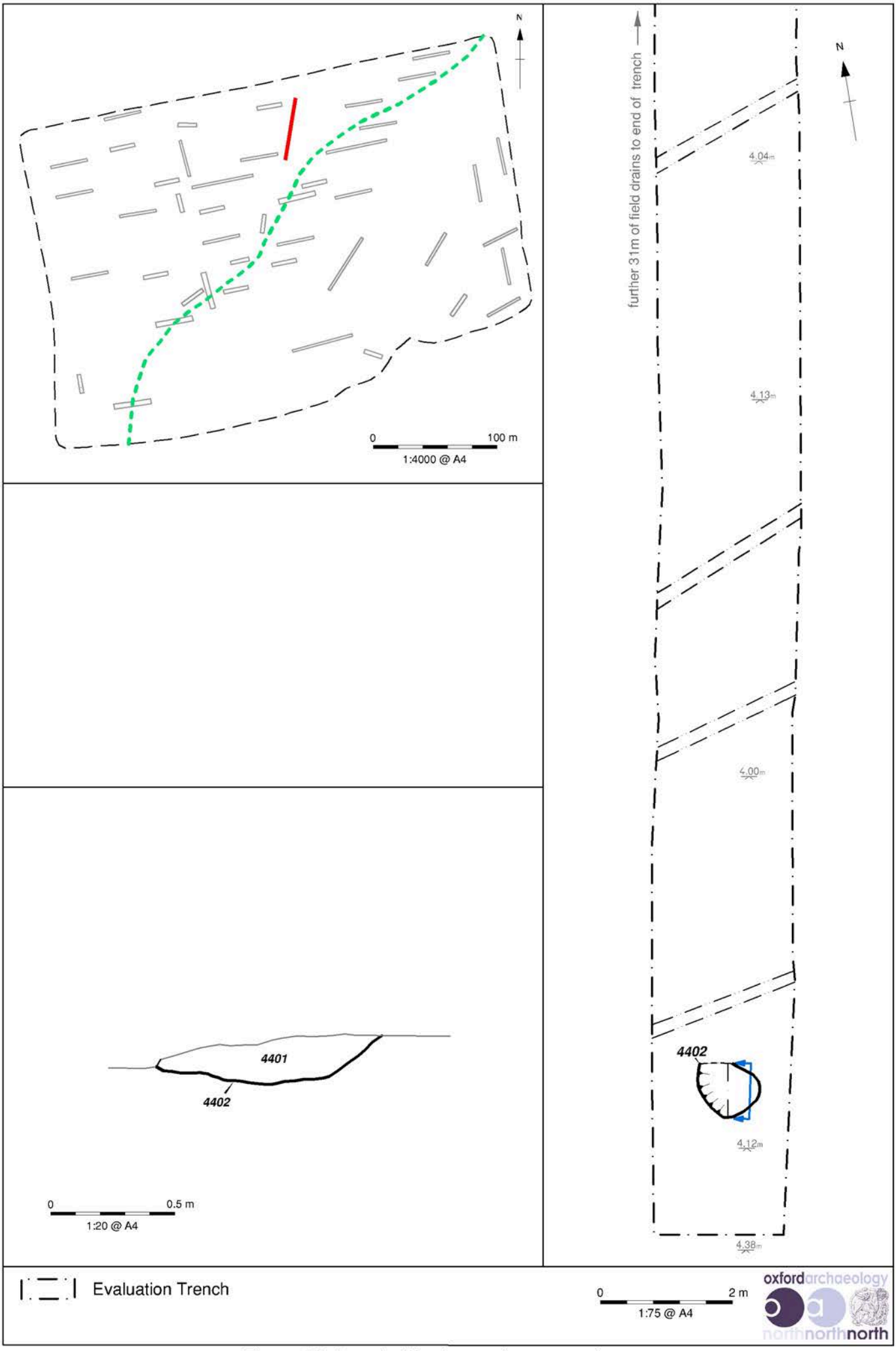

Figure 20: Trench 44, plan and cross-section

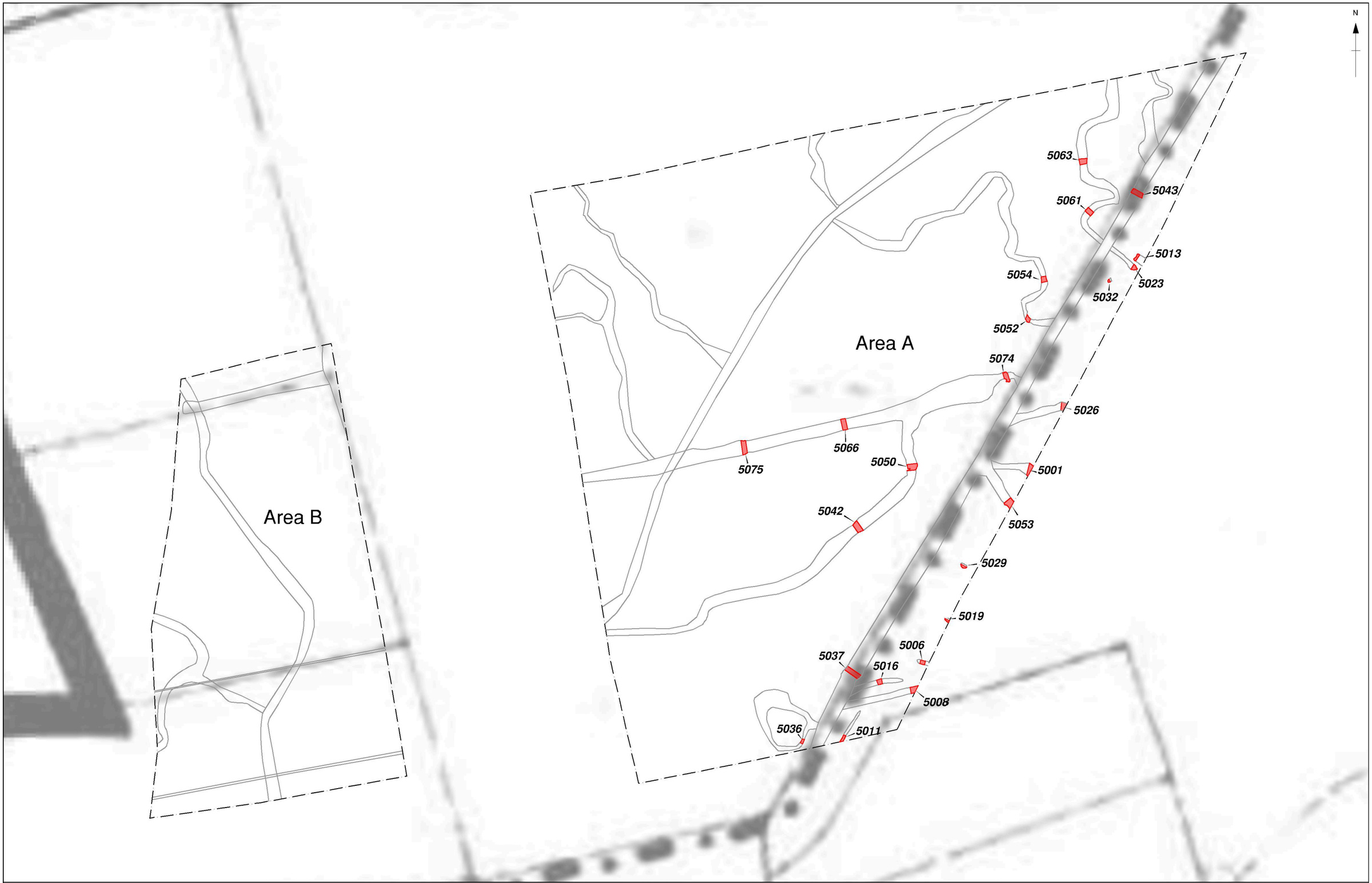

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Figure 21: Strip and Record features superimposed on the Ordnance Survey 6":1 mile first edition map of 1840

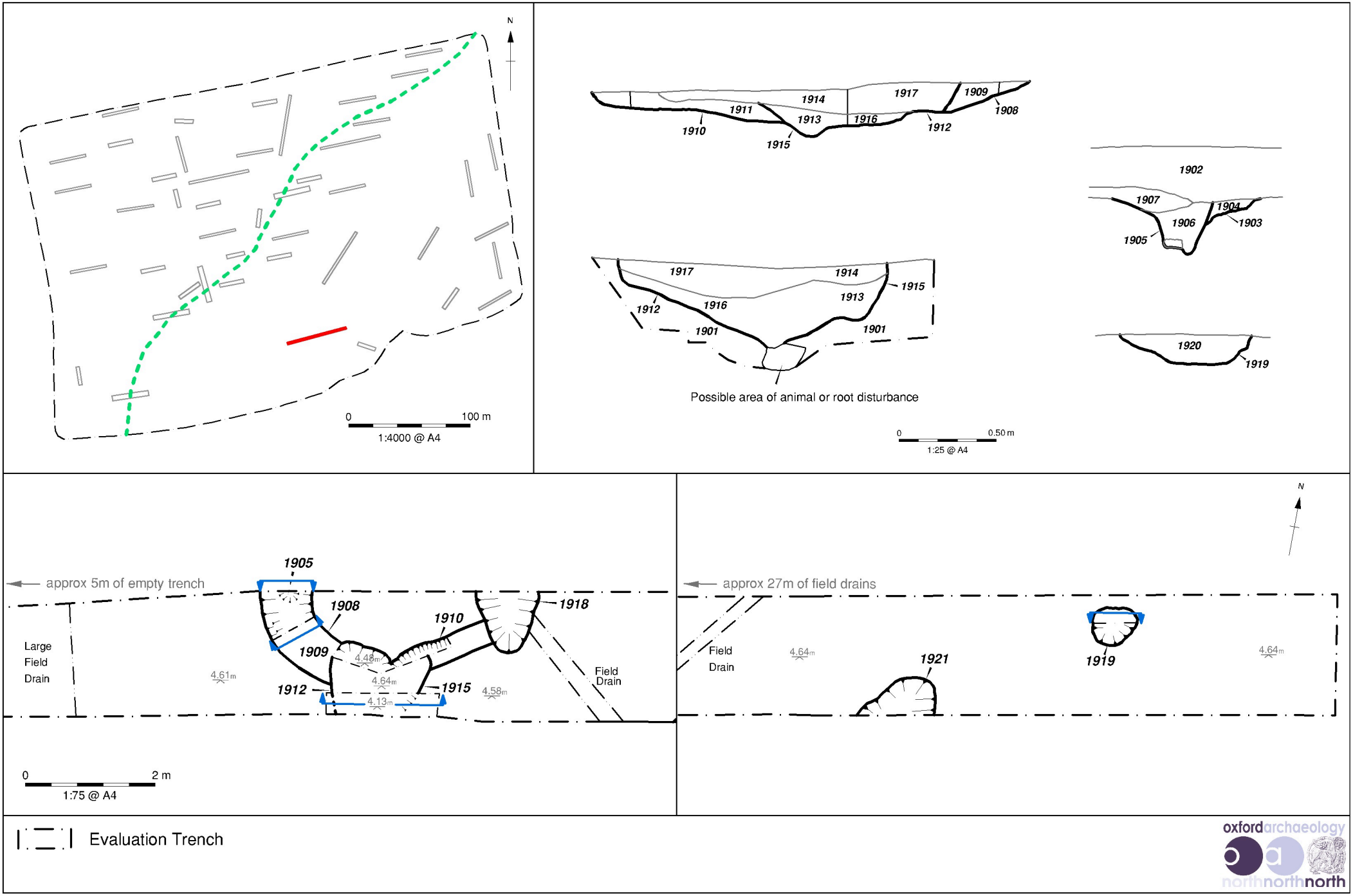


Figure 22: Trench 19, plan and cross-sections

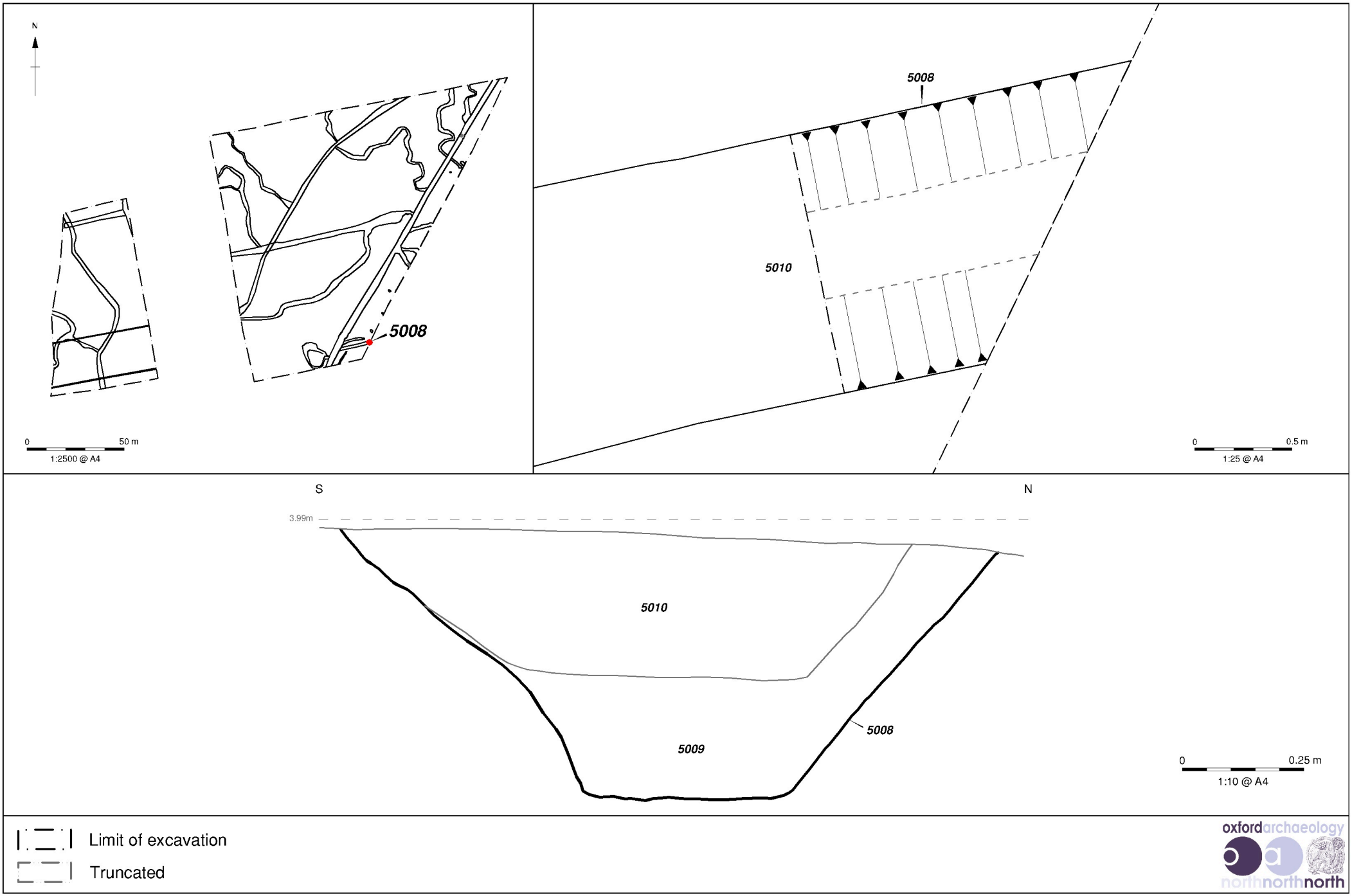


Figure 23: Plan and section of ***5008***

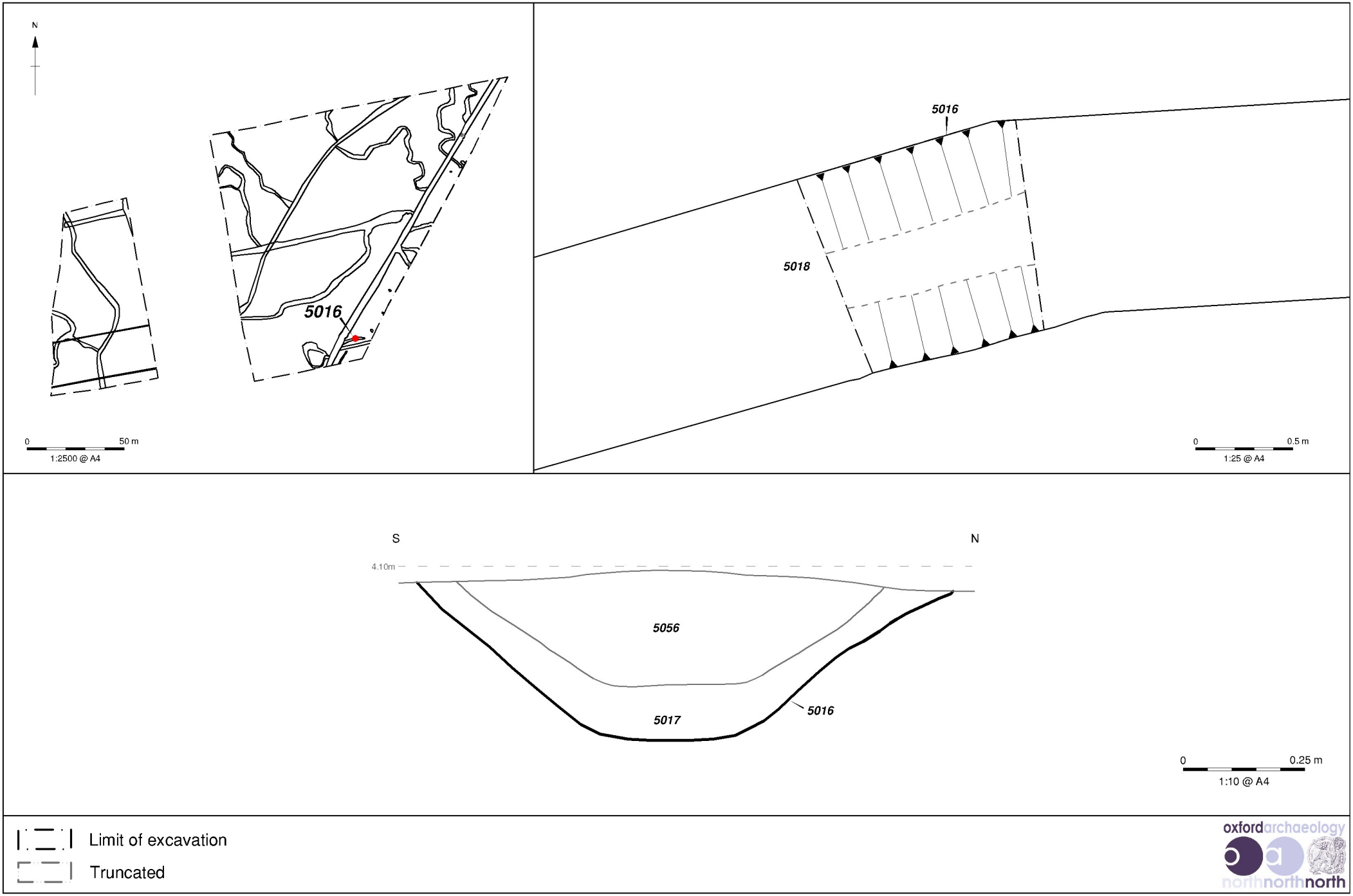


Figure 24: Plan and section of ***5016***

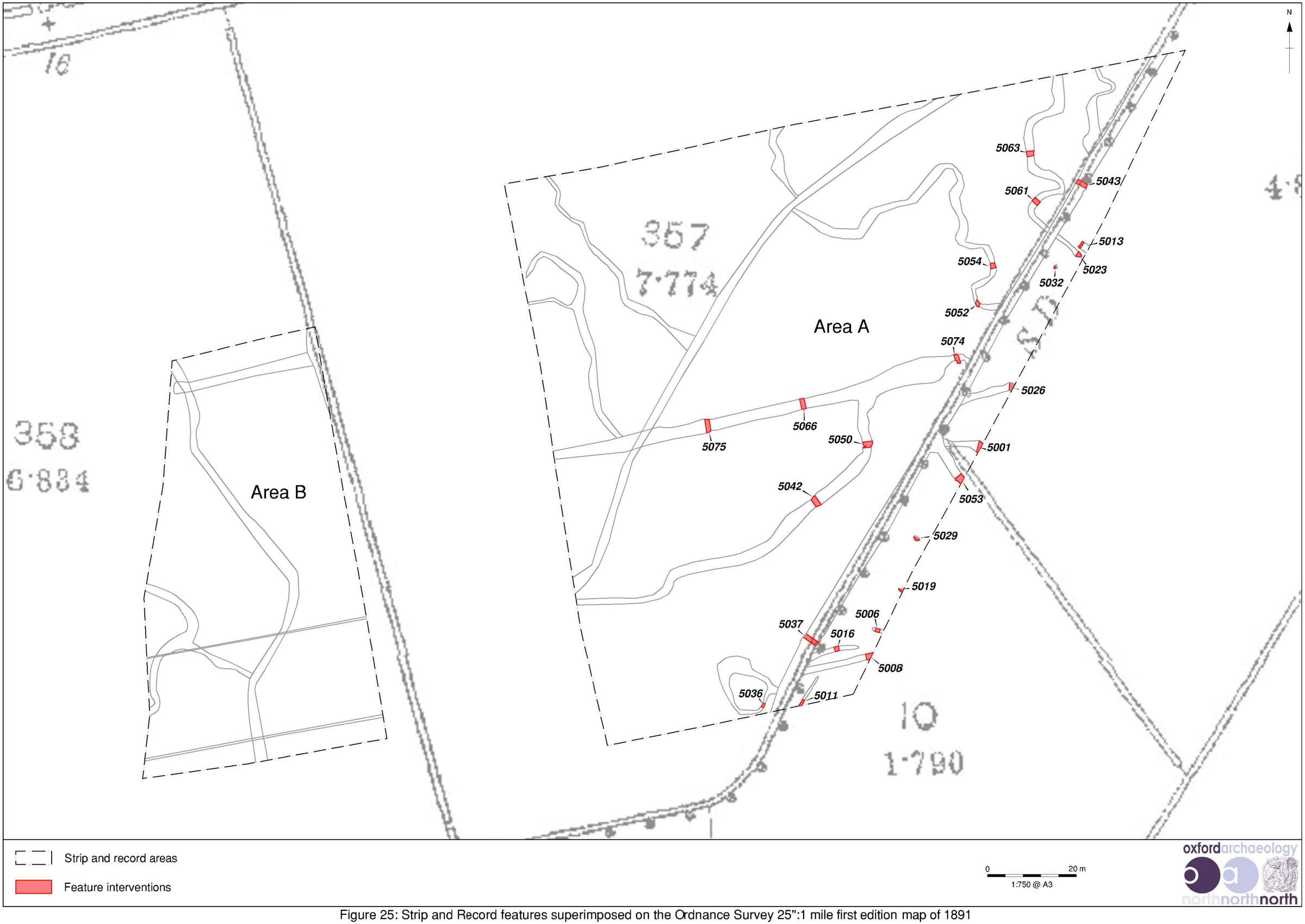


Figure 25: Strip and Record features superimposed on the Ordnance Survey 25":1 mile first edition map of 1891

