A12 Chelmsford to A120 widening scheme

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ENVIRONMENTAL STATEMENT APPENDIX 7.3 PALAEOLITHIC DESK-BASED ASSESSMENT

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A12 Chelmsford to A120: Palaeolithic Desk-based Assessment

Document prepared by:

Francis Wenban-Smith
CAHO-Contracting
University of Southampton
Southampton, SO17 1BF

Contact details:

Tel (direct): 02380-596 864
Tel (mobile): 07771-623 096
Email: [redacted]

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Executive summary

This document is a specialist Palaeolithic desk-based assessment for the northeast part of the A12 Chelmsford to A120 improvement scheme, covering the stretch from Witham to Colchester. The area is rich in Palaeolithic remains, including in particular artefacts and palaeoenvironmental remains from Hoxnian lake and Blackwater terrace deposits near Witham and at Marks Tey. The A12 scheme (or at least the footprint of its possible options and Borrow Pits, considered here) passes through a landscape with varied Pleistocene deposits, of varying Palaeolithic potential.

This Palaeolithic desk-based assessment identifies 18 distinct Palaeolithic and Quaternary (PQ) character zones for the scheme's impact footprint: PQ- 1, 3, 5, 8-12, 13b, 15-20, 22a-b, and 23. Each zone was attributed to one of four categories of Palaeolithic and geo-archaeological potential: UNCERTAIN (n=3), HIGH (n=4), MODERATE (n=8) and LOW (n=2) (**Section 9**; **Tables 13**, **14**).

A phased two-stage approach to Palaeolithic and geo-archaeological evaluation is recommended in all these zones, following consideration of any relevant new information from ongoing and recently-completed geo-technical Ground Investigations.

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A12 Chelmsford to A120: Palaeolithic Desk-based Assessment

*Francis Wenban-Smith (*Department of Archaeology, University of Southampton)

1. Introduction

1.1. Project background

Highways England are currently making a major, multi-billion pound investment in the national road network. The A12 provides a critical link across the east of England, connecting communities in Essex and Suffolk, as well connecting the port of Felixstowe with the national road network via the M25 hub. The section between Chelmsford and Colchester (between junctions 19 and 25) carries a high volume of traffic, leading to congestion and delays. It is therefore proposed to carry out major improvements along this section. These include widening this stretch of the road to a 3-lane dual carriageway, improving the junctions, adding two by-passes (between J22 and J23, and between J24 and J25), and various other improvements for cyclists, pedestrians and public transport.

The proposed scheme is located in Essex (**Figure 1**), between junction 19 (northeast of Chelmsford) and junction 25 (A120/Marks Tey Interchange), a length of approximately 25km. From junction 19, the A12 route runs in a north-easterly direction from Chelmsford towards Colchester, passing via Witham and Kelvedon.

The first part of this stretch runs to the north of, and broadly parallel with, the lower reaches of the Chelmer, and then heads northeast away from the Chelmer towards Witham. Between Witham and Kelvedon the route runs broadly along the valley of the lower part of the Blackwater, crossing it in some places. And the final part of the route cuts across the interfluve between the Blackwater and the Colne catchments, via Marks Tey (J25).

The proposed scheme is designated as a Nationally Significant Infrastructure Project (NISP), and thus its implementation depends upon securing a Development Consent Order (DCO). The application for the DCO must be supported by various documentation, including an Environmental Statement (ES). The contents and scope of this latter document are to a large extent statutorily defined, and outlined in the *National Planning Policy Framework* (initially issued in 2012, but updated in 2018). These include that suitable provision is made to avoid, or if necessary mitigate, impacts of the development upon the historic environment.

As part of the process for the preparation of the application for development consent, preliminary cultural heritage desk-based work has been carried out to inform the Environmental Assessment process. Besides identifying numerous

important remains of later archaeological periods in the vicinity of the scheme (in particular from Late Prehistoric, Roman and Saxon periods), this work has also highlighted an extensive range of known archaeological remains from earlier Prehistoric periods, in particular from the Lower and Middle Palaeolithic (see below: **Section 3.1**, **Table 4**). These represent half a million years of occupation and settlement through the climatic oscillations of the Pleistocene, through to the end of the last ice age approximately 12,000 years BP. As explained in more detail further below (**Section 3.2**), the route corridor provided favourable conditions for early settlement, and preserves an underlying geology of organic-rich silts, sands and gravels that contain rare evidence of human occupation and palaeo-environments from this early period.

Based on Essex Place Services' county-wide predictive model of Palaeolithic potential (see below, *Section 2.2.2*), the route corridor includes two areas with a concentration of deposits initially assessed as of Moderate, High or Very High Palaeolithic potential (**Figure 1**):

- an area from the east of Witham to Feering;
- and an area to the north east of Marks Tey.

Therefore a specialist Palaeolithic desk-based assessment is required to look at these areas more closely, to support the sustainable delivery of the scheme, and in particular to ensure that suitable preliminary work is done for the Environmental Statement that is part of the application for the DCO. As is the case here, it is important and beneficial that specialist advice is sought at the earliest opportunity. This allows suitable monitoring to take place of early Ground Investigations, and allows for proper planning of a suitable programme of any necessary Palaeolithic investigations to ensure that the DCO application is robust in relation to Palaeolithic heritage, and has the support of curatorial stakeholders.

Jacobs UK Ltd - henceforth, Jacobs - have been contracted as Consultant by Highways England to develop the proposed scheme through to submission of the DCO, and in particular to deliver the Environmental Statement and carry out necessary work in relation to cultural heritage for the project. University of Southampton (Francis Wenban-Smith) has in turn been commissioned by Jacobs to deliver a specialist Palaeolithic desk-based assessment focusing on these areas of higher Palaeolithic potential.

This document, forming the required specialist Palaeolithic desk-based assessment, has been prepared by Francis Wenban-Smith (University of Southampton. It includes a glossary of acronyms and technical terms as an appendix (**Appendix A**), designed to help the non-specialist reader.

1.2. Scope of this document

This document is a specialist Palaeolithic desk-based assessment. It focuses on the stretch of the proposed A12 improvement between Witham and Marks Tey, identified as having the highest Palaeolithic potential and hence requiring

specialist input. It has been prepared in accordance with the initial brief provided by Jacobs (2019) and the separately-provided more-detailed Written Specification (Wenban-Smith 2019).

In accordance with CIfA best practice standards for desk-based assessment (CIfA 2014, revised 2017) a desk-based assessment involves the collation and interpretation of available records on the historic background of a site. This work provides a means to assessing the potential for the presence of historic remains that might be impacted by development proposals, and thus aids curatorial decision-making in relation to protecting important remains and, where necessary, carrying out suitable investigations to mitigate development impact.

It is important to emphasise that this work provides an initial assessment of the relative importance of different parts of the project area, based on desk-based information. This initial assessment is likely to be revised and updated as further information becomes available from various sources, such as Ground Investigation (GI) records or archaeological fieldwork.

This document has been commissioned and prepared in accordance with best practice guidelines, in particular those established by the Chartered Institute for Archaeologists (CIfA) and as specified in the brief (Jacobs 2019, Section 1.4: Standards and Guidance).

This document is the second issue of this Palaeolithic desk-based assessment: v1.2 issued on 20th July 2020. This follows from the first issue (v1.1, issued 15th May 2020). This second issue incorporates:

- changes required following internal review comments on the first issue;
- results of the walkover survey (see below, **Sections 5.3** and **Section 7**), which was delayed due to working restrictions relating to Coronavirus;
- adjustments to some Palaeolithic zone boundaries (in particular PQ 16 - see below, **Section 9**, **Table 13**), resulting from the fact that a revised scheme footprint was provided when preparation of v1.1 of this Palaeolithic desk-based assessment was in progress, differing from that given in the original brief.

2. Planning and curatorial background

2.1. Planning background

The proposed A12 improvement scheme has been under consultation since 2017. It is integrated with a joint Local Plan for several garden communities by the Colchester, Braintree and Tendring local authorities. However, the planning processes for the road scheme and the garden communities have separate approval processes, although each impact upon the other.