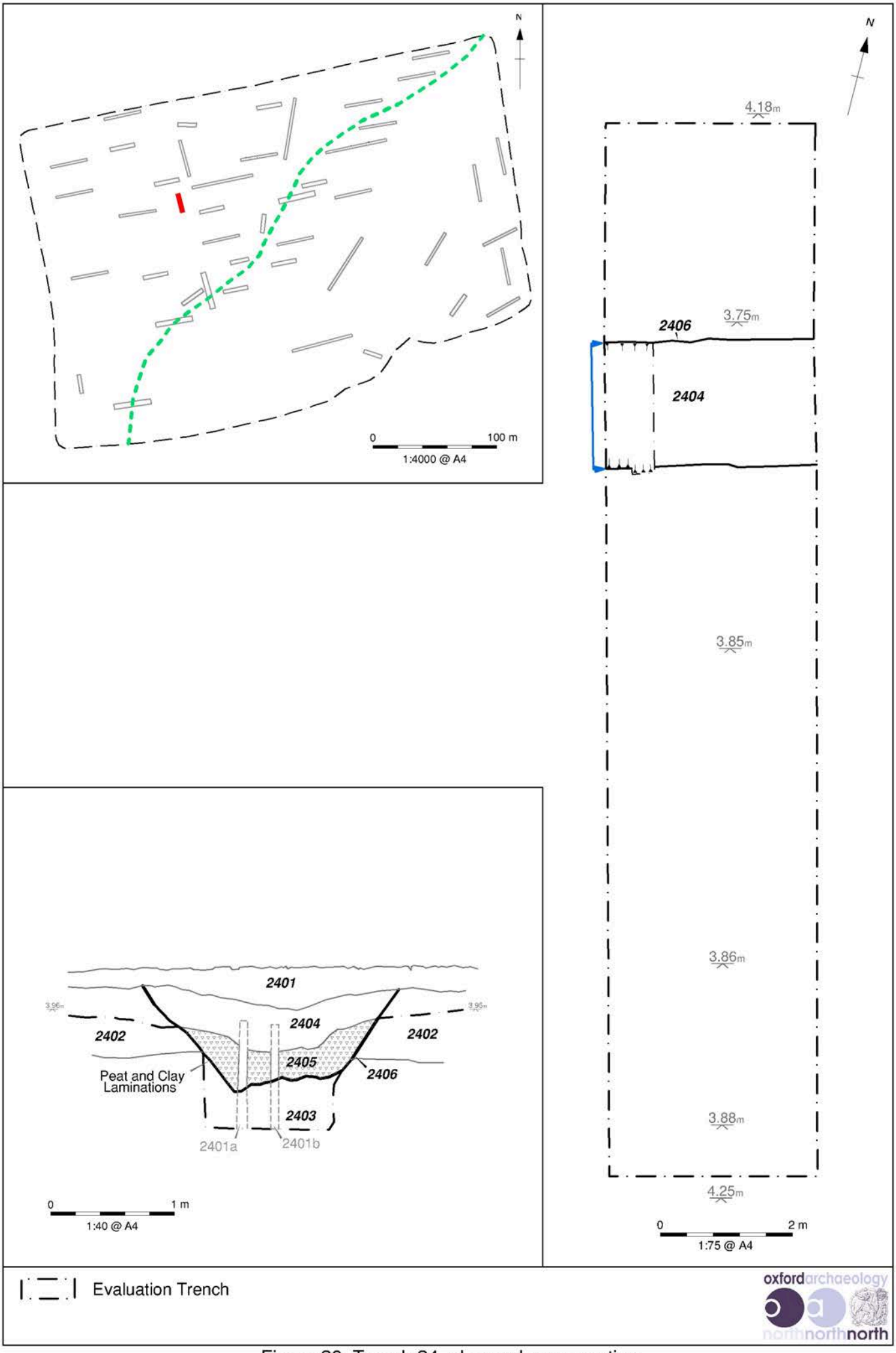


Figure 26: Trench 24, plan and cross-section

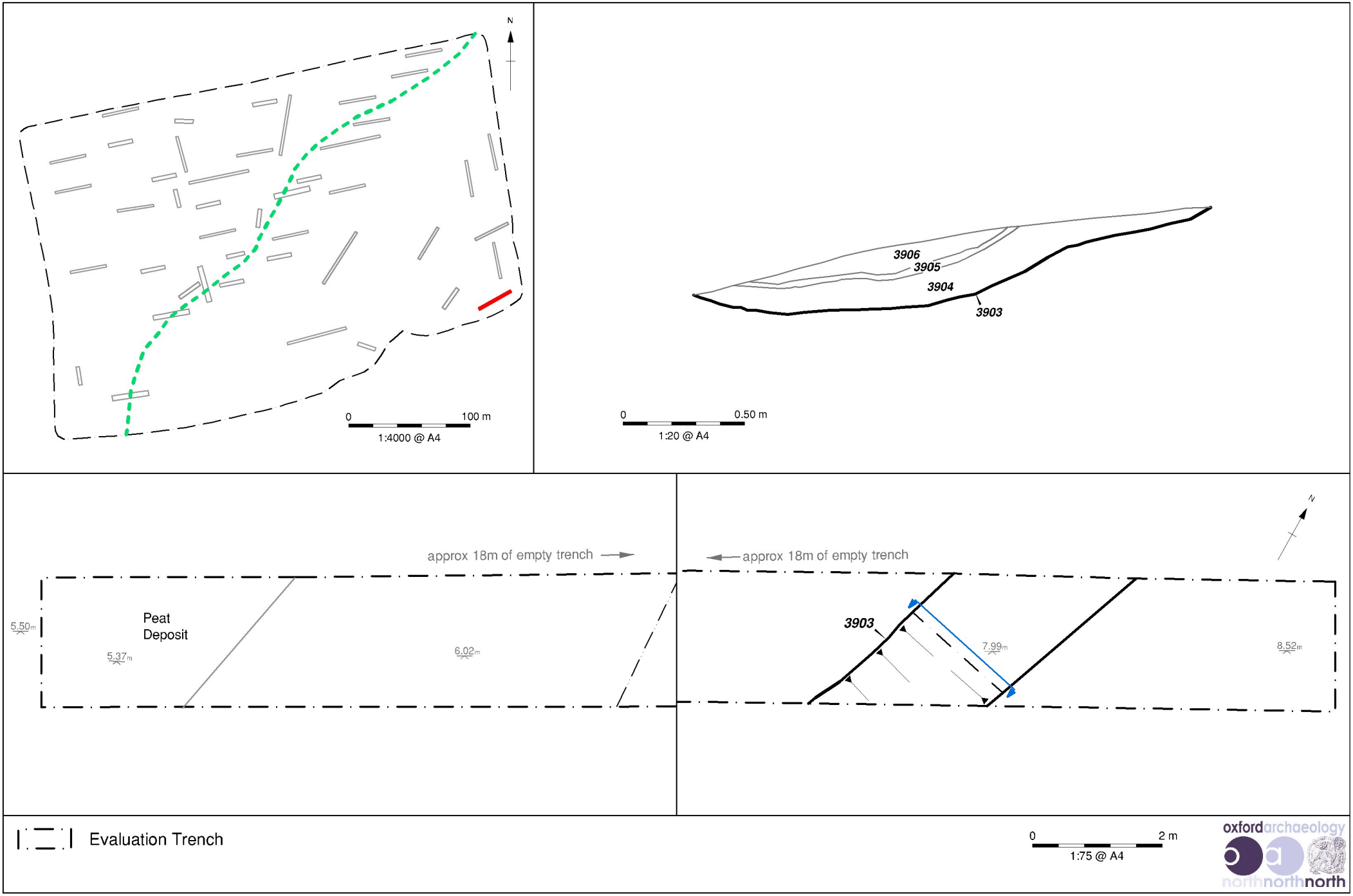


Figure 27: Trench 39, plan and cross-section

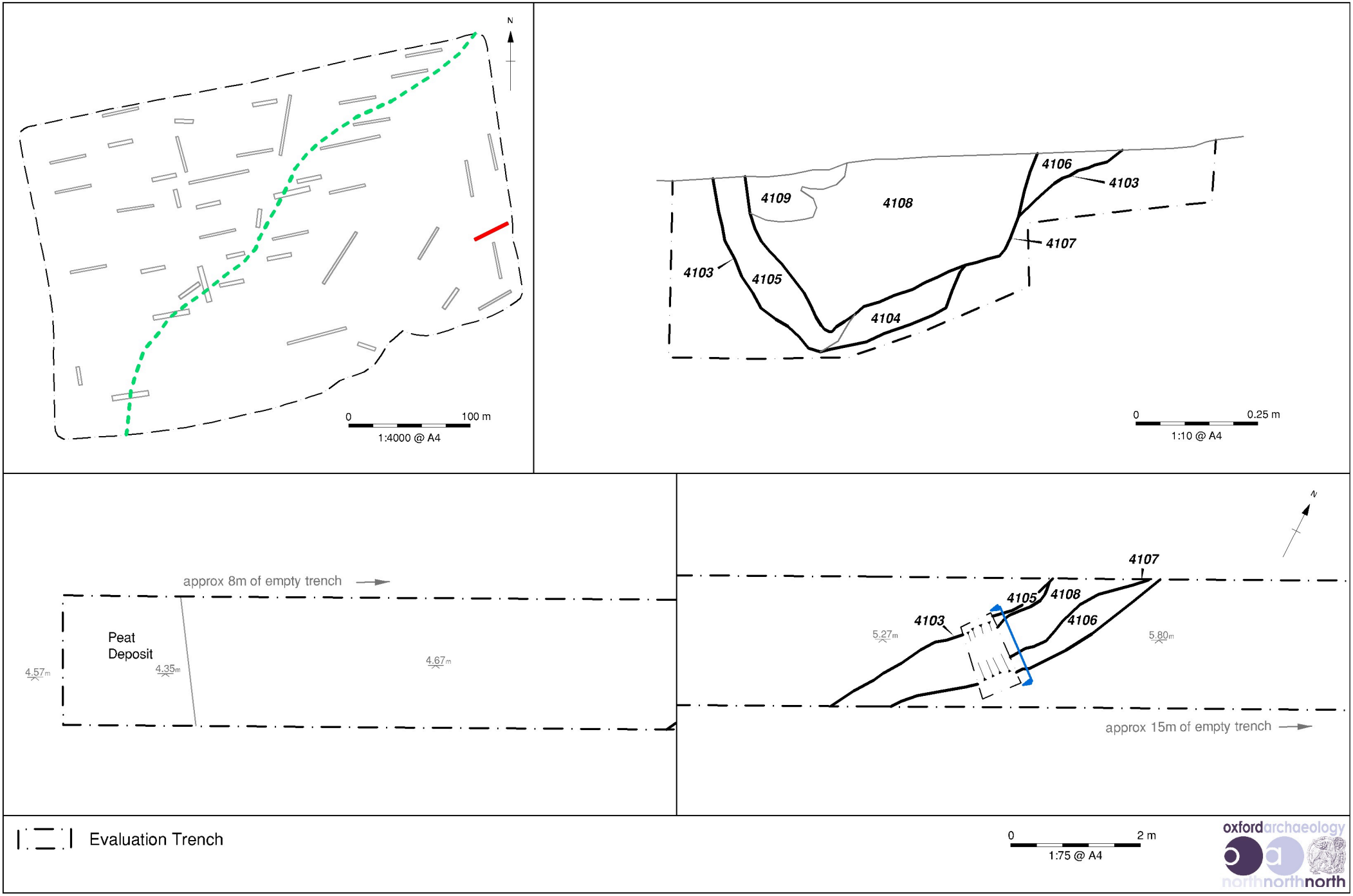


Figure 28: Trench 41, plan and cross-section

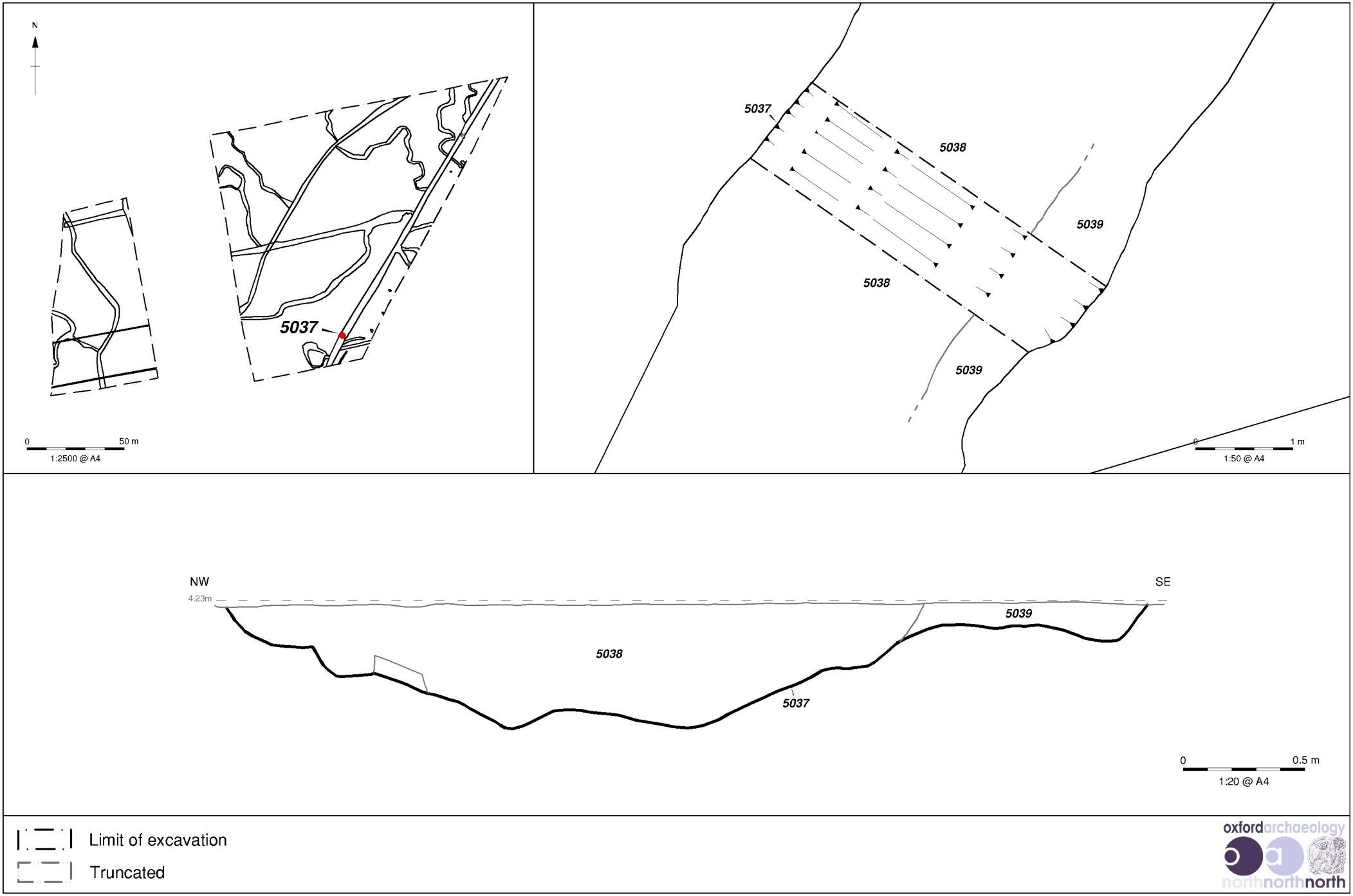


Figure 29: Plan and section of ***5037***

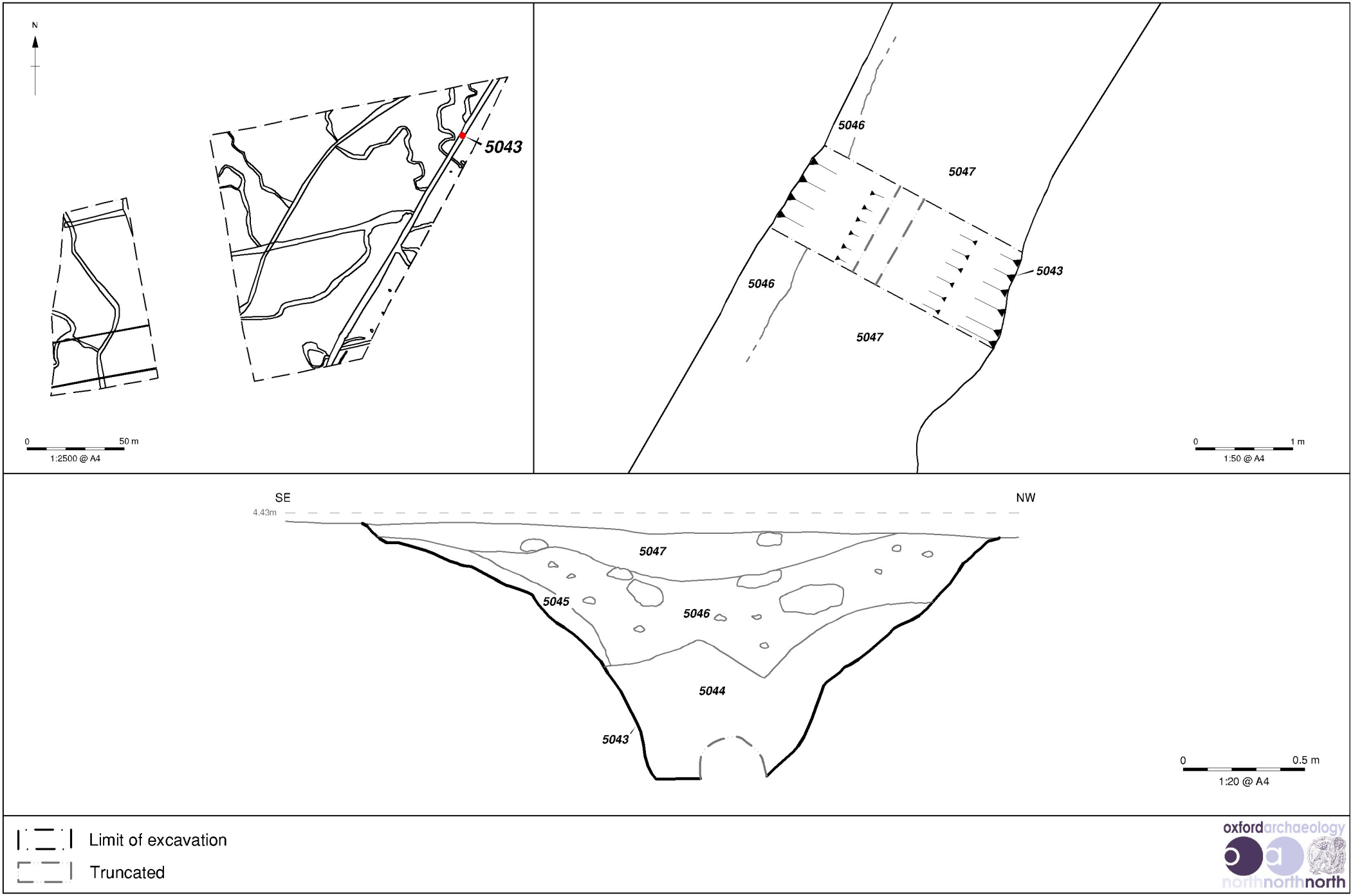
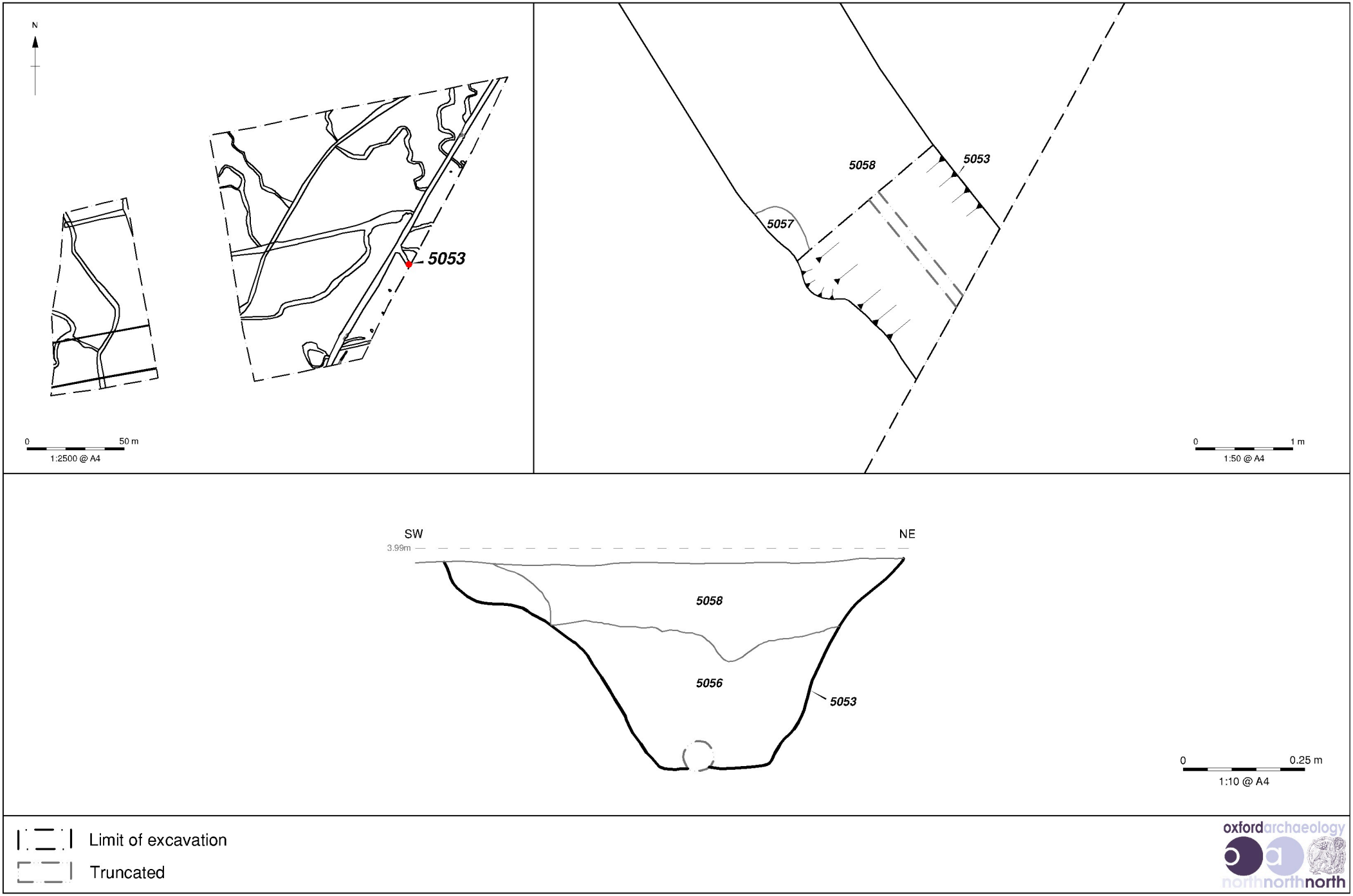