The road scheme, which in accordance with the 2017 White Paper *Fixing our Broken Housing Market* is designed to provide an infrastructure to support new

housing and developments such as garden communities, is designated as a Nationally Significant Infrastructure Project (NSIP). Its implementation thus depends upon securing a Development Consent Order (DCO). The application for the DCO is made to the Planning Inspectorate, who then go through a process of consideration that includes consultation with key stakeholders and public hearings before making a recommendation to the Secretary of State for Transport, who then decides whether the scheme will go ahead. The current programme for this process (as outlined in the Highways England consultation brochure PR/94/19, job BED19_0138, issued in October 2019) is for the DCO application to be submitted in 2021, with the subsequent decision-making process expected to last approximately 18 months.

The application for the DCO must be supported by various documentation, including an Environmental Statement (ES). The contents and scope of this latter document are outlined in the *National Planning Policy Framework* (initially issued in 2012, but updated in 2018), supplemented by the additional requirements specifically for large national infrastructure projects such as this (*National Policy Statement for National Networks* 2014). These include that suitable provision is made to avoid, or if necessary mitigate, impacts of the development upon the historic environment, proportionate to the scale of impact and the significance of the assets affected. To gain the support of curatorial stakeholders, the information provided in the DCO application needs, therefore, to provide an assessment of the significance of heritage assets (designated and undesignated) affected by a scheme. This assessment will be based on desk-based research, but it may also be necessary to implement (or design) programmes of field investigation to assess the significance of assets (or areas) of uncertain significance.

A key aspect of this work is, therefore, the definition and recognition of grades of significance. Various approaches have been historically adopted for assigning significance to heritage assets, for instance based on attribution to grades of significance such as international (very high), national (high), regional (moderate) or local (low), and often based on statutory designation to identify the higher levels. More recently, it has become established that the notion of significance is related to the potential contribution to current research priorities, and thus there has been a general development over recent decades of national and regional research frameworks. These define current research priorities, and thus provide a benchmark against which to judge the significance of heritage assets. These have also been supported by period-specific Guidance documents.

The relevant national and regional research framework documents for the proposed A12 scheme are collated as an appendix (**Appendix B**), and summarised below (**Section 2.2**), along with key National Guidance relating to the identification and protection of Palaeolithic remains.

2.2. Research frameworks and Palaeolithic Guidance

2.2.1. National Palaeolithic research framework

Well-defined research priorities, and statements defining significance, provide the basis for assessment of significance as part of the planning process. Following from PPG 16 (Dept. of Environment 1990) and the integration into the planning process of the requirement for archaeological work to be undertaken in conjunction with development, English Heritage initiated a broad framework of national research priorities in *Exploring our Past* (1991). Three main themes were identified for the Palaeolithic in this initial framework: physical evolution; cultural development; and global colonisation. The research framework for the Palaeolithic has subsequently been kept under review and periodically updated (English Heritage 1999 & 2008).

The current national framework (English Heritage 2008) identifies four primary research themes and eight cross-cutting strategic research and conservation themes.

Primary themes are:

1 - hominin environments and climate drivers

2 - hominin demographies: the palaeoecology of hominin colonisation and the settlement process

3 - how we became human: social, cultural and economic change

4 - sharing human origins, developing new audiences

Strategic research and conservation themes are:

i - areas

ii - understanding the record

iii - dating frameworks

iv - curation and conservation

v - dealing with development

vi - professional training

vii - education

viii - collections and records enhancement

Several specific questions/issues are then presented as priorities under the umbrella of each of these themes. These are, however, indicative rather than restrictive or exclusive; it is expected that other specific questions can arise in relation to the primary themes. The significance of any remains identified in the A12 scheme will be assessed in relation to these themes, and in relation to their potential to contribute to any more-specific research issues under them.

2.2.2. East of England research framework and the Essex Pleistocene predictive Palaeolithic model

Numerous regional research frameworks have been developed to complement the broad national framework, broadly following the Local Government regional groupings of East of England, East Midlands, North-east, North-west, South-east, South-west, West Midlands, Yorkshire & Humber, Solent-Thames and Greater London. The A12 scheme is wholly within the county of Essex, and thus is within the "East of England" region. The initial East of England research framework - under the regional umbrella of "Eastern Counties" - was issued in two parts. Firstly there was a *Resource Assessment* (Glazebrook 1997), and this was followed shortly after by a combined *Research Agenda and Strategy* (Brown & Glazebrook 2000). Both these reports were mainly structured on a period-by-period basis, and included period-specific sections on the Palaeolithic (Austin, 1997 and 2000).

These reports were then reviewed a little more than a decade later, and an updated research framework issued for the East of England as a single report (Medlycott 2011). This report emphasised that it was not intended to replace the previous Eastern Counties research framework reports, but to augment them. In particular, and again on a period-by-period basis, it (a) reviewed key projects undertaken since issue of the *Research Agenda and Strategy* in 2000, (b) examined progress on the research priorities proposed in the latter report, and (c) reconsidered priorities for future work.

Austin's 1997 Palaeolithic resource assessment highlighted the importance of the Lowestoft Till (mapped as Boulder Clay) from the Anglian glaciation, and representing the most southerly advance of glacial ice-sheets during the repeated climatic oscillations through the Palaeolithic (see below, **Section 3.1**, for an overview of the Pleistocene period, and how its changing climate provided the backdrop to the Palaeolithic settlement of Britain) as providing a key stratigraphic tie-point across the eastern region. She characterised the Lower and Middle Palaeolithic resource (see below, **Section 3.1**, **Table 4**, for a brief overview of Palaeolithic sub-divisions) as mostly comprising lithic flakes and tools from river gravels, with a small number of undisturbed sites from palaeo-landsurfaces. Sites from throughout the British Lower/Middle Palaeolithic are present, including pre-Anglian sites such as High Lodge, post-Anglian sites such as Hoxne, and Last glacial Devensian sites at Ipswich. Discoveries over the >20 years since Austin's review have reinforced this picture, with several important (and very early) pre-Anglian sites identified along the East Anglia coastline at Pakefield, Suffolk (Parfitt *et al.* 2005) and Happisburgh, Norfolk (Parfitt *et al.* 2010), and an important Last Glacial site at Lynford, Norfolk (Boismier *et al.* 2012).

She drew attention to the importance of using palaeo-environmental information to help construct an overall regional chronological and palaeo-climatic framework for the Palaeolithic, and to the important contribution of sites without artefactual remains, as well as those where lithic artefacts are present. And she particularly identified post-Anglian lacustrine deposits at Hoxne in Suffolk and Marks Tey in central Essex as being of high importance in this regard. Her overall conclusion

was that the Lower/Middle Palaeolithic resource of East Anglia is of national and international importance.

For the Upper Palaeolithic, the resource in eastern England is sparse, as for most of the country. The period is mostly represented by stray lithic finds of uncertain provenance. There are a few stratified sites with evidence of the final Late Upper Palaeolithic “Long Blade” industry, for instance Titchfield in Norfolk, Sproughton in Suffolk and Carrow Road in Norwich. Despite the paucity of known sites, the region has good potential for the survival of final Upper Palaeolithic sites, at the base of Holocene peat and alluvium in the fens and along river valleys. In general the Upper Palaeolithic is poorly understood in Eastern England, and the rarity of sites increases the importance of any that are found.

The subsequent Palaeolithic research agenda and strategy (Austin 2000) highlighted the successful issue of *The English Rivers Project*’s review of Lower/Middle Palaeolithic finds associated with East Anglian Rivers (Wessex Archaeology 1997) as a key development, and indicated that this should provide a baseline point for further more-focused investigations of the Pleistocene archaeological resource and its palaeoenvironmental potential. This report identified several broad topics as priorities for future work in the region. These included:

- development and testing of new methodologies to understand the potential of the Palaeolithic resource, and enable deposit modelling and the development of predictive landscape models
- linking sequences from different sites to improve understanding of Quaternary chronological frameworks;
- investigating palaeo-environmental remains to study palaeo-environments;
- investigating undisturbed sites to provide detailed information on early hominin behaviour;
- investigating less well-preserved evidence to gain understanding of broader patterns of early hominin activity, and its relationship to the landscape;
- investigation of sites with faunal remains representing diet and tool manufacture.

Some areas of Eastern England were identified as of high potential. These included:

- ancient Thames deposits, both preserved as terrace deposits in the southern part of the region, and also earlier deposits represented by remnant sand/gravel bodies (the Ingham/Bytham river, and the Kesgrave Sands and Gravels) preserved under the Boulder Clay from the Anglian glaciation that covers much of the region
- post-Anglian lacustrine deposits, including those already known at Hoxne and Marks Tey

- major river valleys, where the chronology and Palaeolithic archaeological content of mapped terrace deposits should be more thoroughly investigated, such as the Colne, the Waveney, the Gipping, the Stour and the Blackwater

The research strategy for the Eastern Counties (Wade & Brown 2000) was not laid down on a period-by-period basis initially, but established general principles. It recognised that development-led work had an important contribution to make, and indicated that the research framework should assist in providing a research focus for such work, and in particular that work should be prioritised that addresses the aims put forward in the period-specific research agendas. It also put forward the principle that for heritage impacted by development, it was important to collect data that would otherwise be lost, even if it sometimes wasn't clear how all the data contributed to current research priorities. It was recognised that research questions and priorities would continue to evolve, so that it would be important to archive data that would potentially be relevant in the future, even if present-day analysis focused upon a subset of the overall data collected that was relevant to presently-recognised research questions.

This initial research framework was reviewed and revised a little over ten years later, in the report *Research and Archaeology Revisited: a Revised Framework for the East of England* (Medlycott 2011, ed.). This report emphasised that it augmented, rather than replaced, the two previous research framework reports (Glazebrook 1997, ed., and Brown & Glazebrook 2000, eds). It reviewed key projects that had been undertaken over the decade since the initial research framework agenda and strategy was issued. It considered what progress had been made towards addressing the research priorities previously put forward. And it provided additional indications for future research projects and priorities.

For the Palaeolithic (Medlycott 2011: 3-8), the revised research framework reiterated that the East of England has enormous research potential, with the region's unique geographical situation and landscape history putting it at the forefront of Palaeolithic studies in Britain - as exemplified by work such as that at Pakefield (Parfitt *et al.* 2005), Happisburgh (Parfitt *et al.* 2010) and Linford (Boismier *et al.* 2012), and by research and resource review projects in the region such as the *Thames Estuary Survey of Mineral Extraction Sites* (Essex County Council and Kent County Council, 2004) and the *Medway Valley Palaeolithic Project* (Wenban-Smith *et al.* 2007a,b). It was thought that there had been greater progress in improving understanding of the Lower and Middle Palaeolithic, and less progress for the Upper Palaeolithic (and Mesolithic). Various suggestions for possible future research projects and priorities were put forward, broadly following those indicated in the *Medway Valley Palaeolithic Project* (*ibid.*) with some additions:

- a structured programme of fieldwalking to collect surface finds that might provide new indications of sub-surface deposits with Palaeolithic potential
- targeted investigations of sites from which Palaeolithic remains are known, but without good information on their provenance

- intensive study of artefact-bearing terrace gravel deposits, to investigate and understand the extent to which artefacts are clustered as concentrations and associated with specific horizons
- recovery of larger and well-provenanced artefact assemblages from terrace deposits
- increased attention to the Upper Palaeolithic of the region, and in particular to identify the evidence of the Final Upper Palaeolithic Long Blade industry, and to model the evidence of human activity of this period in the region, which probably represents early Holocene colonisation after the final cold snap of the Last Glacial, and presages the transition to the Early Mesolithic
- understanding the Quaternary chronological framework
- promoting wider community and public engagement with, and understanding and appreciation of, the Palaeolithic and the "Ice Age"
- increased attention to the Palaeolithic and Quaternary in pre-development investigations

Medlycott's general all-period review has since been supplemented for the Palaeolithic and Pleistocene by the Palaeolithic predictive model for Essex put forward in the report *Managing the Essex Pleistocene* (Essex County Council 2015). This report resulted from a project led by Essex County Council with specialist input from Peter Allen (for Pleistocene geology) and Francis Wenban-Smith (for Palaeolithic archaeology). This project followed the *Medway Valley Palaeolithic Project* in addressing the strategic priority of developing predictive models of Palaeolithic potential. However, it built on the *Medway Valley Palaeolithic Project*'s methods, and addressed the whole county of Essex rather than just a small part of it. The primary aims of the project were (a) to develop a methodology for creating a predictive model of the county-wide Palaeolithic resource using readily-available heritage data in conjunction with geological mapping, and (b) at the same time to actually produce such a model. The hope was that this model would then facilitate delivery of consistent and considered responses to development proposals that affected Palaeolithic remains, and help in other aspects of managing the county's important Palaeolithic and Pleistocene resource.

The general approach of the project was to review how the known Palaeolithic sites and find-spots across Essex (as represented in the county Historic Environment Record) mapped onto broad types of Pleistocene deposits. This was then taken as a model for the wider potential of these deposit types. Thus for instance, if the deposit type "river terrace gravel" had produced abundant Palaeolithic finds in one part of the county, then the resulting model indicated that similar finds were likely to be encountered in similar terrace gravels in other parts of the county even in areas where no finds were known.

The report identified 14 major deposit types or "Lithological Units" (LUs) (**Table 1**). An algorithm was then used to attribute deposits of each Lithological Unit to one of six categories of Palaeolithic potential. These categories (**Table 2**) were

based on a combination of factors (Essex County Council 2015: 31-37) such as the prevalence of Palaeolithic sites, the potential for deposits with palaeo-environmental remains, the presumed degree of disturbance, and the proximity of deposit polygons with remains such as these. Precautionary buffers were added around polygons in areas where the extent of important deposits was thought uncertain. Therefore, while LU type follows directly from geological mapping, and while there is a close correspondence between LU type and the assessed category of Palaeolithic potential, one cannot rely directly on the geological mapping to indicate Palaeolithic potential. The resulting county-wide model has been incorporated as a GIS layer within Essex Place Services' computer system, and thus can provide an immediate initial indication of Palaeolithic potential for any proposed development footprint.

Thus for this A12 project, the initial Palaeolithic assessment of potential was based on the Essex Place Services GIS layer. This flagged up that the project corridor crossed several areas with Palaeolithic potential ranging from Moderate to Very High (**Figure 1**), and thus it was thought appropriate to seek specialist input at the outset of the project.

*Age **	*Marine Isotope Stage **	*Lithological Unit - central/south-western Essex*	*Lithological Unit - southern/eastern Essex*
Holocene	1	LU 14 - Tufa; and Alluvium	
Devensian (peak)	2	LU 13 - Shepperton Gravel, and various brickearth deposits (presumed aeolian)	
Devensian (early)	5d-2	LU 12 - Grays and Ilford brickearths LU 11 - Terrace deposits (East Essex rivers: Colne, Blackwater, Chelmer) LU 9 - Lower Thames terrace gravels (eg. Orsett Heath, Corbets Tey, Mucking and Kempton Park) LU 8 - interglacial lacustrine deposits (Hoxnian) in the Blackwater Valley (Rivenhall End) and at Marks Tey	LU 10 - low-level East Essex Thames-Medway gravels (eg. Barling, Southchurch, Asheldham) and buried channels LU 4 - Post-Anglian interglacial channel-fills
Ipswichian	5e		
Saalian Complex	10-6		
Hoxnian	11		
Anglian	12	LU 8 - glacial lacustrine silts LU 7 - Lowestoft Formation: glacial and fluvio-glacial deposits	
Comerian Complex, and prior uncertain attributions	20-13	LU 5 - Woodford Gravel LU 3 - Colchester Formation LU 2 - Sudbury Formation	LU 4 - Colchester Formation (interglacial horizons) LU 6 - high-level East Essex Medway gravels (eg. Oakwood, Canewdon, Chalkwell and Lower Holland)

Even earlier uncertain attributions	Up-to-and-including 21	LU 1 - Stanmore Gravel	-

* see **Section 3.1**, **Table 4** and **Figure 2**

Table 1. Lithological Units defined in the *Managing the Essex Pleistocene* Palaeolithic predictive model (Essex County Council 2015)