Figure 30: Plan and section of ***5043***



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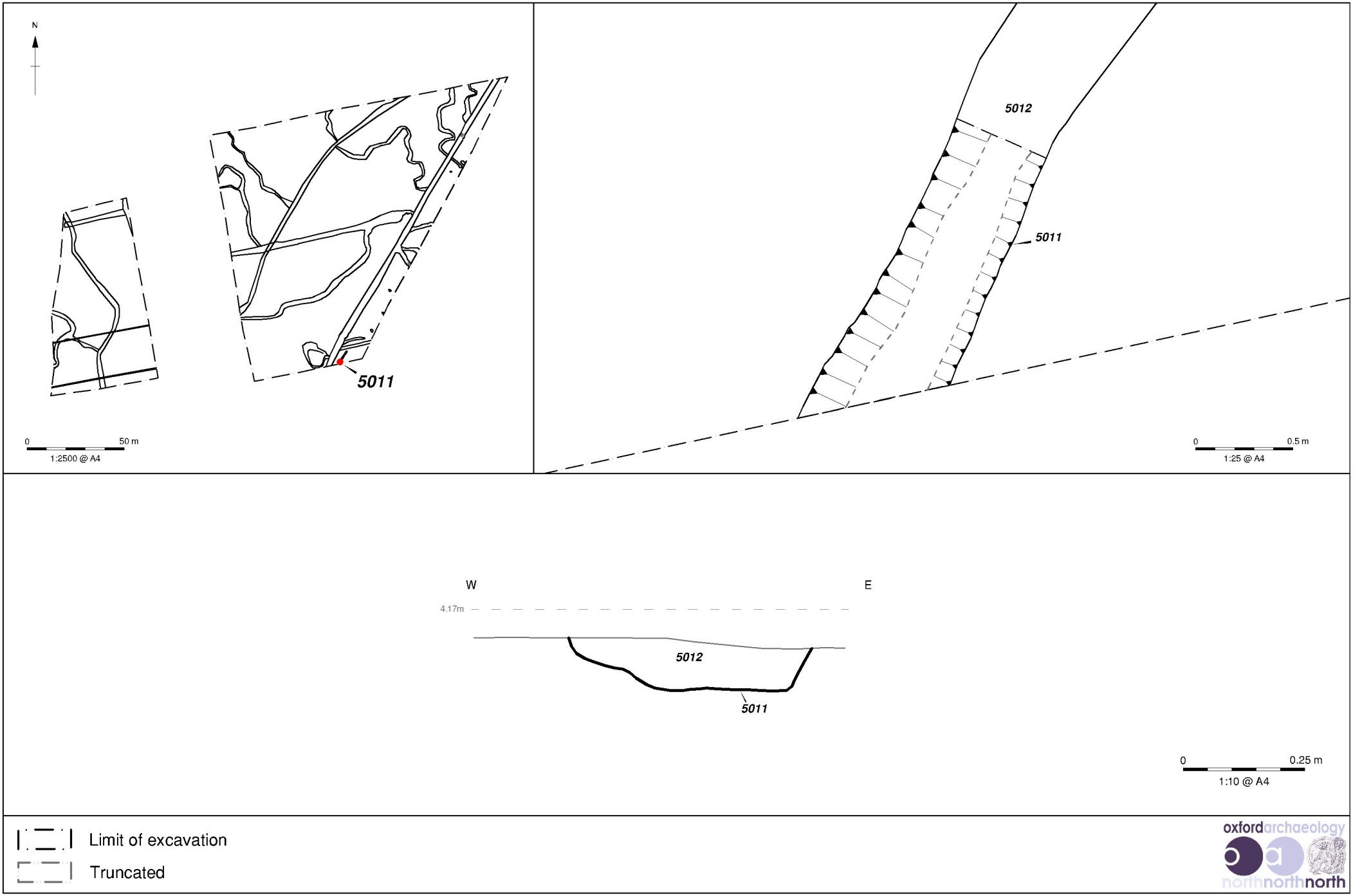

Figure 32: Plan and section of ***5011***

APPENDIX 1: WRITTEN SCHEME OF INVESTIGATION FOR EVALUATION

WALNEY EXTENSION SUBSTATION SITE, HEYSHAM, LANCASHIRE

Written Scheme of Investigation

for Archaeological Evaluation (V2)

Oxford Archaeology North

August 2014

Royal HaskoningDHV and Dong Energy

OA North Reference No: L10786
NGR: SD 42425 60216

1. Introduction

1.1 Project Background

1.1.1 As part of the Walney Extension Offshore Windfarm, Morecambe Bay, Dong Energy (hereafter 'the Client') has submitted proposals for the construction of an on-shore cable and a substation at Heysham, Lancashire (NGR centred SD 42425 60216). The development site is located within an area of archaeological potential and, consequently, Lancashire County Archaeology Service (LCAS; the county council's statutory body responsible for advising planning authorities on heritage matters) requested that the development should be accompanied by an appropriate scheme of archaeological investigation and recording. To further inform the planning process and assist in the formulation of an appropriate scheme of archaeological mitigation, the Principal Archaeologist at Royal HaskoningDHV (RHDHV) has engaged Oxford Archaeology (OA) North to assist with developing a programme of trial-trench evaluation on the proposed substation site. The following document represents a Written Scheme of Investigation (WSI) to carry out the above programme of work and has been prepared in accordance with standard LCAS, Institute for Archaeologists (IfA 2008a; 2008b; 2013) and English Heritage (EH 1991; 2006) requirements and guidelines.

1.1.2 The proposed development area north of the A683 covers *c* 13 ha of agricultural land, within which the substation affects a square area covering *c* 3 ha. Impact within the substation footprint is currently believed to comprise general ground reduction to a depth of *c* 0.5-0.6m below the current ground level (bgl), with localised areas of deep piling (exceeding 4m depth). Around the substation, the development impact is thought to be generally associated with soil stripping within the wider working area, which is likely to have an impact to about 0.5-0.6m bgl.

1.1.3 ***Location and topography***: the proposed substation site lies just to the south-east of Higher Heysham, on the northern side of the A683. It lies at the southern edge of Heysham Moss (and arguably within the former area of that morass; Middleton *et al* 1995, 120, fig 59), with agricultural land to the north and east, and more industrial land to the west. Further to the west is Morecambe bay, whilst the Lune lies to the east, with its estuary just to the south. The topography is flat and low-lying (*c* 4-4.5m OD across the substation site), and the drift geology consists of thick deposits of marine alluvium overlying sandy till (Quest 2014). An extensive network of land drains has been recently installed at the site, but it is believed that the ground still has a propensity for dampness (F Scadgell pers comm).

1.2 Archaeological Background

1.2.1 The investigation site has been the subject of several previous studies, including an *Onshore Archaeology and Cultural Heritage Baseline Assessment* (RSK 2013), an *Environmental Statement: Archaeology and Cultural Heritage* (Royal Haskoning 2013), and a *Geoarchaeological Deposit Model* (Quest 2014). In addition, the nearby Heysham Moss was investigated as part of the North West Wetland Survey (Middleton *et al* 1995). It is not the intention of this section to repeat information that is dealt with more comprehensively in those documents, but rather to provide a brief synopsis to contextualise the proposed archaeological evaluation.

1.2.2 The deposit model (Quest 2014) has indicated that the natural gravelly sand, till, and mudstone that represents the underlying drift geology of the site, forms a natural depression, channel, or glacial scour in the footprint of the substation. The depression appears to coincide almost exactly with the square substation site, so that the surface of the drift geology at the base of the depression lies at *c* -4m OD (*c* 8.5m bgl), rising to *c* -1m OD (5.5m bgl) at the very south-eastern corner of the substation site. The natural deposits continue to rise to the south-east, with a high point of 4m OD (*c* 1.7m bgl) located at the south-eastern edge of the wider application site (an area currently thought to be impacted to around 0.6m bgl). The depression contains deposits of fibrous woody peat between 0.9m and 2.2m thick, the upper surface of which lies at *c* –2m- -3m OD (*c* 6-7m bgl). The peat is thought to represent the development of semi-terrestrial conditions and the growth of Fen Carr woodland. The peat is sealed by a considerable deposit of clay, interpreted as marine alluvium that has filled the depression and other low points in the natural geology, leaving an essentially flat and featureless landscape. Accordingly the alluvium seems to be *c* 6m thick across the majority of the substation footprint, gradually shallowing as the underlying drift deposits rise, so that the clay is only *c* 1.2m thick at the south-eastern edge of the wider application site. Several of the boreholes identified peaty material within the alluvium, perhaps suggesting episodes of stabilisation during the period of clay deposition; however, such observations were not consistent within all the boreholes across the scheme area.

1.2.3 Whilst the alluvium is likely to relate to one of the several marine transgressions to affect the Lancashire coast since the end of the last ice age, the date of the clay, and of the peat deposits, is uncertain. Middleton *et al* (1995, 121) suggest that the peat at Heysham Moss dates to the Flandrian

II/III Transition (essentially the Mesolithic to Neolithic transition, *c* 4000 cal BC), but there the peat sealed, rather than underlay, the marine clay as it appears to do so in the present development site (Quest 2014). Accordingly, the deeply buried peat at the substation site could be considerably earlier.

1.2.4 The heritage assessments identified that there were no known archaeological sites within the site of the substation and its surrounding working area (RSK 2013; RHDHV 2014). Nonetheless, the immediate area contains sites and artefact findspots of Mesolithic and Neolithic date (Middleton *et al* 1995, 121-2). Of particular interest is an apparent palaeochannel that is visible on satellite imagery and traverses the substation site on a north-east/south-west alignment. The feature appears to post-date the deposition of marine alluvium at the site, but may follow an earlier channel. Such natural features frequently attracted human activity during prehistory.

1.2.5 The most extensively excavated example in the wider region is that identified on the Carlisle Northern Development Route, Cumbria, (Brown *et al* in prep). At that site, OA North revealed evidence of Mesolithic, Neolithic and Bronze Age activity, including flint artefact and tool-making debitage scatters, burnt mounds (substantial heaps of heat-affected stones and charcoal, potentially associated with a range of prehistoric cultural activities), and apparently ritualised deposition of artefacts within the palaeochannel, including stone tools and a pair of wooden tridents. Closer to Heysham, OA North identified a small group of prehistoric remains on the edge of a palaeochannel/peat-filled depression, at the site of the Harbour (formerly Whyndyke Farm), on the outskirts of Blackpool (OA North 2014). The findings included a Bronze Age burnt mound (scientifically dated to *c* 1600-1450 cal BC), several pits and gullies, some of which contained evidence of burning similar in character to the burnt mound, and one of which was scientifically dated to the Late Neolithic-Early Bronze Age (*c* 2400 cal BC). In addition, a kite-shaped flint arrowhead of Late Neolithic date was found in the vicinity of the prehistoric features. Similar remains have been identified elsewhere in the Over Wyre mosses to the east of Blackpool and the Fylde coast (Middleton *et al* 1995, 69, 111).

1.2.6 OA North's recent work on the M6 Link Road, between Lancaster and Heysham, has also produced evidence of prehistoric activity in association with palaeochannels (OA North forthcoming). The results are presently being collated, but at one site at Beaumont, just to the north of Lancaster, multi-phase prehistoric remains were again identified in association with a probable palaeochannel. These comprised a soil horizon containing late Mesolithic/Early Neolithic flint tools and working debris, and a number of pits and possible postholes, several of which contained burnt stony material very similar to that which is so characteristic of burnt mounds. At all three of the case studies, it is apparent that the channels and areas of former wetland attracted human activity in several prehistoric periods, with repeated, if not necessarily continuous, activity at those locations.

1.2.7 The presence of any Roman and medieval remains within the development site is harder to define, but the wet area may have been used for pasture prior to drainage schemes and moss reclamation in the medieval and post-medieval periods (Middleton *et al* 1995).

1.3 Oxford Archaeology North

1.3.1 The company, both as Oxford Archaeology North and under the former guise of Lancaster University Archaeological Unit (LUAU), has considerable experience of sites of all periods, having undertaken a great number of small and large scale projects throughout Northern England during the past 35 years. Evaluations, assessments, watching briefs and excavations have taken place within the planning process, to fulfil the requirements of clients and planning authorities, to very rigorous timetables. OA North has particular experience of sites close to the development area, both from an archaeological and a palaeoenvironmental perspective. Indeed, OA North has an experienced and highly respected team of palaeoenvironmentalists, and, as LUAU, was instrumental in undertaking the North West Wetlands Survey, and publishing the results in several monographs in our Lancaster Imprints series.

1.3.2 OA North has the professional expertise and resources to undertake the project detailed below to a high level of quality and efficiency. OA North is an Institute for Archaeologists **(IfA) registered organisation, registration number 17**, and all its members of staff operate subject to the IfA Code of Conduct.

2. Objectives

2.1 The following programme has been designed to assess the subsurface deposits within the development area in order to determine the presence, extent, nature, quality and significance of any archaeological deposits that may be threatened by the proposed development. To this end, the following programme of archaeological work has been designed. The results will provide information as to whether further mitigation works are required prior to, or during, ground works associated with the development. The required stages to achieve these ends are as follows:

2.2 ***Archaeological evaluation****:* to implement a programme of focussed evaluation through the excavation of up to 50 linear trial trenches. Details of the trenches, including specific aims for investigation, are presented in *Appendix 1* and are shown on Figure 1. In particular, several trenches (ATT 016, 018, 022 and 031) have been placed so as to straddle the palaeochannel in areas of deep development impact (i.e. piling) in order to gain an understanding of the deposits within the palaeochannel, and of any archaeological remains that may have lain on its banks. Others (ATT 002-005, 008, and 010-015) have been placed close to one or other edge of the palaeochannel in order to test for the presence of archaeological remains in those areas. ATT 019, 036, and 039-040 have been placed at the southern edge and south-eastern corner of the site, where the geotechnical data suggests that the alluvium is likely to be more shallow as the underlying natural drift geology rises at that location. The remainder of the trenches represent a scatter across the landscape in order to establish the presence and nature of archaeological remains across the rest of the site. Within the substation footprint, several trenches have been placed within areas of deeper impact away from the palaeochannel. A sondage (localised deep excavations by mechanical excavator) within each of those trenches (ATT 007, 011, 023, 027, 029) will aim to characterise the alluvium to a safe depth in order to establish whether the alluvium contains deposits indicative of intermittent stabilisation (i.e. periods where dry land surfaces developed that would have been suitable for, and attractive to, prehistoric human activity).

2.3 ***Collection of Borehole samples***: from two locations within the area of maximum development impact (*i.e.*, within the area of the substation footprint). The borehole samples will capture a complete profile through the sequence of deposits between the surface of the natural glacial till drift deposits, and the base of the topsoil. This will permit the safe and close examination of the deposits, the testing (or 'ground truthing') of the deposit model (Quest 2014) and the opportunity to examine the potential of the material to be informative about the nature and history of the surrounding environment through a range of palaeoenvironmental analyses.

2.4 ***Report and archive****:* a written report will assess the significance of the data generated by this programme within a local and regional context. It will present the results of the evaluation and would make an assessment of the archaeological potential of the area, and any recommendations for further work.

3. Method Statement

3.1 Evaluation

3.1.1 The programme of trial trenching will establish the presence or absence of archaeological deposits and, if identified, will then test their date, nature, likely extent, depth and quality of preservation. In this way, it will adequately sample the threatened available area.

3.1.2 ***Trench configuration:*** the evaluation is required to focus on the area that will be impacted upon by the footprint of the proposed substation and of its surrounding working area. It does not include the cable route, which has been outlined for watching brief at/during construction. It is proposed that up to 50 linear trenches will be excavated, as shown on Figure 1. Their characteristics, dimensions and rationale are outlined in *Appendix 1* and *Section 2.2*.

3.1.3 ***Methodology:*** trenches will be located by use of GPS equipment, which is accurate to +/- 0.25m, or Total Station. Altitude information will be established with respect to Ordnance Survey Datum. All trenches will be excavated in a stratigraphical manner, whether by machine or by hand. Within each trench, the upper horizons of overburden, topsoil, subsoil and any recent made-ground will be rapidly removed by a mechanical excavator fitted with a wide toothless ditching bucket and working under archaeological supervision to the surface of the first significant archaeological deposit or to the level of the natural subsoil. Where appropriate, this deposit will be cleaned by hand, using either hoes, shovel scraping, and/or trowels, depending on the subsoil conditions, and inspected for archaeological features. Topsoil arisings will be stored on one side of the trench, and subsoil arisings will be stored on the other; both will be bunded and sealed as appropriate. As the site is under grass, it is not presently proposed to strip the topsoil from the area of the subsoil spoil heap.

3.1.4 A representative sample of all features of archaeological interest within each trench will be investigated and recorded unless otherwise agreed by the RHDHV archaeologist and LCAS. Except where sondages are to be excavated, the trenches will not be excavated deeper than 1m to accommodate health and safety constraints; any requirements to excavate below this depth will involve modifications to the shape of the trench, and will require a commensurate adjustment to the timetable and resource requirements.

3.1.5 Any investigation of intact archaeological deposits will be exclusively manual. Selected discrete features, such as pits and postholes, would be subject to 50% examination (i.e. half-sectioned), linear features will be subject to a 25% sample where the fill is found to be non-uniform, and 10% where the fill is uniform, and extensive layers will, where possible, be sampled by partial rather than complete

removal. It is hoped that in terms of the vertical stratigraphy, maximum information retrieval will be achieved through the examination of sections of cut features. All excavation will be undertaken with a view to avoiding damage to any archaeological features, which appear worthy of preservation *in situ*.

3.1.6 All information identified in the course of the site works will be recorded stratigraphically, using a system, adapted from that used by Centre for Archaeology Service of English Heritage, with sufficient pictorial record (plans, sections, and high-quality digital photographs) to identify and illustrate individual features. Primary records will be available for inspection at all times.

3.1.7 Results of all field investigations will be recorded on *pro-forma* sheets. The site archive will include both an indexed photographic record and accurate large scale plans and sections at an appropriate scale (1:50, 1:20 and 1:10). At least one long section of each trench within which archaeological remains have been identified will be drawn. In those trenches where no remains have been identified, a measured sketch section will be made, with supporting photographic documentation. All artefacts and ecofacts will be recorded using the same system, and will be handled and stored according to standard practice (following current IfA guidelines) in order to minimise deterioration.

3.1.8 ***Deeper Excavations***: it is likely that a selection of trenches in areas of deeper impact will include deeper excavation, either across much of their area, or, as sondages within localised parts of the trench (see *Appendix 1* and *Section 2.2* for details). The actual depth of such investigation would be dependent on ground conditions, impact depth, and archaeological findings. Stratigraphical mechanical excavation procedure would be similar to that outlined in *Section 3.1.3*. Sondages would be excavated roughly 2m square, and would only be stepped out where there was a need for a member of staff to enter them, and where stepping was viable within the constraints of services, *etc.* As far as possible, sondages will be examined by the palaeoenvironmentalist (*Section 3.1.11*) and recorded on the day that they are excavated, before immediate backfilling. Deep excavations within trenches across the palaeochannel would not exceed impact depth. They would initially be stepped in from the 4m wide trench edges, but, where excavation exceeded 2m bgl, it would not be possible for trenches to be entered for the purposes of investigation, recording and sampling, without further stepping out of the trenches. The latter would need to be undertaken in agreement with the RHDHV archaeologist, and would require amendments to the project timetable and resources. Alternatively, deeper excavations could potentially be recorded from the edges of the trenches. Access to deeper excavation is unlikely to be acceptable on health and safety grounds, in part due to the ground conditions on site.

3.1.9 ***Reinstatement:*** it is understood that there is a basic requirement for reinstatement; the trenches will be backfilled placing the excavated arisings back into the trench in the order that they were removed, so that the topsoil is laid on the top, and the ground will be roughly graded and lightly compacted with the machine bucket. Following agreement with the RHDHV archaeologist and LCAS, any trenches that do not contain archaeological features would be backfilled as soon as possible. It would be preferable for the landowner to agree to the finished reinstated trenches prior to leaving site. Should there be a requirement by the client other than that stated this will involve recosting for an agreed variation. Similarly, if there is any requirement to cut turf prior to excavation and re-lay it following backfilling, this would need to be costed separately as an agreed variation.

3.1.10 ***Fencing/hoarding requirements:*** following consultation with the RHDHV archaeologist it is understood that the site is free from unauthorised ingress and from animals, and that no stock-proof or intrusion-proof barrier fencing materials will be needed for the majority of trenches. Accordingly, open trenches will be demarcated along their long edges by spoil heaps, and at their short ends by orange netlon fencing. Should the hire and erection of heras fencing or similar by OA North staff be required for those trenches, costs for manpower and materials can be included as a contingency as an agreed variation. It is expected that deep excavation will take place within ATT 016, 022 and 031. Accordingly provision has been made for fencing those trenches and their spoil heaps.