Palaeolithic potential	*Primary criteria*	*Additional criteria*
Very High	- Proven association in well-provenanced horizons of artefacts and/or palaeo-environmental remains	- Deposits laid down under conditions suitable for human occupation - Deposits known to be suitable for good preservation and survival of artefacts and/or palaeo-environmental remains
High	- Confident association of deposits with artefacts and/or palaeo-environmental remains - Adjacent to deposits that are categorised as "Very High"	- Direct borehole or other evidence of deposit presence - Deposits laid down under conditions suitable for human occupation - Deposits likely to be suitable for reasonable preservation and survival of artefacts and/or palaeo-environmental remains
Moderate	- Possible presence of deposits with artefacts and/or palaeo-environmental remains - Adjacent to deposits that are categorised as "High"	- Deposits with occasional Palaeolithic findspots of uncertain provenance, probably from different Quaternary deposits than are mapped - Holocene or pre-Quaternary deposits that have produced Palaeolithic finds, and therefore may contain unmapped Quaternary deposits with Palaeolithic potential
Low	- Quaternary deposits contemporary with known hominin occupation, but without any known Palaeolithic or palaeo-environmental remains - Deposits adjacent to areas of higher potential	- Areas of pre-Quaternary bedrock without any known Palaeolithic finds - Deposits laid down under conditions prohibitive to human occupation - Areas where potentially relevant Quaternary sediments are known to have been mostly extracted or otherwise substantially removed by development
Zero	- No association with any known Palaeolithic or palaeo-environmental remains	- Areas where potentially relevant Quaternary sediments are known to have been completely extracted or otherwise entirely removed by development - Pre-Quaternary bedrock that shares no boundaries with Quaternary deposits of any Palaeolithic potential
Uncertain	- Insufficient data to reach any conclusions as to the nature/period of any deposits, or their Palaeolithic potential	-

Table 2. Categories of Palaeolithic potential defined in the *Managing the Essex Pleistocene* Palaeolithic predictive model (Essex County Council 2015)

2.2.3. National Guidance: identifying and protecting Palaeolithic remains

English Heritage (1998) have produced a Guidance note for planning authorities and developers, to aid in the identification and protection of Palaeolithic remains. Although now more than 20 years old, and with a revised version currently in preparation, this document reinforces several important principles, and also provides some useful guidance for the recognition of important remains.

Key principles include:

- development proposals should take account of Palaeolithic remains (as well as those of later periods) so that they may be located, protected or investigated as appropriate to their significance
- information on Palaeolithic remains may be acquired from desk-based assessment, but it may be necessary to obtain further information from a field evaluation
- where development proposals could affect important Palaeolithic sites, the full extent of impact must be assessed in advance of a planning decision
- sites are of varying importance and it is necessary to assess their level of significance before deciding what levels of protection, management or recording are appropriate

As outlined above (*Section 2.2.1*), significance can be assessed on the basis of potential to contribute to current research themes and priorities. Although it is often clear how certain data contribute to the main questions of the period, it is sometimes less clear, and then it can become the role of the specialist to explain how certain apparently-less-significant data can contribute to major objectives. However, it is also possible to spell out a less-contingent set of criteria that are generally agreed as reflecting high importance for a Palaeolithic site, and the inevitability of it being able to make a major contribution to research.

The English Heritage Guidance (1998) includes a list of criteria for the identification of remains that can be regarded as of national importance (**Table 3**). An important aspect of these criteria is that *any one* of them is specified as sufficient for a site to be regarded as of national importance, so a site that matches several of these criteria is clearly of national or international importance.

English Heritage criteria	*Comments*
Human bone	- The full total of Lower/Middle Palaeolithic bone from England comprises one part-skull from Swanscombe (Kent), and a part-tibia and two incisor teeth from Boxgrove (West Sussex); Upper Palaeolithic material is more common, but still very rare and usually found in caves/rock-shelters - any context with bone preservation has the potential to produce human remains

Primary undisturbed context	- almost no sites are totally undisturbed; however minimally-disturbed sites are more common than one might think, and can be found in a range of contexts, including river terrace gravels
Period/area rare	- very contextual to region; generally Palaeolithic remains are rarer north of London and northwest of the A12 due to the landscape effect of repeated glaciations
Organic artefacts	- even rarer than human remains - only liable to be found where suitable conditions for preservation
Well-preserved associated bio-evidence	- often a discussion to be had about whether bio-evidence is behaviourally-related to co-occurring lithic remains, or just in the same deposit as them - but in either case, the evidence is important
Evidence of lifestyle	- can include various types of evidence, such as cut-marked bones, or intra-site patterning of artefacts or faunal remains
Stratigraphic relationships between different archaeological horizons	- a very important factor that enhances the importance of a site, even if the separate horizons do not in themselves have evidence of high importance
Artistic evidence	- another very rare category, can be a portable artefact such as a carved/painted stone or bone, or fixed such as cave-art
Evidence of hearths or structures	- hard to confirm in the field without thorough investigation, and would be an adjunct to an undisturbed site
Resource exploitation	- could relate to the landscape situation of a site, in relation to resources such as flint raw material, a notable feature such as a gully, or to the presence of a resource such as a spring or water-course
Artefacts are particularly abundant	- some sites/horizons are particularly rich, and we still don't know why these few sites were such a focus of activity - key angles of investigation for these sites are: whether this richness represents Palaeolithic behaviour or relates to natural site formation processes, and what is the spatial/vertical extent of the artefact concentration

Table 3. Criteria for national Palaeolithic importance (English Heritage 1998)

3. Archaeological background

3.1. General introduction to the Palaeolithic and the Pleistocene

The Palaeolithic (or Stone Age) represents the earliest phases of human occupation of Britain, as evidenced by the stone tools that survive in ancient deposits attributable to various dates between *c.* 800,000 BP [years Before Present] and the end of the last ice age *c.* 12,000 BP (**Table 4**). Britain was not continuously occupied through the Palaeolithic, due to climatic oscillations which made it periodically too cold to survive. The British Palaeolithic has been subdivided into different stages (Lower, Middle and Upper) based on changes in stone tool types and manufacturing techniques through this period (**Table 4**). The Lower and Middle Palaeolithic periods (lasting from *c.* 800,000 to 40,000 BP) are associated with early forms of human (*Homo heidelbergensis*, and their

Neanderthal descendants). This lineage became extinct between 40,000 and 30,000 BP, and was replaced *c.* 35,000 BP by anatomically modern humans, who are associated with the Upper Palaeolithic (*c.* 35,000 BP to 12,000 BP).

The Palaeolithic (in Britain) is associated with the second half (Middle and Late stages) of the Pleistocene geological epoch, which began c. 2 million years ago. This was a time when the earth's climate oscillated over the course of millennia between cold ice ages (glacials) and warm interglacial periods (Lowe and Walker 2015). The end of the Pleistocene is defined by the end of the last ice age *c.* 12,000 BP, and the subsequent warm phase (which continues to the present day) is known as the Holocene. It is probably no coincidence that the changes in lithic material culture that define the end of the Palaeolithic (and the start of the subsequent Mesolithic period) coincide with the climatic transition that defines the boundary between the end of the Pleistocene and the start of the Holocene.

The term "Quaternary" represents the time period that encompasses both the Pleistocene and Holocene epochs. In practice the terms Pleistocene and Quaternary are often used synonymously, since they have such a substantial overlap. The Pleistocene is also often incorrectly described as a "period" rather than an "epoch". It is useful to note the correct definitions, and to be aware of the slight technical differences when the terms are used correctly. From a Palaeolithic point of view, Palaeolithic remains are mostly associated with Pleistocene deposits. However, archaeological remains from the very end of the Palaeolithic are often buried by, or incorporated in the basal part of, early Holocene deposits (typically alluvium or colluvium). Therefore it is usually correct to regard Quaternary deposits as providing the all-embracing potential source of Palaeolithic remains; although in practice, investigations will mostly be focused on Pleistocene deposits, which are much more varied and represent a far greater timespan.

Pleistocene deposits are generally dated with reference to numbered marine isotope stages (MIS). These are derived from analysis of changing proportions of oxygen isotopes (O^{18} and O^{16}) in the continuous deep-sea sedimentary record that reflect the global climatic oscillations. Even-numbered MIS stages (2,4 *etc.*) represent cold glacial troughs in the continuous sequence, and odd-numbered stages (5, 7 *etc.*) represent warm interglacial peaks. These numbered stages have been dated by various means (primarily radiometric), and thus the continuous deep-sea record provides a reference framework (**Figure 2**) against which the discontinuous terrestrial record can be related.

Key reference stages for the purposes of this report are MIS 12 (the Anglian glaciation, which lasted between c. 475,000 and 425,000 BP), MIS 11 (the Hoxnian interglacial, which followed the Anglian, and lasted between c. 425,000 and 360,000 BP), and MIS 2 which represents the coldest part of the last glacial period (the Devensian) between *c.* 24,000 and 16,000 BP. MIS 2 was followed by some relatively rapid cold and warm oscillations, before the significant warming trend at 11,700 BP that defines the end of MIS 2, and the start of MIS 1 (the present warm Holocene epoch).

Terrestrial deposits can themselves often be directly dated, or can be dated in relation to other deposits on the basis of their contained faunal evidence or their stratigraphic relationships. Therefore, following almost 2 centuries of work, we have quite a good idea of the Pleistocene framework for eastern England, and the relationship of its characteristic glacial deposits with the important well-dated framework of fluvially-lain terrace deposits in the Lower Thames valley (Bridgland 1994).

Traditional Palaeolithic stage	*Updated stage*	*Human species*	*Lithic artefacts and other material culture*	*MI Stage*	*Date (BP)*	*UK geo stage*
Upper Palaeolithic	**Upper Palaeolithic**	Anatomically modern humans (*Homo sapiens sapiens*)	Dominance of blade technology and standardised tools made on blade blanks; personal adornment, cave art, bone/antler points and needles	2-3	10,000-35,000	Late Devensian
Middle Palaeolithic	**British Mousterian**	Neanderthals *(Homo neanderthalensis)*	The appearance of *bout coupé* handaxes; discoidal flake/core reduction strategies	3-5d	35,000-115,000	Early/Middle Devensian
	-	-	Britain uninhabited	5e	115,000-125,000	Ipswichian
	Lower/Middle Palaeolithic	Early pre-Neanderthals, evolving into *Homo neanderthalensis*	Still some handaxe-dominated sites, but growth of more standardised (Levalloisian) flake and blade production techniques (Eg. Crayford)	6-9	125,000-425,000	Saalian complex and Hoxnian
Lower Palaeolithic			Handaxe-dominated (Eg. Swanscombe; Cuxton), but appearance of more standardised flake and blade production techniques (Levalloisian); occasional industries without handaxes (Clactonian)	8-11		
	-	-	Britain uninhabited	12	425,000-480,000	Anglian
	Lower Palaeolithic	*Homo* cf *heidelbergensis*	Handaxe-dominated (Eg. Boxgrove), with occasional unstandardised flake core production techniques and simple unstandardised flake-tools; occasional unifacial flake-tool industries without handaxes (High Lodge)	13	480,000-500,000	Cromerian Complex IV

		Homo ergaster	Simple flake/core industries with no standardised flake-tools (Pakefield; Happisburgh)	13-21?	500,000-850,000	Cromerian Complex I-III

Table 4. Overview of the British Palaeolithic and Pleistocene framework

3.2. Geology and landscape context

The landscape is generally flat and undulating across the East Anglian region, with much of the region lying between 40m and 60m OD. Some areas of higher ground occur, including a ridge reaching *c.* 80-90m OD to the southeast of the A12 corridor - the Danbury-Tiptree ridge; as discussed below this topographic high feature is intrinsically related to the underlying geology and the region's history of landscape development.

An overview of the geology of East Anglia is provided by Lee *et al.* (2015). The solid bedrock of the southern part of the region is formed by the widening eastward extension of the London Basin, filled with Palaeocene silts, sands and clays. The underlying Cretaceous Chalk rises to form the north side of this basin, and forms a major southwest-northeast trending band stretching from the northern outskirts of the Greater London area (St Albans) via Cambridge to the north Norfolk coast.

The overlying superficial Quaternary deposits of the region are extensive and complex. As a simplified overview, they can be divided into five main groups:

Pre-Anglian sands and gravels. These mostly represent the remnants of major fluvial activity across the landscape in the Early Pleistocene, and in the earlier Middle Pleistocene, prior to the major Anglian glaciation. The earliest set of deposits (Stanmore Gravel) probably relates to northward drainage from the Weald region, although another possibility is that this deposit represents the remains of marine regression. Slightly younger than these, the Kesgrave Sands and Gravels relate to drainage from the west, and thus can be understood as early precursors of the Thames.

Lowestoft Formation. This suite of deposits provides a major stratigraphic tie-point across the East of England, and relates to the major Anglian glaciation that lasted for *c.* 50,000 years between *c.* 475,000 and 425,000 BP. The main deposit is an extensive sheet of chalky till, or Boulder Clay, that covers much of the East Anglian region. This till formed under the ice sheet, and thus directly represents the extent of glaciation. The Lowestoft Formation also includes major bodies of sand and gravel - Glacial Sand and Gravel - that formed as waterlain deposits broadly contemporary with the ice-sheet, often at its margins or laid down over Boulder Clay as it contracted at the end of the glacial episode. The Lowestoft Formation also includes rare instances of fine-grained silt/sand deposits, sometimes organic-rich, which relate to lake-development at the end of the Anglian glaciation.

Post-Anglian river terrace systems. These deposits relate to the development of drainage systems after the end of the Anglian glaciation. Prior to the glaciation, the major axis of drainage was of the major ancestral Thames from southwest to northeast. After it, the predominant drainage pattern was of more numerous minor rivers draining to the southeast, such as the Colne, the Blackwater and the Chelmer. Separate post-Anglian terrace systems have developed in each of these river valleys. In each valley, up to five separate terrace levels have often been identified, counting up from the first terrace above modern floodplain (T1) to the highest and oldest terrace remnants on the valley sides (T5). However, dating and inter-valley correlation of these terrace systems is particularly difficult. There is substantial overlap and mingling between the highest terraces and the youngest glacial sands and gravels representing late outwash deposits associated with the retreat of the Anglian ice sheet. Furthermore, each valley's system developed independently, so for instance, T3 in one valley need not be the same as T3 in another. The general lack of organic remains in these post-Anglian river terraces means that it is difficult to date them independently, although there is some potential for the use of radiometric techniques such as optically stimulated luminescence (OSL). Some parts of these terrace systems include organic-rich interglacial lacustrine sediments, in particular in the Roman River valley at Marks Tey and in the Blackwater Valley at Rivenhall End. These deposits have been shown to relate to the post-Anglian Hoxnian interglacial episode, and contain rare and internationally important evidence of this period (see below, **Section 3.4**).

Head deposits. These are slopewash and mass movement deposits, with sediment being reworked from underlying deposits, and then redeposited on the floors and sides of valleys and in landscape depressions after downslope movement. Their sedimentology is very varied, since it depends upon the source material. They are normally predominantly sand/silt/clay with a subsidiary gravel content, often concentrated towards the base of the deposit body. Gravel-free manifestations can be mapped as "Head Brickearth", and conversely gravel-dominant manifestations can be mapped as "Head Gravel". These deposits have formed throughout the Quaternary, so can be of widely varying ages, although almost all present day exposures are thought to be relatively recent, dating from the later part of the last (Devensian) glacial period, or the subsequent Holocene.

Holocene alluvium and coastal zone deposits. Holocene alluvium consists of fine-grained silts and clays, often organic-rich, associated with the present-day river drainage pattern. Coastal zone deposits are more varied. They include estuarine alluvium, storm beach sand/gravel deposits, and tidal flats.

The A12 improvement corridor passes broadly southwest-northeast across central Essex. Here (**Figure 3**), the corridor passes along the southeast edge of the sheet of Boulder Clay representing the Anglian glaciation, in an area where

the underlying bedrock is London Clay. Parts of the route pass over the Boulder Clay itself, and other parts cross into the zone beyond the Boulder Clay, just beyond the edge of the Anglian ice sheet. This is a zone where complex and active processes were taking place throughout the Anglian glaciation as well as after it. It now contains the Blackwater river valley, which is underlain by a deeply-buried channel infilled with Boulder Clay, thought to represent drainage under the Anglian ice sheet. The zone probably also contains remnants of the moraine at the front of the ice sheet, outwash gravels associated with the melting and retreat of the ice sheet, and then lacustrine deposits and terrace sands/gravels formed during the 100s of thousands of years between the end of the Anglian glaciation and the present day. This is thus, even within the generally complex East of England region, a specific area of particular complexity for the superficial Quaternary deposits.

The southeast stretch of the route corridor comes within geological mapping sheet 241 (Chelmsford), and the northeast stretch within sheet 223 (Braintree). These 1:50,000 sheets are covered by the respective British Geological Survey sheet memoirs by Bristow (1985) and Ellison & Lake (1986). The Quaternary deposits along the route corridor are reviewed below, and the correlations of deposits between these two mapping sheets, and with the Lithological Units defined for the *Managing the Essex Pleistocene* project (Essex County Council 2015: 41-108), are summarised here (**Table 5**).