3.1.11 ***Environmental Sampling:*** an assessment of the environmental potential of the site will be undertaken through the examination of suitable deposits by the in-house palaeoecological specialist, who will examine the potential for further analysis. Accordingly, environmental samples (bulk samples of 40 litres volume, to be sub-sampled at a later stage) will be collected from stratified undisturbed deposits and will particularly target negative features (gullies, pits and ditches). Buried soil horizons, palaeochannel deposits and positive features (such as burnt mounds) would be sampled in section through the extraction of monolith samples. An OA North palaeoenvironmentalist will visit site to advise on the extraction of samples, and to examine sondages in order to establish the presence of potential land surfaces interleaved with the alluvium.

3.1.12 The assessment would include, where appropriate, soil pollen analysis and the retrieval of charred plant macrofossils and land molluscs from former dry-land palaeosols and cut features. In addition, samples from waterlogged deposits would be assessed for plant macrofossils, insects, molluscs and pollen. The costs for the palaeoecological assessment are defined as a contingency and will only be called into effect if suitable deposits are identified and will be subject to the agreement of the RHDHV Archaeologist and LCAS.

3.1.13 ***Faunal remains:*** if there is found to be the potential for discovery of bones of fish and small mammals, it would be necessary to discuss a means of extracting a meaningful assemblage of such remains. Such works might include onsite sieving where arrangements can be made for water and for silt sumps, but might more practically be addressed through large-scale bulk sampling of suitable deposits followed by laboratory sieving. Faunal remains will be assessed as appropriate by OA North's specialist in faunal remains, and subject to the results, there may be a requirement for more detailed analysis. A contingency has been included for the assessment of such faunal remains for analysis.

3.1.14 ***Human Remains****:* any human remains revealed by the works will be left *in situ*, covered and protected. No further investigation will continue beyond that required to establish the date and character of the burial. The RHDHV archaeologist, LCAS and the local Coroner will be informed immediately. If removal is essential, the exhumation of any funerary remains will require the provision of a Ministry of Justice license, under section 25 of the Burial Act of 1857. An application will be made by OA North for the site area on discovery of any such remains and the removal will be carried out with due care and sensitivity under the environmental health regulations. The cost of removal or treatment will be agreed with the client and costed as a variation.

3.1.15 ***Treatment of finds:*** all finds will be exposed, lifted, cleaned, conserved, marked, bagged and boxed in accordance with the United Kingdom Institute for Conservation (UKIC) *First Aid For Finds*, 1998 (new edition) and the recipient museum's guidelines. All identified finds and artefacts will be retained, although certain classes of building material can sometimes be discarded after recording if an appropriate sample is retained on advice from the recipient museum's archive curator.

3.1.16 ***Treasure:*** any gold and silver artefacts recovered during the course of the excavation will be removed to a safe place and reported to the local Coroner according to the procedures relating to the Treasure Act, 1996. Where removal cannot take place on the same working day as discovery, suitable security will be employed to protect the finds from theft.

3.1.17 ***Contingency plan:*** a contingency costing can be supplied to the RHDHV archaeologist in order to extend the evaluation in order to further address specific research questions, as required and at the request of the LCAS. A separate contingency, as indicated within the costing document, may also be employed for unseen delays caused by prolonged periods of bad weather, vandalism, discovery of unforeseen complex deposits and/or artefacts which require specialist removal, use of shoring to excavate important features close to the excavation sections etc. Contingencies would be charged in agreement with the client.

3.2 Collection of Borehole Samples

3.2.1 ***Setting-out*****:** the exact locations of Boreholes (BH) 9 and 10 will be surveyed using suitable electronic equipment, such as a total station theodolite, (TST) or differential GPS (DGPS), which can be accurate to within 10mm (Fig 1). The locations to be bored will be demarcated using spray paint, marker flags, or other appropriate means, and the areas will be checked for services.

3.2.2 ***Augering*****:** the firm nature of the substrate means that it will not be possible to use a hand auger, and it is instead proposed that windowless core samples in 1 metre lengths will be taken using a towed Terrier rig operated by suitably qualified engineers working under OA archaeological supervision. It is expected that the cores will be to a depth of *c* 10m bgl (the depth of pile impact), the approximate depth at which glacial till deposits are expected (Quest 2014). It is proposed that a duplicate set of cores should be taken at each location, to facilitate sampling by different specialists, if required, and to ensure that those specialists have sufficient material from the same location, permitting a multi-disciplinary approach and an holistic understanding of the deposits. If the ground is impenetrable to a Terrier rig, it may be necessary, in accordance with a cost variation in agreement with the client, to use a percussion rig to obtain continuous sampling.

3.2.3 ***Recording and rapid laboratory examination*****:** following extraction, cores will be given a unique cross-refererable number, and the relative depth of each 1m section will be recorded for extrapolation from the OD height at the top of the sequence. The site archive will include both a photographic record and maps showing the locations of the cores. Because the cores are windowless, it will be necessary for samples to be taken back to the laboratory at Lancaster for examination. The sample tubes will be opened with suitable cutting equipment, and the core rapidly cleaned with a blunt knife or similar tool to provide a clear surface free of smears.

3.2.4 Recording and litholoGlical assessment of 1m core sections will be undertaken on a summary *pro-forma* sheet by an OA North environmental archaeologist following the English Heritage Guidelines for Geoarchaeology (2007) and using standard quaternary (Late Devensian and Holocene) terminology. The assessment will include the identification of significant layers, descriptions of the colour of the matrix using the Munsell soil charts, the texture of the mineral components, inclusions and the thickness and boundary characteristics of each lithological unit of the cores. It will also identify deposits that are likely to provide significant data on the palaeoenvironmental history of the site and its

surroundings. Accordingly, deposits for sampling, and for specific specialist assessments will be noted at this stage.

3.2.5 Representative cores from each deposit would be retained, but it is not proposed to keep the cores except where they have the potential for the retention of specific palaeoenvironmental or archaeological data. Cores to be retained will be capped and resealed in an appropriate manner to prevent deterioration, induration, or dessication.

3.2.6 ***Environmental Assessments*:** dependent on the results of the initial field assessment, it is proposed that, with the agreement of the Client, LCAS, and the RHDHV archaeologist, a programme of laboratory assessment be undertaken of the biological remains preserved within selected cores retained during the fieldwork. The English Heritage Guidelines for Environmental Archaeology (2011) will be consulted during this phase of the project. Sub-samples would be taken from suitable locations from each core, and subjected to an appropriate scheme of laboratory assessment. These techniques are outlined below, but it is highly unlikely that all retained cores would have material suitable for all forms of assessment. A costed, itemised programme of assessment can be submitted to the RHDHV archaeologist for their approval prior to the assessment works taking place.

3.2.7 ***Pollen**:* the pollen in the sediment will be assessed to help understand the nature and processes of accumulation of the waterlogged deposits and also the local environment. Sub-samples, 10-20 ml in volume, will prepared for pollen analysis using a standard chemical procedure (method B of Berglund and Ralska–Jasiewiczowa (1986), using HCl, NaOH, sieving, HF, and Erdtman's acetolysis, to remove carbonates, humic acids, particles > 170 microns, silicates, and cellulose, respectively. The samples were then stained with safranin, dehydrated in tertiary butyl alcohol, and the residues mounted in 2000 cs silicone oil. Slides will be examined at a magnification of 400x (1000x for critical examination) by equally spaced traverses across at least two slides to reduce the possible effects of differential dispersal on the slide (Brooks and Thomas 1967). For the assessment a pollen count for each sample of at least 100 land pollen and spores will be reached. *Lycopodium* tablets (Stockmarr 1971) will be added to a known volume of sediment at the beginning of the preparation so that pollen concentrations could be calculated. Pollen identification will be made using the keys of Moore *et al* (1991), Faegri and Iversen (1989), and a small modern pollen reference collection. Andersen (1979) will be followed for identification of cereal-type grains. Indeterminable grains will also be recorded as an indication of the state of the pollen preservation. Plant nomenclature will follow Stace 1997. The data will be presented in tables as either percentage values or actual numbers of pollen grains and spores. The interpretation of the data may help in our understanding of the nature in which the waterlogged deposits accumulated and also of the local environment.

3.2.8 ***Waterlogged and charred plant remains*:** the potential for waterlogged and charred plant remains will be assessed in sub-samples from the sediment samples. These will be wet sieved through a series of standard meshes and the residues examined with a binocular microscope. All types of plant material will be noted and identified if possible, as will their relative quantities, in a simple scale of abundant – rare. Plant remains may record the nature of the deposits, the local environment and the economy of the sites.

3.2.9 ***Invertebrate remains*:** the sediment samples may be assessed for invertebrate remains, but this will necessitate large sub-sample and, dependent on the nature of the sediments, may not possible. The samples would be submitted to the relevant specialist, who would process them by paraffin flotation techniques and assess the flots for the presence of invertebrate remains. If these are present they are invaluable to our understanding of the nature of the deposits, possible urban habitation conditions and the economy of the sites.

3.2.10 ***Diatoms***: the sediments may be assessed for the presence and absence of diatoms. If present the diatoms will be identified and quantified. Small sub-samples of the sediment samples will be submitted to the relevant specialist (Dr Philip Barker and), who will prepare 10ml samples following the standard hydrogen peroxide and hydrochloric acid procedure (Batterbbee 1986). Diatoms are freshwater or marine algae with a silica frustule or chamber, which is resistant to decay. They are habitat specific and are therefore a good indicators of such characteristics as salinity and water quality (English Heritage 2002).

3.2.11 ***Foraminifera***: the sediments may be assessed for the presence and absence of foraminifera. Small sub-samples will be submitted to Dr John Whittaker, the specialist, who will process and assess their potential for the survival of foraminifera.

3.2.12 ***Radiocarbon dating***: suitable material for radiocarbon dating may be selected from each of the lithological units and from the top and bottom of the sequence. This material will be submitted to Dr Gordon Cook of the Scottish Universities Environmental Research Centre for AMS dating.

3.3 Report and Archive

3.3.1 ***Report:*** notwithstanding the completion of specialist assessments, a draft report will be submitted to the RHDHV archaeologist within 8 weeks of the completion of fieldwork. Following the incorporation of comments, copies of the final report will be submitted to the RHDHV archaeologist and to LCAS. The report will include:

- a site location plan related to the national grid
- a front cover to include the planning application number and the NGR
- a QA sheet detailing as a minimum title, author, version, date, checked by, approved by the dates on which each phase of the programme of work was undertaken
- a concise, non-technical summary of the results, aims and objectives
- an explanation to any agreed variations to the brief, including any justification for any analyses not undertaken
- a description of the methodology employed, work undertaken and results obtained plans and sections at an appropriate scale showing the location and position of deposits and finds located as well as sites identified during the desk-based assessment
- monochrome and colour photographs as appropriate
- a list of and dates for any finds recovered and a description and interpretation of the deposits identified
- a description of any environmental or other specialist work undertaken and the results obtained
- a statement of the significance of the results in their local, regional and national context, if required, cross referenced to the regional research agendas, as appropriate
- conclusions/discussion
- a summary of the impact of the development on any archaeological remains and, where possible, a model of potential archaeological deposits within as-yet unexplored areas of the development site
- a copy of this WSI, and indications of any agreed departure from the design the report will also include a complete bibliography of sources from which data has been derived.

3.3.2 The report will be in the same basic format as this WSI; a copy of the report can be provided on CD, if required. Recommendations concerning any subsequent mitigation strategies and/or further archaeological work following the results of the field evaluation will be provided in a separate communication.

3.3.3 ***Confidentiality:*** all internal reports to the client are designed as documents for the specific use of the client, for the particular purpose as defined in the project brief and project design, and should be treated as such. They are not suitable for publication as academic documents or otherwise without amendment or revision.

3.3.4 ***Archive:*** the results of all archaeological work carried out will form the basis for a full archive to professional standards, in accordance with current English Heritage guidelines (*Management of Research Projects in the Historic Environment*, 2006 and *Management of Archaeological Projects*, 2nd edition, 1991). The project archive will include summary processing and analysis of all features, finds, or palaeoenvironmental data recovered during fieldwork, which will be catalogued by context.

3.3.5 The deposition of a properly ordered and indexed project archive in an appropriate repository is essential and archive will be provided in the English Heritage Centre for Archaeology format and a synthesis will be submitted to the Lancashire HER, Preston (the index to the archive and a copy of the report). OA North practice is to deposit the original record archive of projects with the appropriate Record Office (in this instance, that at Preston).

3.3.6 All artefacts will be processed to MAP2 standards and will be assessed by our in-house finds specialists. The deposition and disposal of any artefacts recovered in the evaluation will be agreed with the legal owner and an appropriate recipient museum (likely to be the Lancaster Museum). Discussion regarding the museum's requirement for the transfer and storage of finds will be conducted prior to the commencement of the project, and the RHDHV archaeologist and LCAS will be notified of the arrangements made.

3.3.7 ***OASIS:*** an OASIS form will be completed as part of the works.

4. Other Matters

4.1 Health and Safety

4.1.1 OA North provides a Health and Safety Statement for all projects and maintains a Unit Safety policy. All site procedures are in accordance with the guidance set out in the Health and Safety Manual compiled by the Standing Conference of Archaeological Unit Managers (1997). A site-specific Health and Safety plan and Method Statement, accompanied by a written risk assessment has been undertaken in advance of project commencement and copies will be made available on request to all interested parties.

4.1.2 Full regard will, of course, be given to all constraints (services *etc*) during the fieldwork as well as to all Health and Safety considerations. **Information regarding services within the study area has been received and will be used during the course of the evaluation.**

4.2 Project monitoring

4.2.1 While the work is undertaken for the client, LCAS will be kept fully informed of the work and its results, and will be notified a week in advance of the commencement of the fieldwork. Any proposed changes to the WSI will be agreed with RHDHV archaeologist and LCAS in consultation with the client. Fieldwork will be monitored by the RHDHV archaeologist and LCAS on behalf of Dong Energy.

4.3 Work timetable

4.3.1 ***Evaluation trenching*:** Approximately four weeks from Monday 1/9/14 will be required to complete this element, although a few additional days may be needed if there is any requirement for OA North to erect heras fencing prior to works commencing and then dismantle it afterwards. Similarly, any requirement for contingency evaluation at the request of the RHDHV archaeologist and/or LCAS may extend this period slightly.

4.3.2 ***Report:*** copies of the draft report, as outlined in *Section 3.2.1*, will be issued to the client and other relevant parties within eight weeks of the completion of fieldwork, unless otherwise agreed.

4.3.3 ***Archive*:** the archive will be deposited within six months following submission of the report, unless otherwise instructed.

4.4 Staffing

4.4.1 The project will be under the direct management of **Stephen Rowland** (OA North Senior Project Manager) to whom all correspondence should be addressed. The evaluation will comprise a suitably sized team of experienced archaeologists led by an OA North Project Officer. All such staff at OA North are experienced archaeologists capable of undertaking small-, medium- and large-scale projects in a range of urban and rural situations. The finds will be processed, studied and reported upon, either by, or under the guidance of, **Chris Howard-Davies** (OA North Finds Manager) who has extensive experience of finds from all periods, but particularly prehistoric and Roman material. All environmental sampling and assessment will be undertaken under the auspices of **Dr Denise Druce** (OA North Environmental Manager) who has unparalleled experience of palaeoenvironmental work in the North West and who heads an excellent team of environmental archaeologists.

4.5 Insurance

4.5.1 OA North has a professional indemnity cover to a value of £2,000,000; proof of which can be supplied as required.

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APPENDIX 2: WRITTEN SCHEME OF INVESTIGATION FOR STRIP, MAP AND RECORD

WALNEY EXTENSION SUBSTATION SITE, HEYSHAM, LANCASHIRE

Written Scheme of Investigation for Archaeological Strip, Map and Record (V2)

Oxford Archaeology North

February 2015

Royal HaskoningDHV and Dong Energy

OA North Reference No: L10786EX
NGR: SD 42425 60216

1. Introduction

1.1 Project Background

1.1.1 As part of the Walney Extension Offshore Wind Farm, located in the Irish Sea, DONG Energy (hereafter 'the Client') has submitted proposals for the construction of an onshore cable and a substation near Heysham, Lancashire (NGR centred SD 42425 60216). Consent for the project was granted in November 2014. The substation development site is located within an area of archaeological potential and, consequently, Lancashire County Archaeology Service (LCAS; the county council's statutory body responsible for advising planning authorities on heritage matters) requested that the development should be accompanied by an appropriate scheme of archaeological investigation and recording. To date, those works, which have been managed on behalf of the Client by Royal HaskoningDHV (RHDHV), have comprised a baseline assessment (RSK 2013), a technical chapter within an Environmental Statement (RHDHV 2013), a geoarchaeological deposit model (Quest 2014), and a trial-trench evaluation (OA North 2014a).

1.1.2 The archaeological evaluation, undertaken in September 2014 by Oxford Archaeology (OA) North, was focused on the proposed substation site and its immediately surrounding works areas. The archaeological evaluation works within that part of the proposed development area (PDA) confirmed the presence of a postulated palaeochannel extending through the site, and identified further natural and putative anthropogenic features, some of which were of potential prehistoric date. Following discussion of the findings with LCAS, RHDHV commissioned OA North to formulate an appropriate scheme of archaeological mitigation for the area of the substation and its surrounding works areas (note that this does not include the area to the south of the A683 and the cable route, which will be covered by a separate document once further information in terms of the specific engineering approach and requirements is available).

1.1.3 Mitigation works at the substation site comprise a targeted programme of strip, map and record, intended to expose fully, investigate, and define the character of features relating to potential prehistoric activity, located within two targeted areas of the PDA, and to preserve them by record prior to their loss or damage during development. The following document represents a Written Scheme of Investigation (WSI) to carry out the above programme of work, and has been prepared in accordance with standard LCAS, Chartered Institute for Archaeologists (CIfA 2014a; 2014b; 2014c) and English Heritage (EH 1991; 2006) requirements and guidelines.

1.1.4 The PDA is located to the north of the A683 and covers *c* 13 ha of agricultural land, within which the substation affects a square area covering *c* 3 ha. Impact within the substation footprint is currently believed to comprise general ground reduction to a depth of *c* 0.5-0.6m below the current ground level (bgl), with localised areas of deep piling (exceeding 4m depth). Around the substation, the development impact is thought to be generally associated with soil stripping within the wider working area, which is likely to have an impact to about 0.5-0.6m bgl. The results of the trial trenching indicate that such excavations will impact upon any features of archaeological merit, which were almost entirely cut into the top of the natural geology, at depths between 0.25m and 0.5m bgl. The strip, map and record programme will investigate two separate areas of archaeological interest, as defined by a rough spatial cluster of potential archaeological features identified during trial trenching, covering a total of *c* 1.7 ha, largely located within the substation footprint, as well as to the east (see Figure 1).

1.1.5 ***Location and topography***: the proposed substation site lies just to the south-east of Higher Heysham, on the northern side of the A683. It lies at the southern edge of Heysham Moss (and arguably within the former area of that morass; Middleton *et al* 1995, 120, fig 59), with agricultural land to the north and east, and more industrial land to the west. Further to the west is Morecambe Bay, whilst the Lune lies to the east, with its estuary just to the south. The topography is flat and low-lying (*c* 4-4.5m OD across the substation site), and the drift geology consists of thick deposits of marine alluvium overlying sandy till (Quest 2014). An extensive network of land drains has been recently installed at the site, but it is believed that the ground still has a propensity for dampness (F Scadgell pers comm).

1.2 Archaeological Background

1.2.1 The PDA has been the subject of several previous studies, including an *Onshore Archaeology and Cultural Heritage Baseline Assessment* (RSK 2013), an *Environmental Statement: Archaeology and Cultural Heritage* (Royal Haskoning 2013), and a *Geoarchaeological Deposit Model* (Quest 2014). In addition, the nearby Heysham Moss was investigated as part of the North West Wetland Survey (Middleton *et al* 1995). It is not the intention of this section to repeat information that is dealt with more comprehensively in those documents, but rather to provide a brief synopsis to contextualise the

proposed archaeological mitigation. The results of the recent archaeological evaluation (OA North 2014a) are summarised at the end of this section.

1.2.2 The deposit model (Quest 2014) has indicated that the natural gravelly sand, till, and mudstone that represents the underlying drift geology of the site, forms a natural depression, channel, or glacial scour in the proposed footprint of the substation. The depression appears to coincide almost exactly with the square substation site, so that the surface of the drift geology at the base of the depression lies at *c* -4m OD (*c*. 8.5m bgl), rising to *c* -1m OD (5.5m bgl) at the very south-eastern corner of the substation site. The natural deposits continue to rise to the south-east, with a high point of 4m OD (*c* 1.7m bgl) located at the south-eastern edge of the wider application site (an area currently thought to be impacted to around 0.6m bgl). The depression contains deposits of fibrous woody peat between 0.9m and 2.2m thick, the upper surface of which lies at *c* –2m to -3m OD (*c* 6-7m bgl). The peat is thought to represent the development of semi-terrestrial conditions and the growth of Fen Carr woodland. The peat is sealed by a considerable deposit of clay, interpreted as marine alluvium that has filled the depression and other low points in the natural geology, leaving an essentially flat and featureless landscape. Accordingly the alluvium seems to be *c* 6m thick across the majority of the substation footprint, gradually shallowing as the underlying drift deposits rise, so that the clay is only *c* 1.2m thick at the south-eastern edge of the wider application site. Several of the boreholes identified peaty material within the alluvium, perhaps suggesting episodes of stabilisation during the period of clay deposition; however, such observations were not consistent within all the boreholes across the scheme area.

1.2.3 Whilst the alluvium is likely to relate to one of the several marine transgressions to affect the Lancashire coast since the end of the last ice age, the date of the clay, and of the peat deposits, is uncertain. Middleton *et al* (1995, 121) suggest that the peat at Heysham Moss dates to the Flandrian II/III Transition (essentially the Mesolithic to Neolithic transition, *c* 4000 cal BC), but there the peat sealed, rather than underlay, the marine clay as it appears to do so in the present development site (Quest 2014). Accordingly, the deeply buried peat at the substation site could be considerably earlier.

1.2.4 The heritage assessments identified that there were no known archaeological sites within the site of the substation and its surrounding working area (RSK 2013; RHDHV 2014). Nonetheless, the immediate area contains sites and artefact findspots of Mesolithic and Neolithic date (Middleton *et al* 1995, 121-2). Of particular interest was an apparent palaeochannel that is visible on satellite imagery and traverses the substation site on a north-east/south-west alignment. The feature appears to post-date the deposition of marine alluvium at the site, but may follow an earlier channel. Such natural features frequently attracted human activity during prehistory.