The characteristics and depositional interpretation of these deposit groups are discussed further below (**Section 6**), in conjunction with their likely associated Palaeolithic remains as assessed in the *Managing the Essex Pleistocene* project (*ibid.*).

*Age **	*Marine Isotope Stage **	*Lithological Unit* [Managing Essex Pleistocene]	*BGS sheet 223, Braintree*	*BGS sheet 241, Chelmsford*
Holocene	1	Alluvium Head deposits (LU unassigned)	- Alluvium - Head (Domsey Brook, Roman River valley)	- Alluvium - T1 loam (Witham, west of Blackwater, over T3)
Devensian (late, peak LGM and transition to Holocene)	2	LU 13 - aeolian brickearth	- Head (Domsey Brook, Roman River valley)	- Head (flanks of Blackwater valley)
Devensian (full)	5d-2	LU 11 - Terrace deposits (East Essex rivers: Colne, Blackwater, Chelmer)	- River terrace deposits, T1-T3 (Blackwater)	- Head Brickearth (SW of Witham, over Boulder Clay) - River terrace deposits, T1-T3 (Blackwater)
Ipswichian	5e			
Saalian Complex	10-6			
Hoxnian	11			

Hoxnian	11	LU 8 - interglacial lacustrine deposits (Hoxnian) at Marks Tey, and in the Blackwater Valley (Rivenhall End)	- Lacustrine deposits, mostly interglacial (Marks Tey, Roman River valley)	- Lacustrine deposits, Hoxnian interglacial (Witham, and Rivenhall End)
Anglian	12	LU 8 - glacial lacustrine silts LU 7 - Lowestoft Formation: glacial and fluvio-glacial deposits	- River terrace deposits, T4-T5 (Blackwater) - Glacial lake deposits [Lowestoft Formation] - Boulder Clay [Lowestoft Formation]	- River terrace deposits, T4-T5 and Undifferentiated (Blackwater) - Glacial lake deposits - Boulder Clay
			- Glacial Sand and Gravel [Lowestoft Formation]	- Glacial Sand and Gravel [including Chelmsford Gravels, and deposits mapped as Kesgrave Sands and Gravels on sheet 223]
Comerian Complex, and prior uncertain attributions	30?-13	LU 3 - Colchester Formation LU 2 - Sudbury Formation	Kesgrave Sands and Gravels	

* see **Section 3.1**, **Table 4** and **Figure 2**

Table 5. Quaternary mapping of the project area: cross-reference of *Managing the Essex Pleistocene* Lithological Units (LUs) with British Geological Survey mapping

3.3. Regional Palaeolithic background: East Anglia and Essex

As reflected in the regional reviews of Wymer (1985) and Wessex Archaeology (1997), and as identified in the regional Palaeolithic resource assessment (see above, *Section 2.2.2*), the East of England as a whole is a nationally and internationally important area for the Palaeolithic. From an international perspective, England is on the northern edge of the inhabited world. England was periodically colonised from continental Europe through the early Palaeolithic during periods of warmer climate when these early hominins were able to survive, due to the abundance of plant and animal resources and their natural adaptation to milder climatic conditions. However, hominins became locally extinct in Britain during the coldest glacial episodes of the Pleistocene.

Thus the region is an important laboratory for investigating the behaviour and survival capability of early hominins at this time, which mostly represents a period when one of Europe's early colonisers (*Homo heidelbergensis*) was evolving into Neanderthals. This settlement history and evolutionary transition is represented in the Palaeolithic artefacts from the Middle and Late Pleistocene deposits of the region, matching the broadly-known national framework (**Table 5**). However, the extreme scarcity of hominin skeletal material in the UK Palaeolithic record (apart from one early skull from deposits at Swanscombe that seems to show a transitional form between *H. heidelbergensis* and Neanderthal) means that

attempts to link specific tool-types and manufacturing practices with this evolutionary transition remain speculative.

The evidence of Britain's earliest episodes of occupation between *c.* 850,000 and 500,000 BP is preserved in pre-Anglian fluvial and estuarine deposits exposed by coastal erosion at the east coast of East Anglia, at the sites of Pakefield (Parfitt *et al.* 2005) and Happisburgh (Parfitt *et al.* 2010). On dry land, as reviewed in *Managing the Essex Pleistocene* (Essex County Council 2015), there are also relatively common finds from pre-Anglian Kesgrave Sands and Gravels, where these are either naturally exposed or have been dug into by quarrying. The wide spread of glacial till from the Anglian glaciation, which lasted between c. 475,000 and 425,000 BP, reflects growth of a substantial ice-sheet, and Britain would have been uninhabitable through this time.

However, there is abundant evidence of rapid post-Anglian re-colonisation during the subsequent Hoxnian interglacial period. The landscape would have been dominated by ponds, streams and rivers developed over the clayey/gravelly substrate left after the retreat of the ice sheet. The mild climate would have allowed rich and diverse plant and animal communities to flourish, and there would have been abundant flint raw material available for tool manufacture, so it is no surprise that early hominins were also able to flourish. The (often undisturbed, or minimally disturbed) evidence of their presence is mostly found in lake margin and riverbank environments where gentle sediment aggradation took place during the Hoxnian, such as at Barnham and Hoxne in Suffolk, or around the margins of the Hoxnian lake at Marks Tey in Essex. The earliest post-Anglian re-colonisers of eastern England had a relatively simple lithic industry (Clactonian) based on a limited variety of flake tools. Later in the Hoxnian, the lithic industry became dominated by handaxe manufacture (Acheulian). It remains uncertain whether this reflects *in situ* technological change through the Hoxnian (which lasted over 50,000 years), or a second wave of colonisation from continental Europe.

Many Palaeolithic flint tools of less-certain date have been found associated with river terrace deposits (sands and gravels) that have accumulated in river valleys throughout the >400,000 years between the end of the Anglian glaciation and the end of the last ice age *c.* 12,000 BP. And likewise, many finds have been made on the surface of the Anglian till, presumably from unmapped lacustrine or stream-bank deposits. Many of these finds have been transported some distance, others are relatively undisturbed. However, as also pointed out in Austin's (2000) regional research agenda, both types of site can make important contributions to improving our understanding of the Palaeolithic and addressing national and regional research priorities. More-disturbed sites can provide a better overall picture of the technological and typological character of a lithic industry happening in a general area, and at a particular stage of the Pleistocene. Even though they be slightly transported and come from a deposit that may have formed through a period of several thousand years, this is still a relatively tight time window at the wider Pleistocene timescale. Conversely, less-disturbed sites may be relatively unrepresentative of the wider technology/typology of a region, but provide very good insight into particular episodes of behaviour and activity.

There are also likely to be Final Upper Palaeolithic (Long Blade industry) archaeological remains at the base of Holocene alluvial and/or colluvial sequences across the region. Few Upper Palaeolithic remains are known in the region, and these are mostly stray surface finds of uncertain provenance. However, the Thames Basin, immediately to the south of the region, is known as an area with a relatively rich record of Final Upper Palaeolithic activity, with major sites such as Avington VI (Froom 2005), Three Ways Wharf (Lewis & Rackham 2011) and at several localities in the Ebbsfleet Valley (Jacobi 1982; Wenban-Smith, for MOLA, 2019; and Anderson-Whymark 2020). And other sites are known from the northern and eastern parts of East Anglia, such as Sproughton in Suffolk and Carrow Road in Norwich (Barton & Roberts 2020), so it would be surprising if there wasn't evidence of this period in central Essex, even though it hasn't yet been found.

3.4. Key previous work: the A12 project area

Two previous projects have taken place, that provide important data that contribute to this desk-based review, and to our understanding of the Palaeolithic and Pleistocene in the A12 project area. The first of these (Turner 1970) took place many decades ago, in the 1960s, and involved an internationally important analysis of the Hoxnian lake sediments at Marks Tey, at the northeast end of the A12 project corridor. The second of these is a series of smaller and unpublished investigations of post-Anglian terrace and lacustrine deposits in the Blackwater valley at Coleman's Farm, northeast of Witham. These two projects are briefly reviewed here below, and then key data from them are subsequently brought into this Palaeolithic desk-based assessment where relevant.