1.2.5 The most extensively excavated example in the wider region is that identified on the Carlisle Northern Development Route, Cumbria (Brown *et al* in prep). At that site, OA North revealed evidence of Mesolithic, Neolithic and Bronze Age activity, including flint artefact and tool-making debitage scatters, burnt mounds (substantial heaps of heat-affected stones and charcoal, potentially associated with a range of prehistoric cultural activities), and apparently ritualised deposition of artefacts within the palaeochannel, including stone tools and a pair of wooden tridents. Closer to Heysham, OA North identified a small group of prehistoric remains on the edge of a palaeochannel/peat-filled depression, at the site of the Harbour (formerly Whyndyke Farm), on the outskirts of Blackpool (OA North 2014b). The findings included a Bronze Age burnt mound (scientifically dated to *c* 1600-1450 cal BC), several pits and gullies, some of which contained evidence of burning similar in character to the burnt mound, and one of which was scientifically dated to the Late Neolithic-Early Bronze Age (*c* 2400 cal BC). In addition, a kite-shaped flint arrowhead of Late Neolithic date was found in the vicinity of the prehistoric features. Similar remains have been identified elsewhere in the Over Wyre mosses to the east of Blackpool and the Fylde coast (Middleton *et al* 1995, 69, 111).

1.2.6 OA North's recent work on the M6 Link Road, between Lancaster and Heysham, has also produced evidence of prehistoric activity in association with palaeochannels (OA North forthcoming). The results are presently being collated, but at one site at Beaumont, just to the north of Lancaster, multi-phase prehistoric remains were again identified in association with a probable palaeochannel. These comprised a soil horizon containing late Mesolithic/Early Neolithic flint tools and working debris, and a number of pits and possible postholes, several of which contained burnt stony material very similar to that which is so characteristic of burnt mounds. At all three of the case studies, it is apparent that the channels and areas of former wetland attracted human activity in several prehistoric periods, with repeated, if not necessarily continuous, activity at those locations. The presence of any Roman and medieval remains within the development site is harder to define, but the wet area may have been used for pasture prior to drainage schemes and moss reclamation in the medieval and post-medieval periods (Middleton *et al* 1995).

1.2.7 The recent programme of archaeological trial trenching by OA North, focusing directly upon the PDA, was carried out during September 2014 and revealed evidence for the suspected palaeochannel and

potential tributaries (OA North 2014a). It confirmed a stratigraphic sequence that comprised peat, overlain by deeply stratified deposits of marine alluvial flood deposits, into which the palaeochannel/s had been cut. The channel/s had subsequently silted up, and a further period of peat formation followed, with such deposits in-filling much of the remaining channel/s. This later peat horizon probably represents a remnant of Heysham Moss, which is now confined to the north of the site, and which is believed to have formed from the time of the Mesolithic/Neolithic transition onwards.

1.2.8 The trial trenching also revealed a series of putative linear and discrete archaeological features. These features produced no finds and could not consequently be dated, but included the potential remains of a ring ditch, or drip gully, associated with a possible prehistoric/Romano-British round house, as well as the remains of a poorly defined potential field system and additional activity. The fills of these features were characterised by peat formation and could not be easily distinguished from those of a more natural origin that presumably represent the remains of a marshland environment. Consequently, a natural origin for some or all of these features could not be ruled out entirely. The exact nature and extent of these features was, therefore, difficult to gauge within the confines of the trenching, but may represent prehistoric (Bronze Age to Roman) settlement of the floodplain.

1.2.9 In addition, a number of well-defined linear features and several pits were also identified. These were mainly confined to the south-eastern corner of the site and produced material evidence of a late post-medieval or modern origin, probably relating to the enclosure of the area towards the end of the nineteenth century. These features are of little archaeological merit, are not deemed to warrant further investigation and as such are not covered by the proposed strip, map and record scheme outlined in this WSI.

1.3 Oxford Archaeology North

1.3.1 The company, both as Oxford Archaeology North and under the former guise of Lancaster University Archaeological Unit (LUAU), has considerable experience of sites of all periods, having undertaken a great number of small and large scale projects throughout Northern England during the past 35 years. Evaluations, assessments, watching briefs and excavations have taken place within the planning process, to fulfil the requirements of clients and planning authorities, to very rigorous timetables. OA North has particular experience of sites close to the development area, both from an archaeological and a palaeoenvironmental perspective. Indeed, OA North has an experienced and highly respected team of palaeoenvironmentalists, and, as LUAU, was instrumental in undertaking the North West Wetlands Survey, and publishing the results in several monographs in our Lancaster Imprints series.

1.3.2 OA North has the professional expertise and resources to undertake the project detailed below to a high level of quality and efficiency. OA North is a Chartered Institute for Archaeologists **(CIfA) registered organisation, registration number 17**, and all its members of staff operate subject to the CIfA Code of Conduct.

2. Objectives

2.1 ***Strip, Map and Record***: the principal objective of the strip map and record programme will be to expose, investigate, and define the character, composition, extent, and chronology of features relating to potential pre-modern activity, located within two targeted areas of the PDA, and to compensate their future loss during development of the site by preserving them 'by record'. These areas have been agreed upon and defined in consultation between RHDHV, LCAS and OA North, based upon the relative spatial distribution of features of interest identified during the previous phase of archaeological trial trenching (OA North 2014) and are illustrated on Figure 1.

2.2 ***Report and archive:*** a written and illustrated report will present the results of the archaeological investigation. It would make an assessment of the significance of the data generated by this programme within a local and regional context and will make recommendations for any appropriate schemes of analysis and potential publication, if considered appropriate and proportionate to the findings.

3. Method Statement

3.1 Introduction

3.1.1 The following work programme is submitted in line with the objectives summarised above, and in accordance with verbal communication with LCAS (meeting held 23.10.14 with attendees from RHDHV, Dong Energy and OA North). In addition, it takes cognisance of the *Soil Management Plan* (Land Research Services 2014) and the Client's *Code of Practice* (Dong Energy 2014), an on-site meeting with the Client's Health and Safety Manager (13.02.15), and a verbal communication between LCAS and OA North (17.02.15).

3.1.2 ***Site set-up and welfare facilities:*** where OA North is working in concert with a principal contractor, it is assumed that OA North staff would have access to such facilities that are available to the principal (groundwork) contractors. Where OA North is undertaking the works in advance, the following site set-up and welfare materials will be required (note that the stripping of haul road/s and welfare area will follow the archaeological method set out in *Section 3.2*, with any archaeological remains investigated and recorded in a manner that is appropriate to their significance. Arisings from this stripping will be bunded either side of the haul road and around the welfare area, with any subsoil kept separate from topsoil):

- A stripped and stoned haul road between the site entrance, welfare areas and, if large dumpers are to be used, between the archaeological areas and spoil bunding areas;
- A stripped and stoned welfare area;
- Toilet facilities and a washing and drying room adequate for up to 10 people;
- Mess/rest room adequate for up to 10 people;
- A site office adequate for up to 10 people;
- Storage for tools and finds;
- An area for refuelling;
- Parking for works vehicles;

3.1.3 ***Fencing requirements:*** the welfare area will be fenced. Following the initial phase of trial trenching, during consultation it was concluded that the palaeochannel contained within the PDA had been sufficiently examined and characterised within the scope of the earlier works. As the examination of this feature represented the only instance in which more permanent fencing or additional safety precautions were necessary, with regard to deep excavations, it is not anticipated that any further works will achieve sufficient depths to warrant such consideration. Fencing of deep excavations should not, therefore, be an issue in the strip, map and record programme. Should this situation change, however, due to the unlikely discovery of unexpectedly deep archaeological remains, this need will be reviewed and adequate provision made for the safety of staff and the general public.

3.2 Strip, Map and Record

3.2.1 ***Strip, map and record:*** the programme of strip, map and record will accurately record the location, extent, and character of any surviving archaeological features and/or deposits within two areas of interest (Area A and B), defined following synthesis of the results of the archaeological evaluation and subsequent consultation between RHDHV, LCAS, OA North and Dong Energy. **Area A** constitutes the largest block of land at *c* 1.3ha, forming a triangular shape within and to the east of the substation footprint area; it also includes the area of the putative ring gully. **Area B** (*c* 0.4ha) is located further to the west, roughly west of the centre of the substation footprint. The position of the two areas approximately reflects the spatial distribution of features of potential prehistoric origin and archaeological interest, identified during the previous phase of trial trenching. The position of the two areas will be located and set out on site using a Leica GPS1200+ series survey grade system with an accuracy of +/- 0.01m (1cm).

3.2.2 ***Plant:*** the strip, map and record exercise will utilise tracked 360° mechanical excavators fitted with wide (minimum 1.8m) toothless ditching buckets. Such machines can be as large as is considered appropriate for the ground conditions, but they must be capable of sensitive excavation. In addition, judicious use will be made of low ground-pressure tracked bulldozers for removal of the uppermost part of the topsoil, and for pushing arisings into spoil heaps (*Section 3.2.3*). All mechanical excavation will take place under the supervision of suitably experienced archaeologists, the number of whom will be dictated by the number and dispersal of the operating excavators. Dumpers may be used for the removal

of arisings, but they, together with any other plant, must not run across stripped areas until the area has been signed off by the attending archaeologist.

3.2.3 ***Stripping techniques:*** where using a 360° mechanical excavator, the topsoil can be removed in as many 'takes' of the bucket as is seen appropriate by the machine driver, but the final 'take' should aim to leave a smooth, even and clean surface, with a minimum of smearing, polishing and rutting, across a wide area which can then be inspected by the attendant archaeologist for any features of archaeological interest. Where a bulldozer is used to actually excavate topsoil, rather than just push excavated arisings, the following aspects will need to be actively managed and monitored:

- Due consideration should be given to variations in the depth of the topsoil, both as revealed by the programme of trial trenching, but also where variations are observed during the stripping exercise;

- Consideration should be given the to the depth of rutting produced by the 360° mechanical excavator and the bulldozer. This may vary across the site, due to localised differences in the soil, or from day to day, dependent on soil moisture content, as well as how hard the plant is working (*ie*, pushing soil upslope). Accordingly, rutting should be monitored regularly. However much topsoil is removed by the bulldozer, the supervising archaeologist should always try to ensure that a soil thickness greater than the depth of the bulldozer's track ruts is left in place to seal the natural alluvium. For example, the archaeologist observes that the plant tracks leave ruts that are approximately 100mm deep. The results of the evaluation in the corresponding part of the site suggest that the topsoil is 300mm thick. Accordingly, the bulldozer blade is set to remove 150mm of topsoil (leaving a shallow buffer of 50mm between the base of the track ruts and the natural geology). The remaining 150mm depth of topsoil is carefully removed down to the unrutted surface of the natural geology by the 360° mechanical excavator.

- Where it is found that the bulldozer cannot be used to remove topsoil without impacting on potential archaeological deposits, all stripping will be enacted by the 360° mechanical excavator, and the bulldozers will be used for pushing the spoil across unstripped areas and for bunding.

3.2.4 Excavated arisings will be inspected in order to collect any topsoil finds. Where there is a subsoil interface horizon above the surface of the natural boulder clay, this too will be removed (by the 360° mechanical excavator rather than by the bulldozer), ensuring that the final 'take' leaves the uppermost surface of the boulder clay smooth, even and clean, with a minimum of smearing, polishing and rutting. Topsoil and subsoil will be removed and stored separately.

3.2.5 Where appropriate, the surface of the natural geology will be cleaned by hand, using either hoes, shovel scraping, and/or trowels, depending on the subsoil conditions, and inspected for archaeological features. It should be borne in mind that over the course of several days, archaeological features can 'weather-out' and become visible as the minerals within their fills oxidise (ie, rust) upon exposure to the air. This means that features such as ditches, pits and the gullies of timber houses may only be visible after several days. For these reasons, it may be some days before an archaeologist is able to sign-off seemingly archaeologically blank areas of the site.

3.2.6 ***Arisings:*** dependent on the wishes of the client, arisings should be removed from the works areas and stockpiled and bunded at a suitable location within the wider PDA. It is understood that reinstatement will not be required subsequent to completion of the archaeological works, as this may well dovetail with additional topsoil strip in preparation of the actual construction works commencing. The position of any bunds should therefore take account of this and it would ultimately be more cost effective to position them relative to the overall scheme of works.

3.2.7 ***Archaeological supervision and discoveries:*** putative archaeological features and/or deposits identified, together with the immediate vicinity of any such features, will be cleaned by hand, using either hoes, shovel scraping, and/or trowels depending on the soil conditions. These features will be planned using a differential GPS, which is accurate to +/- 0.01m, or Total Station. Altitude information will be established with respect to Ordnance Survey Datum. A selection of the features will be sample-excavated in order to ascertain depths, state of preservation, complexity, function, date and significance.

3.2.8 All such investigation of intact archaeological deposits will be exclusively manual. Selected discrete features, such as pits and postholes, would be subject to 50% examination (ie, half-sectioned) in the first instance, linear features will be subject to a 20% sample with slots a minimum of 1m wide.

3.2.9 ***Recording strategy:*** all information identified in the course of the site works will be recorded stratigraphically, using a system, adapted from that used by Centre for Archaeology Service of English Heritage, with sufficient pictorial record (plans, sections, and digital photographs) to identify and

illustrate individual features. Primary records will be available for inspection at all times. Results, comprising a full description and preliminary classification of features or materials revealed, will be recorded on *pro-forma* context sheets, and will be accompanied with sufficient pictorial record to identify and illustrate individual features. Sections will be generated and features will be planned accurately at appropriate scales. An indexed photographic record, utilising high-resolution digital imaging, will be undertaken simultaneously, and all frames will include a visible, graduated metric scale. The site archive will include both a photographic record and accurate large scale plans and sections at an appropriate scale (1:50, 1:20 and 1:10). All artefacts and ecofacts will be recorded using the same system, and will be handled and stored according to standard practice (following current Chartered Institute for Archaeologists guidelines) in order to minimise deterioration.

3.2.10 ***Significant archaeological findings:*** following the exploratory investigation of the features, should it be found that the archaeological remains are of high significance, it is likely that LCAS would recommend a more formal process of excavation and a revision to the present project design, more accurately reflecting the nature of the discovery, and the attendant academic aims and objectives, both in terms of the fieldwork requirements, and of the post-excavation programme, which may include detailed analysis and publication. All such works would be submitted to the client as a resource variation to the present scope of works.

3.2.11 ***Treatment of finds:*** all finds will be exposed, lifted, cleaned, conserved, marked, bagged and boxed in accordance with the United Kingdom Institute for Conservation (UKIC) *First Aid For Finds*, 1998 (new edition) and the recipient museum's guidelines. All identified finds and artefacts will be retained, although certain classes of building material can sometimes be discarded after recording if an appropriate sample is retained on advice from the recipient museum's archive curator and/or LCAS.

3.2.12 ***Treasure:*** any gold and silver artefacts recovered during the course of the excavation will be removed to a safe place and reported to the local Coroner according to the procedures relating to the Treasure Act, 1996. Where removal cannot take place on the same working day as discovery, suitable security will be employed to protect the finds from theft.

3.2.13 ***Human Remains****:* any human remains revealed by the works will be left *in situ*, covered and protected. No further investigation will continue beyond that required to establish the date and character of the burial. The RHDHV archaeologist, DONG Energy, LCAS and the local Coroner will be informed immediately. If removal is essential, the exhumation of any funerary remains will require the provision of a Ministry of Justice license, under section 25 of the Burial Act of 1857. An application will be made by OA North for the site area on discovery of any such remains and the removal will be carried out with due care and sensitivity under the environmental health regulations. The cost of removal or treatment will be agreed with the client and costed as a variation.

3.2.14 ***Environmental sampling for plants, faunal remains, technological remains and artefacts:*** the recovery of adequate samples of environmental material can provide useful information for an understanding of processes acting upon the site and for placing the site within a wider ecological context. Bulk sediment samples of *c* 40 litres will be collected from any suitable (undisturbed, uncontaminated and of non-modern origin) deposits or features of demonstrable anthropological origin for the recovery of plant and faunal remains.

3.2.15 ***Samples for scientific dating:*** should deposits, or material within deposits, suitable for radiocarbon assay be encountered, samples will be taken wherever possible. These would include well-stratified artefacts and ecofacts, but also suitable material collected from environmental samples through flotation and, in the case of ceramics, from any bulk sieving, wet sieving and hand-collection. Samples for dendrochronological or archaeomagnetic dating would be taken in conjunction with specialist advice, for example if any core structural stones demonstrably associated with hearth, kiln or furnace features were identified during the course of archaeological site works.

3.3 Report and Archive

3.3.1 ***Report:*** notwithstanding the completion of specialist assessments, a draft report will be submitted to the RHDHV archaeologist and DONG Energy within 12 weeks of the completion of fieldwork (although a 'completion statement' detailing the high-level findings must be made available within 2 weeks and an interim report within 4 weeks). Following the incorporation of comments, copies of the final report will be submitted to the RHDHV archaeologist, DONG Energy and to LCAS. The report will include:

- a site location plan related to the national grid
- a front cover to include the planning application number and the NGR
- a QA sheet detailing as a minimum title, author, version, date, checked by, approved by

- the dates on which each phase of the programme of work was undertaken
- a concise, non-technical summary of the results
- aims and objectives
- an explanation to any agreed variations to the WSI, including any justification for any analyses not undertaken
- a description of the methodology employed, work undertaken and results obtained
- plans and sections at an appropriate scale showing the location and position of deposits and finds
- photographic plates as appropriate
- a list of and dates for any finds recovered and a description and interpretation of the deposits identified
- a description of any environmental or other specialist assessment undertaken, the results obtained and of the recommendations for any appropriate programme of analysis
- a statement of the significance of the results in their local, regional and national context, if required, cross referenced to the regional research agendas, as appropriate
- conclusions/discussion
- where there is scope and justified requirement for further work and publication, the scope of those works will be presented within an updated project design, complete with a timetable and schedule of costs
- a copy of this WSI, and indications of any agreed departure from the design
- the report will also include a complete bibliography of sources from which data has been derived.
- a summary of the archive.

3.3.2 The report will be in the same basic format as this WSI; a copy of the report can be provided on CD, if required. Recommendations concerning any subsequent mitigation strategies and/or further archaeological work following the results of the archaeological investigations will be provided in a separate communication.

3.3.3 ***Confidentiality:*** all internal reports to the client are designed as documents for the specific use of the client, for the particular purpose as defined in the project brief and project design, and should be treated as such. They are not suitable for publication as academic documents or otherwise without amendment or revision.

3.3.4 ***Archive:*** the results of all archaeological work carried out will form the basis for a full archive to professional standards, in accordance with current English Heritage guidelines (*Management of Research Projects in the Historic Environment*, 2006 and *Management of Archaeological Projects*, 2nd edition, 1991). The project archive will include summary processing and analysis of all features, finds, or palaeoenvironmental data recovered during fieldwork, which will be catalogued by context.

3.3.5 The deposition of a properly ordered, fully integrated and indexed project archive in an appropriate repository is essential and archive will be provided in the English Heritage Centre for Archaeology format and a synthesis will be submitted to the Lancashire HER, Preston (the index to the archive and a copy of the report). Dependent on the quantity and significance of any finds, the archive will either be deposited with the Lancaster Museum, or, where no artefactual archive is to be retained, with the Lancashire Record Office, Preston.

3.3.6 All artefacts will be processed to MAP2 standards and will be assessed by OA North's in-house finds specialists. The deposition and disposal of any artefacts recovered in the course of the archaeological investigations will be agreed with the legal owner and an appropriate recipient museum (likely to be the Lancaster Museum). Discussion regarding the museum's requirement for the transfer and storage of finds will be conducted prior to the commencement of the project, and the RHDHV archaeologist and LCAS will be notified of the arrangements made.

3.3.7 ***OASIS:*** an OASIS form will be completed as part of the works.

4. Other Matters

4.1 Health and Safety

4.1.1 OA North must provide a Health and Safety Statement and copy of their company Safety policy. All site procedures must be in accordance with the guidance set out in the Health and Safety Manual compiled by the Standing Conference of Archaeological Unit Managers (1997). A site-specific Health and Safety plan and Method Statement, accompanied by a written risk assessment will be undertaken in advance of project commencement and copies must be made available on request to all interested parties.

4.1.2 Full regard must be given to all constraints (services *etc*) during the fieldwork as well as to all Health and Safety considerations. **Information regarding services within the study area will be provided by DONG Energy and must be used during the course of the archaeological investigation works.**

4.2 Project monitoring

4.2.1 While the work is undertaken for the client, LCAS will be kept fully informed of the work and its results, and will be notified a week in advance of the commencement of the fieldwork. Any proposed changes to the WSI will be agreed with the RHDHV archaeologist, DONG Energy and LCAS in consultation with the client. Fieldwork will be monitored by the RHDHV archaeologist and LCAS on behalf of DONG Energy.

4.3 Work timetable

4.3.1 ***Strip, Map and Record***: approximately four to six weeks will be required to strip Areas A and B. Dependent on the nature of the findings, it may be possible to complete investigation and recording of archaeological remains within that period. However, it is possible that up to six additional weeks may be required to complete the investigation.

4.3.2 ***Report:*** copies of the draft report, as outlined in *Section 3.3.1*, will be issued to the client and other relevant parties within twelve weeks of the completion of fieldwork, unless otherwise agreed. A 'completion statement' must, however, be made available within two weeks, detailing the high-level findings of the archaeological investigation works and an interim report made available within four weeks.

4.3.3 ***Archive***: the archive must be deposited within six months following submission of the report, unless otherwise instructed.

4.4 Staffing

4.4.1 The project will be under the direct management of **Stephen Rowland** (OA North Senior Project Manager) to whom all correspondence should be addressed. The strip, map and record will involve a suitably sized team of experienced archaeologists led by an OA North Project Officer. All such staff at OA North are experienced archaeologists capable of undertaking small-, medium- and large-scale projects in a range of urban and rural situations. The finds will be processed, studied and reported upon, either by, or under the guidance of, **Chris Howard-Davies** (OA North Finds Manager) who has extensive experience of finds from all periods, but particularly prehistoric and Roman material. All environmental sampling and assessment will be undertaken under the auspices of **Dr Denise Druce** (OA North Environmental Manager) who has unparalleled experience of palaeoenvironmental work in the North West and who heads an excellent team of environmental archaeologists.

4.5 Insurance

4.5.1 OA North has a professional indemnity cover to a value of £2,000,000; proof of which can be supplied as required.

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APPENDIX 3: SUMMARY OF TRENCH RESULTS

Phase 1: Palaeochannel development

Phase 1a: Additional palaeochannels and probable natural features

Phase 2: Post medieval or modern features

Trench	**Dimension**	**Orientation**	**Rational**	**Provisional Phasing**	**Description of Findings**
ATT001	30m x 2m	E-W	Sample general area north of palaeochannel	None	Blank. No archaeology Topsoil>0.30m thick Clay natural
ATT002	30m x 2m	E-W	Sample general area north of palaeochannel	None	Blank. No archaeology Topsoil>0.30m thick Subsoil reported but probably result of over machining Clay natural
ATT003	30m x 2m	E-W	Sample general area north of palaeochannel	None	Blank. No archaeology Topsoil>0.30m thick Clay natural
ATT004	30m x 2m	E-W	Sample general area south of palaeochannel	Phase 1a	Topsoil>0.20m thick Possible shallow ditch/gully (404)[405] extending NE-SW Clay natural
ATT005	50m x 2m	E-W	Sample general area south of palaeochannel	Phase 1a	Topsoil>0.30m thick Possible ring ditch/drip gully with a peaty upper fill (***502***)(***508***)[***503***] and (***504***)(***507***)[***505]*** Possible stake hole (***509***)[***510***] Clay natural
ATT006	30m x 2m	E-W	Sample general area north of palaeochannel	Phase 1a	Topsoil>0.20m thick Possible shallow ditch/gully extending N-S (***604***)[***605***] A possible pit (***606***)[***607***] and a natural feature (***611***)[***612***] One linear feature discounted as natural Clay natural
ATT007	20m x 3m	E-W	Sample general area north of palaeochannel Sondage excavated toinvestigate the uderlying alluvial deposits	None	Blank. No archaeology Topsoil>0.28m thick Clay natural>1.50m thick Dark grey alluvial deposits>2m thick End of excavation
ATT008	20m x 3m	E-W	Sample general area south of palaeochannel	None	Blank. No archaeology Topsoil>0.18m thick Clay natural
ATT009	30m x 2m	E-W	Sample general area south of palaeochannel	None	Blank. No archaeology Topsoil>0.20m thick Subsoil reported>0.20m thick but probably just over machining of natural Clay natural
ATT010	15m x 3m	N-S	Sample general area north of palaeochannel	Phase 1a	Topsoil>0.20m thick Subsoil>0.05m thick but probably representing over machining A linear feature was identified in plan extending E-W and after excavation of a box section was found to potentially consist of 3 or more cuts and associated

Trench	Dimension	Orientation	Rational	Provisional Phasing	Description of Findings
					sequence of fills. Primary feature [***1001***](***1008***)(***1002***) Secondary feature [***1005***](***1006***)(***1009***)(***1007***) Tertiary feature [***1003***](***1004***) Field drain Clay natural
ATT011	30m x 2m	E-W	Sample general area south of palaeochannel. Sondage to be excavated	Phase 1a	Topsoil>0,30m thick. Linear feature representing a possible ditch terminal extending N-S across west end. Includes a sequence of two potential cuts and associated fill sequence as well as a possible post hole excavated into the top Primary feature [***1102***]+[***1110***] (***1103***)+(***1111***) Secondary feature may include a pit cut into the ditch terminus [***1104***]+[***1112***] (***1105***)(***1106***)(***1107***)+(***1113***)(***1114)(1115***)(***1116***)(***1118***) Possible post hole [***1108***](***1109***) Possible second ditch terminus at eastern end of trench [***1119***](***1120***)(***1121***)(***1122***)
ATT012	15m x 3m	E-W	Sample general area north of palaeochannel	None	Blank. No archaeology Topsoil>0.35m An irregular feature with a peaty fill was examined but identified as bioturbation or other natural origin Clay natural
ATT013	20m x 3m	NE-SW	Sample general area north of palaeochannel	Phase 1a and 2	Topsoil>0.30m thick Field drains aligned E-W Shallow gully/ditch on same alignment as field drains [***1303***](***1302***) A possible irregular pit with a peaty fill [***1305***](***1304***) Clay natural
ATT014	20m x 3m	E-W	Sample general area south of palaeochannel.	Phase 1	Blank. No archaeology Topsoil>0.53m thick Shallow sondage excavated at east end to explore a possible buried soil horizon which proved negative Southern edge of the main palaeochannel evident extending across the NW corner of the trench, not excavated Clay natural
ATT015	20m x 3m	E-W	Sample general area south of palaeochannel. Sondage excavated across the eastern end of trench	Phase 1a	Topsoil>0.30m thick A single ditch [***1506***](***1504***)(***1505***) curves from the north to the west. At its western extent the ditch split into two separate features [***1507***](***1509***) and [***1508***](***1510***) Clay natural>1.40m thick Sondage revealed alluvial deposits below the clay natural >2.30m thick
ATT016	30m x 4m	E-W	Excavated across the palaeochannel	Phase 1	No archaeology Topsoil>0.30m thick Sondage excavated across the main palaeochannel and additional feature

Trench	Dimension	Orientation	Rational	Provisional Phasing	Description of Findings
					interpreted as a tributary palaeochannel
ATT017	15m x 3m	N-S	Sample general area west of palaeochannel.	Phase 1a	Topsoil>0.35m thick Possible linear feature extending E-W very vague diffuse edge and doubtful lower fill Clay natural
ATT018	30m x 4m	E-W	Excavated across the palaeochannel	Phase 1	No archaeology Topsoil>0.55m thick Palaeochannel exposed in plan but not otherwise excavated Clay natural
ATT019	50m x 2m	E-W	Sample general area away from and south of the palaeochannel	Phase 2	Topsoil>0.40m thick Series of 6 or more field drains Large linear subsequently found to contain a large ceramic drain Series of linear features [***1903***](***1904***) + [***1910***](***1911***) cut by several pits [***1912***][***1915***](***1916***)(***1913***) one obviously modern [***1918***]. A possible posthole was cut into one section of the ditch. An area of made ground deposits not excavated Two possible pit features located in the eastern end of trench [***1921***](***1922***) and [***1919***](***1920***) Clay natural with increasing stone + sand content
ATT020	50m x 2m	NE-SW	Sample general area away from and south of the palaeochannel	Phase 1a and 2	Topsoil>0.30m thick Field drain extending length of trench A possible shallow pit with peaty fill at the NE end of trench [***2001***](***2002***) with another feature discounted as rooting One ditch [***2004***](***2003***) extending E-W with a second probable ditch running parallel 2m to the north [***2007***](***2006***)(***2005***) May intersect a further but more doubtful ditch extending N-S [***2010***](***2009***)(***2008***) Clay natural
ATT021	20m x 3m	E-W	Sample general area north of palaeochannel	Phase 1a	Topsoil>0.50m thick Field drain extended length of trench Possible shallow ditch/gully extending NW-SE [***2105***](***2104***) Uncertain feature at western end of trench [***2103***](***2102***) Clay natural
ATT022	30m x 4m	N-S	Excavated across the palaeochannel	Phase 1	No archaeology Topsoil>0.30m thick Sondage excavated across the main palaeochannel Clay natural
ATT023	30m x 2m	E-W	Sample general area away from and north of the palaeochannel Sondage excavated	Phase 1	Blank. No archaeology Topsoil>0.30m thick Sondage excavated to a depth of >4m at eastern end of trench Clay natural>1.24m thick

Trench	Dimension	Orientation	Rational	Provisional Phasing	Description of Findings
			at eastern end of trench.		Alluvial deposits>2.50m thick A piece of bog wood was encountered at the top of the alluvium, wood sampled
ATT024	15m x 3m	N-S	Sample general area away from and north of the palaeochannel	Phase 2	Topsoil>0.18m thick Subsoil>0.40m thick A linear feature extended E-W across the northern end of trench [***2506***](***2504***)(***2505***) containing peat layers, interpreted as a possible palaeochannel Clay natural>0.30m thick Alluvial deposits exposed at base
ATT025	20m x 3m	E-W	Sample general area away from and north of the palaeochannel	None	Blank. No archaeology Topsoil>0.50m thick Subsoil>0.20m thick Modern field drain Clay natural
ATT026	30m x 2m	E-W	Sample general area north of the palaeochannel	None	Blank. No archaeology Topsoil>0.25m thick Field drains Clay natural
ATT027	20m x 3m	E-W	Sample general area away from and north of the palaeochannel. Sondage excavated at western end of trench.	Phase 1a	Topsoil>45m thick Possible irregular pit with a peaty fill [***2704***](***2703***)(***2702***) Sondage excavated to >4m depth Clay natural>1.50m thick Alluvial deposits>2m thick
ATT028	30m x 3m	E-W	Sample general area away from and north of the palaeochannel	None	Blank. No archaeology Topsoil>0.60m thick Field drain Clay Natural
ATT029	20m x 3m	E-W	Sample general area away from and north of the palaeochannel Sondage excavated at eastern end of trench.	Phase 1a	Topsoil>0.40m thick Irregular linear feature meandering SW-NE [***2903***]+[***2905***] (***2904***)(***2906***)(***2907***) Possible palaeochannel Sondage excavated to >4m depth Clay natural>1.50m thick Alluvial deposits>2m thick
ATT030	15m x 3m	E-W	Sample general area away from and north of the palaeochannel	None	Blank. No archaeology Topsoil>0.30m thick Field drain Irregular features containing peaty fills examined but dismissed as natural Clay natural
ATT031	30m x 4m	E-W	Excavated across the palaeochannel	Phase 1 and 1a	Topsoil>0.60m thick Field drain Linear feature with a peaty fill thought to be a ditch cut into top of palaeochannel [***3103***](***3104***)(***3105***) Upon excavation of sondage across palaeochannel found to be the upper fill of the channel One possible irregular pit with a peaty fill dismissed as natural Clay natural>0.50m thick Alluvial deposits exposed at base of

Trench	Dimension	Orientation	Rational	Provisional Phasing	Description of Findings
					channel
ATT032	50m x 2m	E-W	Sample general area away from and north of the palaeochannel	Phase 1a	Topsoil>0.50m thick A possible shallow linear feature extending NE-SW and terminating in the trench [***3209***](***3208***) with wood in the fill A possible pit [***3211***](***3210***) Several other linear and discrete features were examined but thought to be natural Clay natural
ATT033	30m x 2m	E-W	Sample general area away from and north of the palaeochannel	None	Blank. No archaeology Topsoil>0.20m thick Subsoil>0.40m thick Clay natural
ATT034	30m x 2m	E-W	Sample general area away from and north of the palaeochannel	None	Blank. No archaeology Topsoil>0.20m thick Subsoil>0.40m thick Clay natural
ATT035	30m x 2m	E-W	Sample general area away from and north of the palaeochannel	None	Blank. No archaeology Topsoil>0.70m thick Clay natural
ATT036	15m x 3m	NW-SE	Sample general area away from and south of the palaeochannel	Phase 1a	Topsoil>0.40m thick Irregular spread of peaty material probably a tree throw Very shallow linear feature extending E-W [***3601***](***3602***) Clay natural with increasing stone + sand content
ATT037	30m x 2m	NE-SW	Sample general area away from and south of the palaeochannel at the base of a rising slope to the SE	None	Blank. No archaeology Topsoil>0.36m thick Peat horizon exposed. Unclear if this overlies the alluvial deposits or represents peat deposits exposed as overburden thins rising up the slope
ATT038	30m x 2m	NE-SW	Sample general area away from and south of the palaeochannel at the base of a rising slope to the SE	Phase 2	Topsoil>0.30m thick Series of field drains An isolated feature interpreted as a post hole [***3803***](***3804***) Clay natural
ATT039	30m x 2m	E-W	Sample general area away from and south of the palaeochannel on a slope rising to the SE	Phase 2	Topsoil>0.55m thick Shallow linear feature extending NE-SW sandy fill containing stone and coal Clay natural with increasing stone + sand content
ATT040	30m x 2m	N-S	Sample general area away from and south of the palaeochannel on top of a slope descending to the SW	None	Blank. No archaeology Topsoil>0.40m thick Clay natural with increasing stone + sand content
ATT041	30m x 2m	E-W	Sample general area away from and south of the palaeochannel on a slope rising to	Phase 2	Topsoil>0.50m thick Possible ditch extending NE-SW with a modern mixed fill [***4103***](***4104***)(***4105***) with possible recut [***4107***](***4108***)(***4109***) Peat deposit at base of slope

Trench	Dimension	Orientation	Rational	Provisional Phasing	Description of Findings
			the SE		Clay natural with increasing stone + sand content
ATT042	30m x 2m	N-S	Sample general area away from and south of the palaeochannel	None	Blank. No archaeology Topsoil>0.40m thick Clay natural
ATT043	30m x 2m	N-S	Sample general area away from and south of the palaeochannel	None	Blank. No archaeology Topsoil>0.60m thick Clay natural
ATT044	50m x 2m	N-S	Sample general area away from and north of the palaeochannel	Phase 1a	Topsoil>0.45m thick Series of field drains Shallow pit with peaty fill at southern end [***4402***](***4401***) Irregular feature examined at northern end of trench but found to be natural Clay natural
ATT045	30m x 2m	N-S	Sample general area away from and north of the palaeochannel	None	Blank. No archaeology Topsoil>0.30m thick Series of field drains Clay natural

APPENDIX 4: CONCORDANCE OF CONTEXTS

Trench No	Context No	Context Type	Description
ATT004	0403	Deposit	Light grey silty clay natural
ATT004	0404	Deposit	Medium brown silty clay fill of ***0405***
ATT004	0405	Cut	Shallow V-shaped cut of possible ditch
ATT004	0406	Deposit	Medium grey brown silty clay topsoil
ATT005	0501	Deposit	Topsoil
ATT005	0502	Deposit	Dark grey brown silty clay secondary fill of ***0503***
ATT005	0503	Cut	V-shaped cut of curvilinear ditch/gully
ATT005	0504	Deposit	Dark reddish brown silty clay secondary fill of ***0505***
ATT005	0505	Cut	V-shaped cut of curvilinear ditch/gully
ATT005	0506	Deposit	Light yellow grey clay natural
ATT005	0507	Deposit	Yellowish grey silty clay primary fill of ***0505***
ATT005	0508	Deposit	Medium light grey silty clay primary fill of ***0503***
ATT005	0509	Deposit	Dark grey brown silty clay fill of ***0510***
ATT005	0510	Cut	Subcircular cut of possible stake hole
ATT006	0601	Deposit	Light yellow grey clay natural
ATT006	0604	Deposit	Medium brown silty clay fill of ***0605***
ATT006	0605	Cut	Irregular shaped cut of possible ditch
ATT006	0606	Deposit	Medium brown silty clay fill of ***0607***
ATT006	0607	Cut	Sun-oval cut of possible pit
ATT006	0611	Deposit	Medium brown silty clay fill of ***0612***
ATT006	0612	Cut	Sub-oval cut of probable natural feature
ATT006	0614	Deposit	Medium grey brown silty clay topsoil
ATT010	1001	Cut	U-shaped cut of possible ditch
ATT010	1002	Deposit	Light grey blue fill of ***1001***
ATT010	1003	Cut	U-shaped cut of possible ditch/gully
ATT010	1004	Deposit	Medium grey silty clay fill of ***1003***
ATT010	1005	Cut	Irregular shaped possible re-cut of ***1001***
ATT010	1006	Deposit	Dark grey silt clay fill of ***1005***
ATT010	1007	Deposit	Light yellowish grey silty clay fill of ***1005***
ATT010	1008	Deposit	Dark brown silty clay fill of ***1001***
ATT010	1009	Deposit	Medium greyish orange fill of ***1005***
ATT011	1101	Deposit	Medium grey brown silty clay topsoil
ATT011	1102	Cut	V-shaped cut of possible ditch
ATT011	1103	Deposit	Medium grey brown silty clay fill of ***1102***
ATT011	1104	Cut	Slightly irregular V-shaped possible re-cut of ***1102***
ATT011	1105	Deposit	Light greyish brown silty clay fill of ***1104***
ATT011	1106	Deposit	Dark reddish brown silty clay fill of ***1104***
ATT011	1007	Deposit	Medium greyish brown silty clay fill of ***1104***
ATT011	1108	Cut	V-shaped cut of possible post hole
ATT011	1109	Deposit	Light grey silty clay fill of ***1108***
ATT011	1110	Cut	U-shape cut of possible ditch
ATT011	1111	Deposit	Medium greyish brown silty clay fill of ***1110***
ATT011	1112	Cut	U-shaped re-cut of ***1110***
ATT011	1113	Deposit	Medium greyish brown silty clay fill of ***1112***
ATT011	1114	Deposit	Dark reddish brown silty clay and peat fill of ***1112***
ATT011	1115	Deposit	Medium greyish brown silty clay fill of ***1112***
ATT011	1116	Deposit	Yellowish brown sandy clay fill of ***1112***
ATT011	1117	Deposit	Medium greyish brown silty clay topsoil
ATT011	1118	Deposit	Medium greyish brown re-deposited topsoil
ATT011	1119	Cut	Irregular shaped cut of possible ditch terminal
ATT011	1120	Deposit	Medium yellowish brown silty clay fill of ***1119***
ATT011	1121	Deposit	Dark brown silty clay and peat fill of ***1119***
ATT011	1122	Deposit	Medium greyish brown silty clay fill of ***1119***
ATT013	1301	Deposit	Medium greyish brown silty clay topsoil

Trench No	Context No	Context Type	Description
ATT013	1302	Deposit	Medium orange brown silty clay fill of ***1303***
ATT013	1303	Cut	V-shaped cut of ditch
ATT013	1304	Deposit	Dark grey brown silty clay and peat fill of ***1305***
ATT013	1305	Cut	Irregular shaped cut of possible pit
ATT015	1501	Deposit	Light greyish brown silty clay topsoil
ATT015	1502	Deposit	Light grey silty clay subsoil
ATT015	1503	Deposit	Light grey clay natural
ATT015	1504	Deposit	Light brownish grey clayey silt fill of ***1506***
ATT015	1505	Deposit	Dark greyish brown clayey silt primary fill of cut ***1506***
ATT015	1506	Cut	Irregular shaped cut of ditch
ATT015	1507	Cut	Irregular shaped cut of ditch
ATT015	1508	Cut	Irregular shaped cut of ditch
ATT015	1509	Deposit	Dark brown clayey silt fill of ***1507***
ATT015	1510	Deposit	Dark brown clayey silt fill of ***1508*** produced post-med pot
ATT017	1701	Deposit	Light brownish grey silty clay topsoil
ATT017	1702	Deposit	Dark grey brown silty clay with peat fill of ***1704***
ATT017	1703	Deposit	Medium grey brown silty clay fill of ***1704***
ATT017	1704	Cut	Irregular shaped cut of possible ditch
ATT017	1705	Deposit	Medium orange brown clay natural
ATT017	1706	Deposit	Medium orange grey brown clay natural
ATT019	1901	Deposit	Light yellowish grey clay natural
ATT019	1902	Deposit	Medium grey brown silty clay topsoil
ATT019	1903	Cut	Curvilinear cut of ditch/gully same as ***1908*** and ***1910***
ATT019	1904	Deposit	Medium greyish brown silty clay fill of ***1903***
ATT019	1905	Cut	V-shaped cut of possible post hole truncating ***1904***
ATT019	1906	Deposit	Dark grey silty clay fill of ***1905***
ATT019	1907	Deposit	Dark brown silty clay fill of ***1905***
ATT019	1908	Cut	Curvilinear cut of ditch/gully same as ***1903*** and ***1910***
ATT019	1909	Deposit	Medium greyish brown silty clay fill of ***1908***
ATT019	1910	Cut	Curvilinear cut of ditch/gully same as ***1903*** and ***1908***
ATT019	1911	Deposit	Medium greyish brown silty clay fill of ***1910***
ATT019	1912	Cut	Sub-circular cut of pit truncating ***1911***
ATT019	1913	Deposit	Dark brown silty clay fill of ***1915***
ATT019	1914	Deposit	Medium greyish brown silty clay fill of ***1915***
ATT019	1915	Cut	Irregular shaped cut of pit truncating ***1911***
ATT019	1916	Deposit	Dark brown silty clay fill of ***1912***
ATT019	1917	Deposit	Medium greyish brown silty clay fill of ***1912***
ATT019	1918	Cut	Cut of modern pit
ATT019	1919	Cut	Oval cut of pit
ATT019	1920	Deposit	Dark brown silty clay fill of ***1919***
ATT019	1921	Cut	Oval cut of pit
ATT019	1922	Deposit	Dark reddish brown silty clay fill of ***1921***
ATT020	2001	Cut	Sub-circular cut of possible pit
ATT020	2002	Deposit	Dark grey brown silty clay with peat fill of ***2001***
ATT020	2003	Deposit	Dark grey brown with orange brown mottling silty clay fill of ***2004***
ATT020	2004	Cut	V-shaped cut of ditch
ATT020	2005	Deposit	Dark grey brown silty clay secondary fill of ***2007***
ATT020	2006	Deposit	Medium orange brown silty clay possible primary fill of ***2007***
ATT020	2007	Cut	Uneven V-shaped cut of possible ditch
ATT020	2008	Deposit	Dark grey brown silty clay fill of ***2010***
ATT020	2009	Deposit	Medium grey brown silty clay possible primary fill of ***2007***
ATT020	2010	Cut	Uncertain V-shaped cut of possible ditch/gully
ATT020	2011	Deposit	Medium grey brown silty clay topsoil
ATT020	2012	Deposit	Light yellow grey clay natural