3.4.1. Hoxnian lake sediments at Marks Tey

A major programme of investigations was carried out by Turner in the 1960s (Turner 1970). Deep deposits of clayey/silty sediments suitable for brick manufacture had been exploited for many years here (WH Collier's Brickworks), and it was known that these overlay Anglian till, and were organic-rich in places and had produced a variety of faunal and plant remains. A detailed investigation took place, using data from numerous historic boreholes undertaken by the brickworks integrated with data from new boreholes undertaken as part of the research programme. This work allowed a detailed reconstruction of the subsurface deposit sequence, and demonstrated the development here of a major post-Anglian lake, infilling a deep depression in the surface of the Anglian till (mapped geologically as Boulder Clay).

The lake deposits had a distinctive fine laminar structure, reflecting annual seasonal variations of rainfall and sediment input. In conjunction with an intensive programme of pollen analysis, it was therefore possible to construct a year-by-year framework of climatic change through the Hoxnian, and to directly count how many years each subsidiary climatic stage lasted. This framework remains of international and national importance in (a) understanding the Hoxnian interglacial period itself, and (b) providing a more general template for patterns of post-glacial

vegetational change in temperate regions, through the repeated cold/warm cycles of the Pleistocene.

Recovery and analysis of Palaeolithic artefacts were not, however, aspects of this work. The investigation focused upon deep sequences that would have accumulated at the bottom of a deep body of quiet water, and thus not in a situation conducive for hominin activity. However, it is likely that early humans would have been active around the margins of the Marks Tey lake, in areas where the sediments were too thin or not suitable for brick-making, and thus where they remain unexploited and unexposed. Several Palaeolithic artefacts have been found in and around the Marks Tey brickworks (see below, **Section 8** and **Appendix F**), and one unpublished investigation has found artefacts in conjunction with mammalian remains (M White, pers. comm.).

3.4.2. Terrace and lacustrine deposits at Coleman's Farm, Witham

As reviewed below (**Section 8** and **Appendix F**), numerous Palaeolithic artefacts have been found associated with post-Anglian terrace deposits along the Blackwater valley, and in particular with Terrace 3, representing the transition from the Anglian glaciation to the Hoxnian interglacial. Many have been found on land belonging to Coleman's Farm, northeast of Witham. This is also an area where post-Anglian lake deposits have been identified. Therefore a small test pit investigation (eleven test pits) was carried out in 2006 (by F Wenban-Smith and MR Bates), in the hope of finding a site with undisturbed lake-margin occupational evidence, followed by three boreholes in 2009. Although such a site was not found, the investigation did reveal numerous exposures through the complex deposit sequence in the area, clarifying the distribution and relationships of Boulder Clay, terrace sands and gravels, Hoxnian lake deposits, and overlying Head deposits. Various palaeo-environmental remains were recovered and analysed, including ostracods, molluscs and pollen.

This initial work was then supplemented by a larger programme of pre-quarrying investigations between 2008 and 2015, in a nearby field a short distance to the southwest. Preliminary boreholes were carried out in 2008 to scope the sub-surface deposits (Brewer Geological Services 2008). This was followed by a programme of test pit evaluation in 2014, involving 25 test pits (Bates, with Wenban-Smith 2014), and then there was a final test pit and trench investigation in 2015, when 23 further test pits or trenches were dug (Bates 2015).

This accumulation of work, in conjunction with numerous borehole logs available from the area, provides a substantial body of data that allows good knowledge of the sub-surface deposits in this area, which has high Palaeolithic potential and is also affected by the footprint of the new proposed route of the A12 to the northeast of Witham.

4. Aims and objectives

4.1. General aims

Following from the Brief (Jacobs 2019) and as specified in more detail in the Method Statement (Wenban-Smith 2019), the general aims of this Palaeolithic desk-based assessment are to:

- to provide an overview of varying Pleistocene deposit character and Palaeolithic potential along the route of the project
- determine the potential location, survival, state of preservation and likely extent of any Palaeolithic deposits;
- assess the archaeological and palaeo-environmental importance of any Palaeolithic deposits;
- assess the potential for the presence of residual and/or re-deposited Palaeolithic artefacts along the proposed scheme corridor
- to highlight areas of uncertainty, where further information is required to reach a reasonably confident understanding of the likely significance of any archaeological and palaeo-environmental remains and their vulnerability to impact by the project
- recommend any potential techniques or actions that could be incorporated into future investigations (including, but not limited to, field evaluation and mitigation) to (a) improve understanding of the nature and significance of deposits potentially impacted by the proposed scheme and (b) reduce the impact of any possible effects of the proposed scheme upon Palaeolithic remains
- to present these results as a report supported by suitable figures and appendices, for consideration by Jacobs and other stakeholding parties (in particular Historic England regional advisors, and planning archaeologists from Essex County Council and Colchester Borough Council)

4.2. Specific objectives

Specific objectives of this Palaeolithic desk-based assessment are:

- to develop a preliminary understanding of the distribution and variety of sub-surface natural deposits along the route of the project, both Quaternary ("Drift") and pre-Quaternary ("Solid");
- to consider the likely age and environments of deposition for the range of deposits identified;
- to assess archaeological potential and importance along the project route, with reference to relevant national and regional research frameworks (**Appendix B**), and taking account of artefactual and palaeo-environmental remains, and sedimentological sequences, as contributors to our understanding of the historic environment

- to produce a preliminary Palaeolithic and Quaternary characterisation for the project footprint, dividing it into different areas of varying sub-surface geology and Palaeolithic archaeological potential
- to identify areas of uncertainty with insufficient data to reach a confident assessment of potential, and to provide recommendations for suitable investigations to resolve any uncertainty
- to provide outline programmes of evaluation (and/or other strategies of investigation) to gain sufficient information to determine the nature of any Palaeolithic remains and develop suitable programmes of mitigation in advance of the scheme's implementation

5. Methods and approaches

5.1. Desk-based assessment: a deposit-centred approach

In accordance with Historic England best practice, the approach taken here to assessing Palaeolithic potential is "deposit-centred", following the principles established in the Solent-Thames (Wenban-Smith *et al.* 2014) and South-East regional research frameworks (Wenban-Smith *et al.* 2010, revised in 2017 and 2019). Although artefact finds are the most direct evidence of Palaeolithic human activity, research into, and understanding of, the period depends almost more upon understanding the depositional processes of the sediment in which they were found and any post-depositional disturbance that may have affected any artefacts recovered, and on analysis of any associated palaeo-environmental evidence.

Therefore the starting point for this Palaeolithic desk-based assessment is to review the variety and distribution of Pleistocene deposits in the project corridor, and to consider how they formed, what palaeo-environmental remains they contain, and what the implications of their formation and post-depositional processes could be for interpretation of any contained Palaeolithic remains.

This deposit-centred starting point is then supplemented by a detailed review of all known Palaeolithic findspots within a 3km buffer of the project footprint (**Figure 1**). This provides an initial indication of where Palaeolithic remains are already known, and how they contribute (or have the potential to contribute) to current regional, national and international research framework priorities. Palaeolithic finds are rare, and often dependent upon where large-scale deposit impact (such as quarrying) has taken place and where people have chosen to look for finds. Therefore it is important to take a wide buffer around the project scheme since finds from a particular deposit type in one area, may reflect potential of that same deposit type in another area without any finds.

5.2. Sources

5.2.1. Pleistocene deposits: presence and distribution

Primary sources for developing an initial understanding of the variety and distribution of Pleistocene deposits in the project area were:

- British Geological Survey mapping, and regional and sheet memoirs;
- borehole data from the British Geological Survey on-line archive;
- published academic papers, grey literature reports and other published works;
- information from archives held by organisations and individuals.

The sources used have been collated as appendices, grouped into geological mapping and memoirs (**Appendix C**) and those that primarily relate to Palaeolithic archaeological reviews and projects (**Appendix D**). However there is substantial cross-over in these sources between archaeological and geological data.

5.2.2. Palaeolithic site data

The starting point for collating information on known Palaeolithic sites were the Historic Environment Records (HERs) for the project area, covering the scheme footprint and a 3km buffer around it (**Figure 1**). Although this project area is wholly within Essex, its eastern part falls within the district covered by Colchester Borough Council's separate heritage register. Therefore one set of HER records was obtained from Essex County Council (Place Services), and another from Colchester Borough Council's heritage team.