Trench No	Context No	Context Type	Description
ATT021	2101	Deposit	Light yellowish grey clay natural
ATT021	2102	Deposit	Medium brown sandy clay fill of ***2103***
ATT021	2103	Cut	Irregular shaped cut of possible pit or linear terminus
ATT021	2104	Deposit	Medium brown sandy clay fill of ***2105***
ATT021	2105	Cut	Slightly irregular cut of possible shallow ditch/gully
ATT021	2109	Deposit	Medium grey brown silty clay topsoil
ATT022	2201	Deposit	Dark brown silty clay with peat fill of palaeochannel ***2204***
ATT022	2202	Deposit	Light bluish grey silty clay primary fill of palaeochannel **2204**
ATT022	2203	Deposit	Medium greyish blue silty clay marine alluvial layer
ATT022	2204	Cut	V-shaped cut of palaeochannel
ATT022	2205	Deposit	Medium grey brown silty clay topsoil
ATT022	2206	Deposit	Medium yellowish orange silty clay natural
ATT022	2207	Deposit	Same as ***2206***
ATT024	2401	Deposit	Medium grey brown clayey silt topsoil
ATT024	2402	Deposit	Medium orange brown clay natural
ATT024	2403	Deposit	Medium grey silty clay marine alluvial deposit
ATT024	2404	Deposit	Light grey and orange brown clay secondary fill of ***2406***
ATT024	2405	Deposit	Dark brown and medium grey silty clay with peat layers primary fill of ***2406***
ATT024	2406	Cut	Slightly irregular V-shaped cut of ditch or possible palaeochannel
ATT027	2701	Deposit	Medium grey brown silty clay topsoil
ATT027	2702	Deposit	Dark grey brown silty clay with peat fill of ***2704***
ATT027	2703	Deposit	Medium grey brown with orange mottling silty clay fill of **2704**
ATT027	2704	Cut	Sub-rectangular shaped cut of possible pit
ATT027	2705	Deposit	Light yellow grey clay natural
ATT029	2901	Deposit	Medium grey brown silty clay topsoil
ATT029	2902	Deposit	Light yellowish grey clay natural
ATT029	2903	Cut	Curvilinear cut of sinuous feature
ATT029	2904	Deposit	Medium reddish brown silty clay with peat fill of ***2903***
ATT029	2905	Cut	Curvilinear cut of sinuous feature
ATT029	2906	Deposit	Medium yellowish grey silty clay fill of ***2905***
ATT029	2907	Deposit	Same as ***2906***
ATT029	2908	Deposit	Medium reddish brown silty clay with peat fill of ***2905***
ATT031	3101	Deposit	Light brownish grey clayey silt topsoil
ATT031	3102	Deposit	Light orange brown clay natural
ATT031	3103	Deposit	Dark brown silty clay with peat fill of palaeochannel ***3106***
ATT031	3104	Deposit	Light grey clay fill of palaeochannel ***3106***
ATT031	3105	Deposit	Medium grey clay marine alluvial deposit
ATT031	3106	Cut	V-shaped cut of palaeochannel
ATT032	3201	Deposit	Light yellowish grey clay natural
ATT032	3202	Deposit	Medium grey brown silty clay with peat fill of ***3203***
ATT032	3203	Cut	Sub-oval cut of probable natural feature
ATT032	3204	Deposit	Dark greyish brown sandy clay fill of ***3205***
ATT032	3205	Cut	Irregular cut of probable natural linear feature
ATT032	3206	Deposit	Medium yellow brown fill of ***3207***
ATT032	3207	Cut	Irregular cut of possible natural linear feature
ATT032	3208	Deposit	Medium Grey brown sandy clay fill of ***3209***
ATT032	3209	Cut	Shallow cut of possible ditch/gully
ATT032	3210	Deposit	Medium brown sandy clay fill of ***3211***
ATT032	3211	Cut	Sub-oval shaped cut of a possible pit
ATT032	3217	Deposit	Medium grey brown silty clay topsoil
ATT036	3601	Cut	Shallow cut of possible ditch
ATT036	3602	Deposit	Medium grey silty clay fill of ***3601***

Trench No	Context No	Context Type	Description
ATT036	3603	Cut	Irregular cut of probable tree throw
ATT036	3604	Deposit	Dark grey sandy clay fill of ***3603***
ATT038	3801	Deposit	Dark greyish brown silty clay topsoil
ATT038	3802	Deposit	Light orange grey clay natural
ATT038	2803	Cut	Circular cut of possible post hole
ATT038	3804	Deposit	Medium brown sandy silty clay fill of ***3803***
ATT039	3901	Deposit	Medium greyish brown silty clay topsoil
ATT039	3902	Deposit	Light yellowish grey clay natural
ATT039	3903	Cut	Shallow concave cut of probable ditch
ATT039	3904	Deposit	Medium brown sandy clay fill of ***3903***
ATT039	3905	Deposit	Medium brown sandy silty clay fill containing frequent coal inclusions of cut ***3903***
ATT039	3906	Deposit	Medium brown sandy silty clay fill containing post-med pottery, metal and CBM of cut ***3903***
ATT041	4101	Deposit	Light yellowish brown sandy clay natural
ATT041	4102	Deposit	Medium grey brown silty sandy clay topsoil
ATT041	4103	Cut	U-shaped cut of possible ditch
ATT041	4104	Deposit	Medium yellowish grey silty clay fill of ***4103***
ATT041	4105	Deposit	Medium grey silty clay fill of ***4103***
ATT041	4106	Deposit	Light brown silty clay fill of ***4103***
ATT041	4107	Cut	U-shaped possible re-cut of ***4103***
ATT041	4108	Deposit	Medium grey silty clay fill of ***4107***
ATT041	4109	Deposit	Medium grey silty clay fill of ***4107***
ATT044	4401	Deposit	Dark brown silty clay with peat fill of ***4402***
ATT044	4402	Cut	Sub-circular fill of possible pit
ATT044	4403	Deposit	Medium grey brown silty clay topsoil
ATT044	4404	Deposit	Light yellowish grey clay natural
Area A	5000	Layer	Clay Natural
Area A	5001	Cut	East-west aligned ditch
Area A	5002	Deposit	Primary fill of ditch ***5001***
Area A	5003	VOID	VOID
Area A	5004	VOID	VOID
Area A	5005	Layer	Topsoil
Area A	5006	Cut	Cut of ditch
Area A	5007	Deposit	Fill of ditch ***5006***
Area A	5008	Cut	Cut of ditch
Area A	5009	Deposit	Primary fill of ditch ***5008***
Area A	5010	Deposit	Secondary fill of ditch ***5008***
Area A	5011	Cut	Cut of north-east/south-west aligned ditch/gully
Area A	5012	Deposit	Fill of ditch/gully ***5011***
Area A	5013	Cut	Cut of north-east/south-west aligned ditch/gully terminus
Area A	5014	Deposit	Primary fill of ditch/gully terminus ***5013***
Area A	5015	Deposit	Secondary fill of ditch/gully terminus ***5013***
Area A	5016	Cut	Cut of ditch
Area A	5017	Deposit	Primary fill of ditch ***5016***
Area A	5018	Deposit	Secondary fill of ditch ***5016***
Area A	5019	Cut	Cut of discrete feature
Area A	5020	Deposit	Fill of ***5019***
Area A	5021	Deposit	Black sand band within ***5019***
Area A	5022	Deposit	Grey deposit within ***5019***
Area A	5023	Cut	Cut of possible terminus to linear feature
Area A	5024	Deposit	Primary fill of ***5023***
Area A	5025	Deposit	Secondary fill of ***5023***
Area A	5026	Cut	Cut of gully
Area A	5027	Deposit	Primary fill of ***5026***

Trench No	Context No	Context Type	Description
Area A	5028	Deposit	Secondary fill of ***5026***
Area A	5029	Cut	Cut of discrete feature
Area A	5030	Deposit	Primary fill of ***5029***
Area A	5031	Deposit	Secondary fill of ***5029***
Area A	5032	Cut	Cut of discrete feature
Area A	5033	Deposit	Primary fill of ***5032***
Area A	5034	Deposit	Secondary fill of ***5032***
Area A	5035	Deposit	Fill of palaeochannel ***5036***
Area A	5036	Cut	Cut of palaeochannel
Area A	5037	Cut	Cut of post-medieval boundary feature
Area A	5038	Deposit	Fill of ***5037***
Area A	5039	Deposit	Primary fill of ***5037***
Area A	5040	Deposit	Secondary fill of ***5042***
Area A	5041	Deposit	Primary fill of ***5042***
Area A	5042	Cut	Cut of palaeochannel
Area A	5043	Cut	Cut of post-medieval ditch
Area A	5044	Deposit	Primary fill of ditch ***5043***
Area A	5045	Deposit	Secondary fill of ditch ***5043***
Area A	5046	Deposit	Tertiary fill of ditch ***5043***
Area A	5047	Deposit	Quaternary fill of ditch ***5043***
Area A	5048	Deposit	Fill of ***5050***
Area A	5049	Deposit	Fill of ***5050***
Area A	5050	Cut	Cut of palaeochannel
Area A	5051	Deposit	Fill of ***5052***
Area A	5052	Cut	Cut of palaeochannel
Area A	5053	Deposit	Fill of ***5054***
Area A	5054	Cut	Cut of palaeochannel
Area A	5055	Cut	Cut of post-medieval ditch
Area A	5056	Deposit	Fill of ***5055***
Area A	5057	Deposit	Fill of ***5055***
Area A	5058	Deposit	Fill of ***5055***
Area A	5059	Deposit	Fill of ***5061***
Area A	5060	Deposit	Fill of ***5061***
Area A	5061	Cut	Cut of palaeochannel
Area A	5062	Deposit	Fill of ***5063***
Area A	5063	Cut	Cut of palaeochannel
Area A	5064	Deposit	Fill of ***5063*** consisting of re-deposited clay
Area A	5065	Deposit	Fill of ***5063***
Area A	5066	Cut	Cut of palaeochannel
Area A	5067	Deposit	Primary fill of ***5066***
Area A	5068	Deposit	Secondary fill of ***5066***
Area A	5069	Deposit	Tertiary fill of ***5066***
Area A	5070	Deposit	Quaternary fill of ***5066***
Area A	5071	Cut	Cut of field drain
Area A	5072	Deposit	Fill of ***5071***
Area A	5073	Deposit	Fill of ***5074***
Area A	5074	Cut	Cut of palaeochannel
Area A	5075	Cut	Cut of palaeochannel
Area A	5076	Deposit	Fill of ***5075***
Area A	5077	Deposit	Fill of ***5075***
Area A	5078	Deposit	Fill of ***5075***
Area A	5079	Deposit	Fill of ***5075***
Area A	5080	Deposit	Fill of ***5075***

APPENDIX 5: STRATIGRAPHIC LOGS

OXFORD ARCHAEOLOGY

BOREHOLE RECORDING SHEET

SUMMARY DETAILS			
Site code	Walney Substation	**Terrier Rig boreholes with retrieval of 1m cores**	
Borehole No.	10		
Easting	342466.31		
Northing	460333.97		
GL ELEV (m aOD)	4.30m	**Logged by**	Mairead Rutherford
Total depth (m)	10.00 m	**Date**	24/09/2014

COMPOSITE LITHOLOGICAL LOG

Depth (m)		Keyword	Upper contact	Description
From	**To**			
0	0.20	Missing		
0.20	0.60	Clay		Stiff, brown, rootlets
0.60	1.00	Clay	Gradual	Very stiff, brown
1.00	1.26	Missing		
1.26	1.80	Clay		Stiff, brown/grey
1.80	6.91	Silty clay	Gradual	Soft, grey, sticky
6.91	7.00	Peat	Sharp	Crumbly, black, plant fragments
7.00	7.88	Silt	-	Grey, sticky, plant fragments
7.88	8.00	Peat	Sharp	Soft, brown, crumbly, silty
8.00	8.58	Silt	-	Sticky, grey
8.58	8.91	Peat	Sharp	Soft, brown, crumbly, wood
8.91	9.40	Silt	Sharp	Sticky, grey
9.40	9.75	Sand	Sharp	Soft, wet, grey
9.75	10.00	Gravel	Sharp	Grey

OXFORD ARCHAEOLOGY

BOREHOLE RECORDING SHEET

SUMMARY DETAILS			
Site code	Walney Substation	**Terrier Rig boreholes with retrieval of 1m cores**	
Borehole No.	9		
Easting	342352.95		
Northing	460240.88		
GL ELEV (m aOD)	4.25	**Logged by**	Mairead Rutherford
Total depth (m)	10m	**Date**	24/09/2014

COMPOSITE LITHOLOGICAL LOG

Depth (m)		Keyword	Upper contact	Description
From	**To**			
0	0.30	Topsoil		Indurated sandy clay and topsoil
0.30	1.00	Clay	Gradual	Stiff, orange/brown
1.00	1.50	Missing		
1.50	2.06	Clay		Stiff, orange/brown
2.06	2.10	Disturbed	Sharp	Topsoil/earth layer
2.10	6.93	Silty clay	Sharp	Soft, grey, sticky
6.93	7.00	Peat	Sharp	Dark brown, crumbly
7.00	7.76	Silt	-	Wet, sticky, grey
7.76	8.00	Peat	Sharp	Dark brown, crumbly
8.00	8.67	Silty clay	-	Grey
8.67	8.80	Peat	Transitional	Dark brown, crumbly
8.80	9.00	Sand	Sharp	Soft, grey, fine
9.00	9.70	Silt	-	Wet, sticky, grey
9.70	10.00	Sand	Sharp	Wet, grey, fine

OXFORD ARCHAEOLOGY

BOREHOLE RECORDING SHEET

SUMMARY DETAILS			
Site code	Walney Substation	**Monolith 1601**	
Trench	16		
GL ELEV (m aOD)	4.10m	**Logged by**	Mairead Rutherford
Total depth (m)	1.20m	**Date**	24/09/2014

COMPOSITE LITHOLOGICAL LOG

Depth (m)		Keyword	Upper contact	Description
From	**To**			
0	0.20	Topsoil	-	Indurated organic rich soil, rootlets
0.20	0.33	Peat	Gradual	Crumbly dry peat, rootlets, clay
0.33	0.35	Clay	Sharp	Organic rich
0.35	0.80	Clay	Sharp	Grey/orange, soft, iron-staining
0.80	0.90	Clay	Gradual	Sticky, grey
0.90	1.20	Clay	Gradual	Blue/grey, soft, organic (?) staining

OXFORD ARCHAEOLOGY

BOREHOLE RECORDING SHEET

SUMMARY DETAILS			
Site code	Walney Substation	**Monolith 1602**	
Trench	16		
GL ELEV (m aOD)	4.10m	**Logged by**	Mairead Rutherford
Total depth (m)	1.24m	**Date**	24/09/2014

COMPOSITE LITHOLOGICAL LOG

Depth (m)		Keyword	Upper contact	Description
From	**To**			
0	0.24	Peat	-	Disturbed crumbly peat
0.24	1.04	Clay	Sharp	Grey/orange, soft, iron-staining
1.04	1.24	Clay	Gradual	Grey/blue clay

OXFORD ARCHAEOLOGY

BOREHOLE RECORDING SHEET

SUMMARY DETAILS			
Site code	Walney Substation	**Monolith 22**	
Trench	22		
GL ELEV (m aOD)	4.37m	**Logged by**	Mairead Rutherford
Total depth (m)	1.10m	**Date**	24/09/2014

COMPOSITE LITHOLOGICAL LOG

Depth (m)		Keyword	Upper contact	Description
From	**To**			
0	0.18	Peat	-	Dry, hard, peaty organics
0.18	0.31	Peat	Gradual	Crumbly peat
0.31	0.76	Clay	Sharp, diagonal	Grey/orange clay, contact 0.27-0.31m
0.76	1.10	Clay	Gradual	Grey/blue, sticky, organic mottling

OXFORD ARCHAEOLOGY

BOREHOLE RECORDING SHEET

SUMMARY DETAILS			
Site code	Walney Substation	**Monolith 2401**	
Trench	24		
GL ELEV (m aOD)	Section line 3.96m	**Logged by**	Mairead Rutherford
Total depth (m)	0.90m	**Date**	24/09/2014

COMPOSITE LITHOLOGICAL LOG

Depth (m)		Keyword	Upper contact	Description
From	**To**			
0	0.08	Clay	-	Disturbed clay, soil, sand flecks
0.08	0.13	Clay	Sharp	Orange stiff clay
0.13	0.37	Clay	Gradual	Dark grey, stiff, iron-staining
0.37	0.40	Peat	Sharp	Soft, silty peat, diagonal contact
0.40	0.50	Clay/Peat	Gradual	Mixed clay/peat bands
0.50	0.90	Clay	Gradual	Soft, grey, organic staining

OXFORD ARCHAEOLOGY

BOREHOLE RECORDING SHEET

SUMMARY DETAILS			
Site code	Walney Substation	**Monolith 3101**	
Trench	31		
GL ELEV (m aOD)	Section line 3.96m	**Logged by**	Mairead Rutherford
Total depth (m)	0.94m	**Date**	24/09/2014

COMPOSITE LITHOLOGICAL LOG

Depth (m)		Keyword	Upper contact	Description
From	**To**			
0	0.04	Peat	-	Dry, crumbly, rootlets
0.04	0.08	Peat/Clay	Gradual	Mixed peat and orange/grey clay
0.08	0.80	Clay	Sharp	Grey/orange, iron-staining
0.80	0.95	Clay	Gradual	Blue/grey

APPENDIX 6: SUMMARY OF POLLEN ASSESSMENT RESULTS

Sample		**1601b**	**1601b**	**1601b**	**1601b**	**1601b**	**1601b**	**1601b**	**1601b**	**1601b**	**2401a**	**2401a**	**2401a**	**2401a**
Feature		Palaeo-channel	Palaeo-channel	Palaeo-channel	Palaeo-channel	Palaeo-channel	Palaeo-channel	Palaeo-channel	Palaeo-channel	Palaeo-channel	Palaeo-channel	Palaeo-channel	Palaeo-channel	Palaeo-channel
Context		*1605*	*1605*	*1605*	*1605*	*1604*	*1604*	*1604*	*1603*	*1603*	*2404*	*2404*	*2404*	*2405*
Preservation		Good	Good	Good	Good	Mixed	Mixed	Mixed	Mixed	Mixed	Good	Good	Good	Good
Potential		Yes	Yes	Yes	Yes	Possible	Possible	Possible	Possible	Possible	Yes	Yes	Yes	Yes
Depth (m)		0.10	0.20	0.30	0.35	0.40	0.60	0.80	1.00	1.20	0.10	0.20	0.30	0.40
Trees/Shrubs														
Alnus	Alder	60	85	18	33	12	21	8	14	7	57	72	69	76
Betula	Birch	8		6	3	4	3	6	4	3	13	1	7	6
Pinus	Pine	1	1			4	4	3	6	8		1	1	1
Fraxinus	Ash	1	1			2		1				1		1
Corylus avellana -type	Hazel-type	24	12	8	17	17	19	19	17	11	13	7	7	13
Tilia	Lime	1	1		1	1				1			1	3
Quercus	Oak	10	9	6	9	15	30	17	33	16	7	12	9	11
Salix	Willow	1	1	1						1		2	1	
Ulmus	Elm			5		3	2	2	4	3			1	
Calluna	Heather	1									3	1	6	1
Hedera	Ivy		1											
Crataegus-type	Hawthorn												1	
Sorbus-type	Whitebeam/Rowan													
Crops														
Cereal-type	Cereals							1				2		
Herbs														
Apiaceae	Carrot family: includes cow parsley and sweet cicely				1						1			
Artemisia	Mugwort					1				1				
Asteraceae	Daisy family: includes			2						1				

Sample		**1601b**	**1601b**	**1601b**	**1601b**	**1601b**	**1601b**	**1601b**	**1601b**	**1601b**	**2401a**	**2401a**	**2401a**	**2401a**
	ragworts and fleabanes													
Brassicaceae	Cabbage family: includes garlic mustard and cuckoo flowers			1										
Caryophyllaceae	Pink family: includes chickweeds, mouse-ears and campions													
Chenopodiaceae	Goosefoot family			2		1		1	1	1				
Centaurea cyanus	Cornflower													
Centaurea nigra	Black Knapweed													
Cirsium-type	Thistle-type													
Cyperaceae	Sedges		1	9	1	1	1	2		1	1			4
Epilobium-type	Willowherb-type													
Filipendula	Meadowsweet													
Limonium vulgare	Common sea lavender			1										
Poaceae	Grasses	15	1	46	63	6	7	2	1	9	5	14	5	9
Plantago lanceolata	Ribwort plantain										1	3	1	
Plantago maritima	Sea plantain							1		1				
Polygonumaviculare	Knotgrass													
Potentilla-type	Cinquefoil-type											1		
Ranunculus-type	Buttercup-type											1		
Rumex-type	Docks/Sorrels							1		2				
Rubiaceae	Bedstraw family										1			
Succisa pratensis	Devil's Bit Scabious													
Taraxacum-type	Dandelion-type	1	1											
Trifolium-type	Clover-type													
	Indeterminate herbs		1						3	1	2	1		1
	Total land pollen	**123**	**115**	**105**	**128**	**67**	**87**	**64**	**83**	**67**	**104**	**119**	**109**	**126**
	Number of traverses	1	1	2	6	10	10	10	10	10	2	1	1	1
Lycopodium	Exotic	1	10	1	10	11	17	18	37	15	4	1	3	1
Aquatics														
Typha latifolia	Bulrush								1					1
Typha angustifolia	Lesser Bulrush													
Potamogeton	Pondweed										1			

Sample		**1601b**	**1601b**	**1601b**	**1601b**	**1601b**	**1601b**	**1601b**	**1601b**	**1601b**	**2401a**	**2401a**	**2401a**	**2401a**
Ferns and Mosses														
Dryopteris	Buckler-ferns							1						
Polypodium	Polypodies	3	4			1	1	1	3	2		4	4	2
Pteridium	Bracken	1	1				3	1	1	1				
Pteropsida	Monolete ferns	1	1	2	2	1	1	1	3	2	2	3	4	3
Sphagnum	Bog moss spores	8	1					2			1	3	4	3
Algae														
Pediastrum	Freshwater colonial alga						1	1		3				
Botryococcus	Freshwater colonial alga							2						
Mougeotia	Green alga*			1										
Spirogyra	Green alga		1	1										
Microscopic charcoal		3	1	26	45	110	110	76	76	90	46	10	8	15
Non-pollen palynomorphs														
Coniochaeta xylariispora							1			6				
Kretzschmaria deusta							1	1						
Glomus HdV-207										2				
Foram test linings									1	2				
Dinoflagellate cysts						4	2		7	4				1
Carboniferous pollen (RW)					1	4	5	8	5	5		1		1
Broken grains			2			6	2	1	3	1				
Concealed grains		2			2	1		2	4	4			1	2
Crumpled grains				5		2		2	3	3	3	1	2	1
Corroded grains										1				

Sample		**2401a**	**2401a**	**BH10**	**BH10**	**BH10**	**BH10**	**BH10**	**BH10**	**BH10**	**BH10**	**BH10**	**BH10**	
Feature		Palaeo-channel	Palaeo-channel	-	-	-	-	-	-	-	-	-	-	
Context		*2403*	*2403*											
Preservation		Mixed	Mixed											
Potential		No	No											
Depth (m)		0.50	0.70	6.80	6.95	7.50	7.90	8.50	8.60	8.70	8.80	8.90	9.00	
Trees/Shrubs														
Alnus	Alder	9			1				4	1				
Betula	Birch	1	1	1	3	2	4	2	4	2	7	6		
Pinus	Pine	7	9	10	3	6	5	13	16	8	7	1	3	
Fraxinus	Ash													
Corylus avellana -type	Hazel-type	2	3	6	5	1	10	3	9	5	38	12	3	
Tilia	Lime	1												
Quercus	Oak	2	3	2	2	1	1	8	2	3		1		
Salix	Willow				1	1			1	2	2	1		
Ulmus	Elm	1					1		1		1			
Calluna	Heather													
Hedera	Ivy													
Rosaceae	Rose family													
Sorbus-type	Whitebeam/Rowan													
Crops														
Secale	Rye													
Cereal-type	Cereals													
Herbs														
Apiaceae	Carrot family: includes cow parsley and sweet cicely									1				
Artemisia	Mugwort													
Asteraceae	Daisy family: includes ragworts and fleabanes	1										2	1	
Brassicaceae	Cabbage family: includes garlic mustard and cuckoo flowers													

Sample		**2401a**	**2401a**	**BH10**	**BH10**	**BH10**	**BH10**	**BH10**	**BH10**	**BH10**	**BH10**	**BH10**	**BH10**	
Caryophyllaceae	Pink family: includes chickweeds, mouse-ears and campions													
Chenopodiaceae	Goosefoot family		2	1					1	1				
Centaurea cyanus	Cornflower													
Centaurea nigra	Black Knapweed													
Cirsium-type	Thistle-type													
Cyperaceae	Sedges				15	3	8		4	3	13	5	20	
Epilobium-type	Willowherb-type													
Filipendula	Meadowsweet									1				
Poaceae	Grasses		2	4	2	1	1		1	2	8	6	1	
Plantago lanceolata	Ribwort plantain													
Polygonum aviculare	Knotgrass													
Potentilla-type	Cinquefoil-type				1						1	1		
Ranunculus-type	Buttercup-type													
Rumex-type	Docks/Sorrels													
Rubiaceae	Bedstraw family													
Silene-type	Campions										1			
Succisa pratensis	Devil's Bit Scabious													
Taraxacum-type	Dandelion-type													
Trifolium-type	Clover-type													
	Indeterminate herbs										3	1		
	Total land pollen	**24**	**20**	**24**	**33**	**15**	**30**	**26**	**43**	**29**	**81**	**36**	**28**	
	Number of traverses	10	10	10	10	10	10	10	10	10	10	10	10	
Lycopodium	Exotic	16	28	14	32	14	10	28	30	9	23	10	27	
Aquatics														
Typha latifolia	Bulrush													
Typha angustifolia	Lesser Bulrush										2	3		
Potamogeton	Pondweed													
Ferns and Mosses														
Polypodium	Polypodies	6			1	1							1	
Pteridium	Bracken	1		1	4				2			1		
Pteropsida	Monolete ferns		10	1		8	11	1	11	6	40	10	10	

Sample		**2401a**	**2401a**	**BH10**	**BH10**	**BH10**	**BH10**	**BH10**	**BH10**	**BH10**	**BH10**	**BH10**	**BH10**	
Sphagnum	Bog moss spores				1	1	1		2		8	7	83	
Algae														
Pediastrum	Freshwater colonial alga		1											
Botryococcus	Freshwater colonial alga													
Spirogyra	Green alga			1			1							
Microscopic charcoal		58	190	170	10	200	5	230	24	100	20	48	93	
Non-pollen palynomorphs														
Gelasinospora			1											
Glomus					1				2			1		
Cercophora									1		1			
Coniochaeta xylarispora					1				3		1	2		
Kretzschmaria deusta										1				
Foram test linings			1					1						
Dinoflagellate cysts			6	1		1		1						
Carboniferous pollen (RW)		2	2	5	3			10	2	4		1	8	
Broken grains			2		1						3	1		
Concealed grains					1			1	2		2		1	
Crumpled grains		1	6		2	2			4		1	1		
Corroded grains														

APPENDIX 7: SUMMARY OF THE PLANT AND CHARCOAL ASSESSMENT

Sample No.	**Context No.**	**Feature Type**	**Amount processed (l)**	**Flot vol (ml)**	**Matrix**	**Waterlogged/ modern plant remains**	**Charred plant remains**	**Charcoal**	**Potential charcoal**	**Potential WPR/wood**	**Potential CPR**	**Potential c14**
501	502	Gully/ditch 503	30	150	Modern roots++++, Earthworm egg cases++, HAVM++++, Coal+, Fungal sclerotia+	++*Chenopodium album*	+Poaceae stem fragments	<2mm++++, >2mm+++ Mostly *Quercus* sp, including small twig fragments				Yes
1002	1002	Ditch 1001	10	25	Modern roots++++, HAVM++							
1101	1105	Possible pit 1104	5	200	Roots/amorphous organic ++++, Insect remains+, HAVM+++							
1301	1302	Gully/ditch 1303	10	25	Modern roots++++, HAVM++	+*Rubus fruticosus*		<2mm+, >2mm+ *Quercus* sp				
1502	1505	Ditch 1505	10	50	Modern roots++++, Wood+++, Earthworm egg cases+	++*Juncus, Chenopodium album*						
1904	1922	Pit 1921	10	50	Modern roots++++, Earthworm egg cases++	++Juncus, *Betulaceae*		>2mm++++ Mostly indeterminate, few *Alnus/Corylus* & Maloideae				Yes
2001	2001	Pit/posthole 2001	19	250	Modern roots+++, HAVM++++							

Sample No.	Context No.	Feature Type	Amount processed (l)	Flot vol (ml)	Matrix	Waterlogged/ modern plant remains	Charred plant remains	Charcoal	Potential charcoal	Potential WPR/wood	Potential CPR	Potential c14
2002	2003	Ditch 2004	10	120	Modern roots++++, Coal+, HAVM++++	+++*Juncus*						
2003	2005	Ditch 2006	10	100	Modern roots++++, Fossilised root channels in matrix of hardened clay	+*Carex trigonous*		>2mm+ Indeterminate				
2004	2008	Gully/ditch 2010	10	75	Modern roots++++							
2110	2104	Gully/ditch 2105	10	400	Modern roots++++, Wood++++, Calcined bone+, fungal sclerotia ++, HAVM++++	++*Eupatorium cannabinum, Chenopodium album, Rubus fruticosus*. Wood highly degraded.		< 2mm++				
2701	2702	Pit 2704	10	100	Modern roots++++, Wood++	+++ Juncus, *Rubus fruticosus*		<2mm+, >2mm+ Indeterminate and *Alnus/Corylus*				Yes
2901	2904	Possible palaeochannel 2903	10	380	Modern roots++++, Glass+, Calcined bone+, Wood++,		+*Avena* sp, culm node, Poaceae stem fragments	<2mm++++, >2mm++ *Quercus* sp			Possibly, if process the remainder	Yes

Sample No.	Context No.	Feature Type	Amount processed (l)	Flot vol (ml)	Matrix	Waterlogged/ modern plant remains	Charred plant remains	Charcoal	Potential charcoal	Potential WPR/wood	Potential CPR	Potential c14
					HAVM++++, Insects+, Fungal sclerotia++			and *Alnus/Corylus*				
3101	3104	Possible palaeochannel 3106	10	30	Modern roots+++, Wood+, Insects+			<2mm++, >2mm+ Indeterminate				
3212	3208	Gully/ditch 3209	10	350	Amorphous organic++++, Wood++++, Fungal sclerotia++	Wood highly degraded						
3216	3210	Possible pit 3211	20	150	Modern roots+++, HAVM++++, Coal+							
4101	4108	Gully/ditch recut 4107	10	90	Modern roots++++, Insects+, Fossilised root channels in matrix of hardened clay (similar to Sample 2003)			>2mm+++, A little diffuse porous, mostly *Quercus* sp				Yes
4401	4401	Pit 4402	10	150	Modern roots++++, Coal+, Wood+++, Insects+, Fungal sclerotia++		+++Poaceae stem fragments and stem bases, *Chenopodium album*	<2mm++++, >2mm++ Indeterminate and *Alnus/Corylus*				Yes

Walney Extension Cable Palaeoenvironmental Assessment Results. Recorded on a scale of + to ++++, where + is rare (up to 5 items), ++ is frequent (6-25 items), +++ is common (26-100 items), and ++++ is abundant (>100 items). HAVM = heat affected vesicular material

APPENDIX 8: SUMMARY OF THE DIATOM ASSESSMENT RESULTS

Diatom Taxon/Laboratory Sample Number	**D1**	**D2**	**D3**	**D4**	**D5**	**D6**	**D7**	**D8**	**D9**	**D10**	**D11**	**D12**	**D13**	**D14**	**D15**	**D16**	**D17**	**D18**	**D20**	**D21**	**D23**	**D24**	**D25**	**D26**	**D27**	**D28**	**D29**	**D30**	**D31**
Polyhalobous																													
Campylosira cymbelliformis					1																								
Cymatosira belgica		1		1	1	2	2																						
Grammatophora sp.		1				1																							
Plagiogramma staurophorum			1																										
Paralia sulcata	1	2	3	3	3	3	3											1	1	1		1	1	1		1	1	1	1
Podosira stelligera	1	1	1		2	1	1	2							1	1	2					1		1	1	2	1		
Rhaphoneis amphiceros				1	1													1											
Rhaphoneis minutissima			1		1	2																							
Rhaphoneis sp.			1																										
Rhaphoneis surirella		1			1	1																							
Thalassionema nitzschiodes						1	1																						
Polyhalobous to Mesohalobous																													
Actinoptychus		1		1		1	1																				1		

Diatom Taxon/Laboratory Sample Number	**D1**	**D2**	**D3**	**D4**	**D5**	**D6**	**D7**	**D8**	**D9**	**D10**	**D11**	**D12**	**D13**	**D14**	**D15**	**D16**	**D17**	**D18**	**D20**	**D21**	**D23**	**D24**	**D25**	**D26**	**D27**	**D28**	**D29**	**D30**	**D31**
undulatus																													
Cocconeis scutellum						1									1														
Navicula flanatica						1																							
Mesohalobous																													
Bacillaria paradoxa					1																								
Caloneis westii																	1	1				1	1						1
Catenula adhaerans						1																							
Cyclotella striata			1			1	1			1																			
Diploneis aestuari						1																							
Diploneis interrupta		1											1						1							1			
Diploneis didyma													1	1	1		1				1	1				1			
Diploneis smithii																			1										
Navicula peregrina		3	1	1																									
Nitzschia punctata																						1							
Nitzschia granulata			1																										
Nitzschia hungarica						1	1																						
Nitzschia navicularis		2	2	1	1		1						2	2	2		1		1	1	2	1	1	1	1	2	1	2	2
Nitzschia sigma				1																									
Scoliopleura tumida		1																											
Synedra pulchella									1	1	1	1																	
Thalassiosira decipiens						1																							
Mesohalobous to Oligohalobous Halophilous																													
Cyclotella meneghiniana									1		1																		
Nitzschia levidensis						1																							
Nitzschia tryblionella						1																							
Oligohalobous Halophilous																													

Diatom Taxon/Laboratory Sample Number	**D1**	**D2**	**D3**	**D4**	**D5**	**D6**	**D7**	**D8**	**D9**	**D10**	**D11**	**D12**	**D13**	**D14**	**D15**	**D16**	**D17**	**D18**	**D20**	**D21**	**D23**	**D24**	**D25**	**D26**	**D27**	**D28**	**D29**	**D30**	**D31**
Navicula cincta								1																					
Navicula mutica		1																											
Oligohalobous Indifferent																													
Achnanthes hungarica									1		1																		
Epithemia sp.				1																									
Fragilaria capucina									1																				
Frustulia vulgaris								1																					
Gomphonema angustatum	1																												
Gomphonema parvulum									2	1	1	1																	
Hantzschia amphioxys												1																	
Pinnularia borealis										2	1				cf														
Pinnularia major	cf																												
Pinnularia obscura									1																				
Pinnularia viridis										2	1																		
Halophobous																													
Eunotia sp.										1	1																		
Eunotia pectinalis var. minor									3	1		1																	
Eunotia pectinalis var. minor fo. Impressa									1																				
Eunotia curvata									3	1		1																	
Eunotia naegelii									1																				
Eunotia tenella									1																				
Pinnularia divergentissima										1																			
Tabellaria flocculosa																	1												
Tabellaria sp.												1																	

Diatom Taxon/Laboratory Sample Number	**D1**	**D2**	**D3**	**D4**	**D5**	**D6**	**D7**	**D8**	**D9**	**D10**	**D11**	**D12**	**D13**	**D14**	**D15**	**D16**	**D17**	**D18**	**D20**	**D21**	**D23**	**D24**	**D25**	**D26**	**D27**	**D28**	**D29**	**D30**	**D31**
Unknown Salinity Group																													
Amphora sp.							1																						
Cocconeis sp.		1		1			1																						
Cyclotella sp.				1																									
Cymbella sp.	1								1	1	1																		
Diploneis sp.																			1			1		1					
Fragilaria sp.					1				1		1																		
Gyrosigma sp.				1		1	1																						
Indeterminate centric sp.																	1				1				1		1		1
Indeterminate pennate sp.																							1	1		1			
Navicula sp.								1			1	1																	
Nitzschia sp.	1	1			1	1				1	1											1							
Pinnularia sp.		1									1	1																	
Stauroneis sp.			1																										
Surirella sp.						1																							
Thalassiosira sp.					1	1	1																						
Unknown diatom fragment																					1								
Unknown Naviculaceae				1				1							1	1								1					

APPENDIX 9: FORAMINIFERAL ENVIRONMENTS

Below are listed the main foraminiferal species that occur in the samples from the London Gateway boreholes OA11, 12, 17c and 20. The best information on their ecology and distribution is to be found in Murray, (1979) and in "Appendix I, Ecological Data" of Murray (2006), from which the following is derived.

[Euryhaline – able to withstand a wide range of salinities (>0-35‰)] [TOC – Total Organic Carbon]

BRACKISH SPECIES

Jadammina macrescens: Epifaunal on decaying vegetation and infaunal down to 60cm, an herbivore and detrivore. Widespread on high to mid saltmarsh.

Trochammina inflata: Epifaunal and infaunal down to 60cm. An herbivore and detrivore. Widespread on high to mid saltmarshes.

Arenoparrella mexicana: Mid-high saltmarsh species originally of the Caribbean region; usually rare and subsidiary in NW Europe, as here. Has identical lifestyle to *J. macrescens* and *T. inflata* (see above).

Ammonia spp.: Infaunal and herbivores; common in sediments with highly variable mud and TOC contents; mid-low saltmarsh to subtidal, in salinities not usually below 10‰; also able to tolerate low oxygen. [The small, flat unornamented forms, as are present here, are difficult to name specifically (several species may be present) but they usually indicate low brackish conditions, as in estuarine tidal mudflats and low-mid saltmarsh].

Elphidium williamsoni: Infaunal and an herbivore; common in sediments with highly variable mud and TOC contents; mid-low saltmarsh, intertidal to subtidal; euryhaline.

Haynesina germanica: Infaunal, an herbivore on diatoms and cyanobacteria; common in sediments with highly variable mud and TOC contents; mid-low saltmarsh, intertidal to subtidal; euryhaline.

APPENDIX 10: SUMMARY OF THE FORAM ANALYSIS RESULTS

Sample 1601a

CONTEXT	**1605**	**1604**				**1603**	
Depth (bgl)	27-30cm	37-40cm	47-50cm	57-60cm	77-80cm	97-100cm	117-120cm
Elevation (O.D.)	+3.83/3.80m	+3.73/3.70m	+3.63/3.60m	+3.53/3.50m	+3.33/3.30m	+3.13/3.10m	+2.93/2.90m
plant debris + seeds	x	x	x	x	x	x	x
charcoal/burnt vegetation		x	x		x	x	
insect remains		x	x	x	x	x	x
cladocera/cladoceran ephippia		x	x				
brackish foraminifera			x	x	x	x	x
iron mineral/tubes				x	x		
brackish ostracods						x	x
	peat						
Ecology	***Freshwater wetland***		***Brackish tidal mudflats giving way completely to saltmarsh***				
			TIDAL ACCESS				
BRACKISH FORAMINIFERA							
CONTEXT	***1605***	***1604***				***1603***	
Depth (bgl)	8-10cm	18-20cm	25-27cm	45-47cm	55-57cm	65-67cm	73-75cm
Elevation (O.D.)	+3.83/3.80m	+3.73/3.70m	+3.63/3.60m	+3.53/3.50m	+3.33/3.30m	+3.13/3.10m	+2.93/2.90m
Jadammina macrescens			**x**	**o**	**x**		**x**
Miliammina fusca				**o**			
Haynesina germanica					**o**	**xx**	**x**
Elphidium williamsoni						**x**	**x**
***Ammonia* sp.**							**o**

(brackish)							
BRACKISH OSTRACODS							
CONTEXT	***1605***	***1604***				***1603***	
Depth (bgl)	8-10cm	18-20cm	25-27cm	45-47cm	55-57cm	65-67cm	73-75cm
Elevation (O.D.)	+3.83/3.80m	+3.73/3.70m	+3.63/3.60m	+3.53/3.50m	+3.33/3.30m	+3.13/3.10m	+2.93/2.90m
Leptocythere lacertosa						**x**	**o**
Organic remains are recorded on a presence (x)/absence basis.							
Foraminifera and ostracods are recorded: o – one specimen; x – present (several specimens); xx – common							
Agglutinating foraminifera of mid-high saltmarsh	**Calcareous foraminifera of low-mid saltmarsh and tidal flats**						
Brackish ostracods of tidal flats							

Sample 2401a

CONTEXT	**2404**			**2405**		**2403**			
Depth (bgl)	8-10cm	18-20cm	25-27cm	45-47cm	55-57cm	65-67cm	73-75cm	78-80cm	87-90cm
Elevation (O.D.)	+3.88/3.86m	+3.78/3.76m	+3.71/3.68m	+3.57/3.55m	+3.41/3.39m	+3.37/3.35m	+3.23/3.21m	+3.18/3.16m	+3.09/3.06m
plant debris + seeds	x	x	x	x	x	x	x	x	x
insect remains	x	x	x	x			x	x	x
cladocera/cladoceran ephippia		x	x						
charcoal			x						
freshwater ostracods			x						
iron mineral/tubes				x	x	x	x	x	x
brackish foraminifera					x	x	x	x	x
		peaty		*peaty*					

Ecology	***Freshwater wetland***				***Mid-high saltmarsh***				
					TIDAL ACCESS				
BRACKISH FORAMINIFERA									
CONTEXT	**2404**			**2405**		**2403**			
Depth (bgl)	8-10cm	18-20cm	25-27cm	45-47cm	55-57cm	65-67cm	73-75cm	78-80cm	87-90cm
Elevation (O.D.)	+3.88/3.86 m	+3.78/3.76 m	+3.71/3.68 m	+3.57/3.55 m	+3.41/3.39 m	+3.37/3.35 m	+3.23/3.21 m	+3.18/3.16 m	+3.09/3.06 m
Trochammina inflata					xxx	xxx	xxx	xxx	xxx
Jadammina macrescens					xxx	xxx	xxx	xxx	xxx
Arenoparrella mexicana								x	
FRESHWATER OSTRACODS									
CONTEXT	**2404**			**2405**		**2403**			
Depth (bgl)	8-10cm	18-20cm	25-27cm	45-47cm	55-57cm	65-67cm	73-75cm	78-80cm	87-90cm
Elevation (O.D.)	+3.88/3.86m	+3.78/3.76m	+3.71/3.68m	+3.57/3.55m	+3.41/3.39m	+3.37/3.35m	+3.23/3.21m	+3.18/3.16m	+3.09/3.06m
Cypria ophtalmica			x						
Organic remains are recorded on a presence (x)/absence basis.									
Foraminifera and ostracods are recorded: o – one specimen; x – present (several specimens); xxx – abundant									
Agglutinating foraminifera of mid-high saltmarsh									

Borehole 10

Depth (bgl)	**1.50m**	**2.50m**	**3.50m**	**4.50m**	**5.50m**	**6.50cm**	**6.80m**	**6.95m**	**7.48-7.50m**	**7.90m**	**8.48-8.50m**	**8.60m**	**8.80m**	**9.00m**	**9.48-9.50m**
Elevation/depth (O.D.)	+2.80m	+1.80m	+0.80m	-0.20m	-1.20m	-2.20m	-2.50m	-2.65m	-3.18/3.20m	-3.60m	-4.18/4.20m	-4.30m	-4.50m	-4.70m	-5.18/5.20m
plant debris + seeds									x		x				x
insect remains															
iron mineral/iron tubes															
brackish foraminifera									x		x				x
brackish ostracods															
								peat		*peat*		*peaty clay*	*peat*		
Ecology	***Mid-high saltmarsh and associated mudflats***								***Saltmarsh***		***Saltmarsh and mudflats***			***Inception of saltmarsh***	
	TIDAL ACCESS							?	TIDAL	?	TIDAL ACCESS		?	TIDAL ACCESS	

BRACKISH FORAMINIFERA															
Depth (bgl)	1.50m	2.50m	3.50m	4.50m	5.50m	6.50cm	6.80m	6.95m	7.48-7.50m	7.90m	8.48-8.50m	8.60m	8.80m	9.00m	9.48-9.50m
Elevation/depth (O.D.)	+2.80m	+1.80m	+0.80m	-0.20m	-1.20m	-2.20m	-2.50m	-2.65m	3.18/3.20m	-3.60m	-4.18/4.20m	-4.30m	-4.50m	-4.70m	-5.18/5.20m
Trochammina inflata									**xx**		**x**				**x**
Jadammina macrescens									**xx**		**xx**				**x**
Arenoparrella mexicana															

Haynesina germanica									**x**		**x**				**x**
Elphidium williamsoni									**x**						
***Ammonia* sp. (brackish)**											**x**				**x**
BRACKISH OSTRACODS															
Depth (bgl)	1.50m	2.50m	3.50m	4.50m	5.50m	6.50cm	6.80m	6.95m	7.48-7.50m	7.90m	8.48-8.50m	8.60m	8.80m	9.00m	9.48-9.50m
Elevation/depth (O.D.)	+2.80m	+1.80m	+0.80m	-0.20m	-1.20m	-2.20m	-2.50m	-2.65m	3.18/3.20m	-3.60m	4.18/4.20m	-4.30m	-4.50m	-4.70m	-5.18/5.20m
Organic remains are recorded on a presence (x)/absence basis.															
Foraminifera and ostracods are recorded: o – one specimen; x – present (several specimens); xx – common; xxx – abundant															
Agglutinating foraminifera of mid-high saltmarsh															
Calcareous foraminifera of low-mid saltmarsh and tidal flats															