Relevant records were obtained as a search for any records including the terms Palaeolithic or Pleistocene, and any records for which their date range included any part of the Palaeolithic period. Thus the provided records included material categorised as generally "Prehistoric". All the records provided were initially examined and preliminarily attributed to a broad period category (**Table 6**). Those that clearly did not relate to the Palaeolithic - categorised as "post/non-Palaeolithic" - were excluded from more-detailed subsequent consideration.

	Presumed period				
HER source	*Lower/Middle Palaeolithic*	*Prehistoric /Palaeolithic?*	*post/non-Palaeolithic*	*Pleistocene Environmental Find-spot [PEFS]*	*Total*
Colchester BC	11	10	26	3	50
Essex CC	15	10	13	1 *	39 *
Total	26	20	39	4	89

Table 6. Breakdown of HER records from Essex County Council and Colchester Borough Council *[The Essex CC record from Coleman's Farm contained two attributions: a Lower/Middle Palaeolithic findspot, and a separate Pleistocene Environmental Findspot]

Previous work on county HERs (for instance in Kent for the *Stour Basin Palaeolithic Project*, KCC Heritage Conservation 2015) has indicated that county HERs may have substantial omissions and inaccuracies for Palaeolithic data when compared with key Palaeolithic syntheses and primary published sources. Key Palaeolithic syntheses include the pioneering national syntheses of Evans in the late 19th century (Evans 1872 and 1897), the more-recent national Gazetteer of Roe (1968), and then the regional syntheses of Wymer (1985), and the *English Rivers Palaeolithic Project* (Wessex Archaeology 1997). These sources provide as-complete-as-possible lists of Palaeolithic sites known when they were compiled, and provide primary published sources for most.

Previous research has also shown that important Palaeolithic archaeological data can be found in primarily geological sources such as late 19th and early 20th century sheet memoirs, in series such as the regular Field Guides produced by the Quaternary Research Association for annual visits to various parts of Britain, and as a by-product of various research projects that have taken place since the most recent formal synthesis (Wessex Archaeology 1997) that may not have reached the HER.

Therefore, while the Essex and Colchester HERs were the starting point for collation of Palaeolithic find records, these were supplemented by a systematic review of (a) key syntheses that have already collated Palaeolithic site information for the project area, and (b) primary published sources for each site. Each Palaeolithic site, or findspot, was allocated a unique identifying number in a sequence prefixed by "P-" for "Palaeolithic/Proxy", and a register was maintained of how these numbers cross-referenced with the HER identifiers and those allocated in the English Rivers synthesis. Site data were collated in a systematic framework, and the data recorded for each site are listed below (**Table 7**).

The primary site data were then checked against, and cross-referenced with, the HER data. This led to recognition of numerous duplications, omissions and inconsistencies. Some HER records included information on more than one Palaeolithic site, and conversely, many sites in the HER were represented by more than entry. Furthermore, many sites in the primary literature were not listed in the HER, although conversely the HER did provide the only information on a few sites, particularly those originating from relatively-recent fieldwork and the Portable Antiquities Scheme (PAS).

This process ultimately led to an overall collation of the location and characteristics of known Palaeolithic sites in and near the project area. These were collated into an appendix (**Appendix F**), and shown on maps in conjunction with geological mapping and landscape topography (**Figures 4**-**6**) to aid in identification of zones of different Quaternary character and Palaeolithic potential ("PQ zones").

The full list of sources that were initially consulted are given as appendices (**Appendix C** for primarily geological sources, and **Appendix D** for primarily archaeological sources). And primary sources for key individual sites are included

as a separate section within the appendix listing all the Palaeolithic sites identified in and around the project footprint (**Appendix F**, **Section F.3**).

Site data	*Explanation*
P- no.	Unique Palaeolithic site identifier, used/assigned in this Palaeolithic Desk-based Assessment
Site	Site name, and summary information on finds
CBC HER no.	Unique HER no. in the Colchester Borough Council HER database
ECC MonUID	Unique HER no. in the current Essex County Council HER database
Essex SMR no.	Historic SMR no. used in the previous Essex County Council Sites and Monuments Record
ERPP 3, map.site	Site identification (if applicable) within the national Palaeolithic survey of the *English Rivers Palaeolithic Project* (Wessex Archaeology 1997)
Rec-Type	Record type, one of: Mon - Palaeolithic flint artefact/s provenanced to a known context Mon/PE - Palaeolithic flint artefact/s well-provenanced to a known context, in association with faunal or other palaeoenvironmental remains F-spot - location of Palaeolithic flint artefact find/s, with less-reliable info on its/their provenance F-spot? - location of Prehistoric (possibly Palaeolithic) flint artefact find/s, with less-reliable info on its/their provenance PEFS (Pleistocene Environmental Find-spot) - site with faunal or other palaeoenvironmental remains Geo - a significant geological sequence or feature, but lacking artefactual or palaeoenvironmental remains
NGR-E	OS grid easting, to nearest metre
NGR-N	OS grid northing, to nearest metre
Acc	Accuracy of OS grid location, one of: A (Accurate) - site is accurately located based on reliable primary sources E (Estimated) - site location can be estimated with reasonable confidence based on primary sources G (General) - sites and finds from a general area, lacking good information on location and provenance
Artefacts	Information on the quantity and variety of artefactual remains found
Palaeo-environmental remains	Information on the quantity and variety of faunal and other palaeo-environmental remains found
Geo attribution	Interpretation of likely geological context for Palaeolithic finds (see **Appendix F**, **Section F.1**, **Table F-2**, for details, and their interpreted depositional and post-depositional history
Primary sources	Key primary source references (listed in **Appendix F**, **Section F.3**)

Table 7. Data recorded for Palaeolithic sites [listed in **Appendix F, Section F.2**].

5.3. Walk-over survey

A short walk-over survey was conducted by the Palaeolithic specialist on 23rd and 24th June 2020. Due to the size of the project area (*c.* 600ha for the road scheme options, and a further *c.* 70ha for additional borrow pit areas), it was not practical to literally walk over it all.

Three areas, or issues, were identified beforehand as meriting particular attention during the walkover investigation:

WO1 - the area to the northeast of Witham, in the vicinity of Coleman's Farm, where numerous Palaeolithic artefacts and fossils have been found in an area where Hoxnian lacustrine sediments overlie Blackwater Terrace deposits;

WO2 - sites of proposed borrow pits I, J and K;

WO3 - the area northeast of A12 Junction 25, where the scheme impacts Hoxnian lacustrine deposits in the vicinity of Marks Tey, and where there are also exposures of deeper-lying Kesgrave Sands and Gravels that also have Palaeolithic potential.

In practice, the survey was divided into two parts, with a day allocated to each. On the first day, a pre-arranged visit was made to Mr Simon Brice of Colemans Farm, Witham, to check the numerous records of Palaeolithic finds that are listed in the Essex HER as having been made by him on his farmland in the scheme footprint since *c.* 1980. Besides there being some confusion in the HER records of exactly what finds were made when, and where, there is also an HER record - MEX10366 - relating to a map showing various findspots. It was hoped to consult this map. Furthermore, Mr Brice reported the recent recovery of numerous mammoth teeth and other mammalian bones, as well as some Palaeolithic artefacts, from the nearby Colemans Quarry. Therefore, the opportunity was taken to (a) examine this newly-recovered material, and (b) to visit this quarry with Mr Brice, so as to gather good information on the location and provenance of these new finds.

On the second day, the remaining part of the Palaeolithic project area was driven through, in conjunction with frequent on-foot walk-overs of key areas. The general topography and landscape were observed, and key areas were visited on foot to look for, and take notes on, topographic features and exposures that would help in the Palaeolithic and Quaternary assessment.

Numerous photographs were taken throughout both days of the field survey, and attention was also paid to identifying current land usage, and potential and constraints for future field evaluation.

The results of the walk-over survey are summarised below (**Section 7**) and have been incorporated in this updated issue of this report. Apart from the visit to Mr Brice, and to Colemans Quarry at the invitation of Mr Brice (and escorted by him), the survey adhered to publicly-accessible locations. It also took place with all regard for Health and Safety, with careful attention to safe parking, and the use of PPE when on foot.

5.4. Palaeolithic and Quaternary (PQ) zones: identification and assessment

Based on the geological and Palaeolithic site information outlined above (**Section 5.2**), the A12 project footprint was divided into 24 character areas. These are represented in the landscape as 26 actual Palaeolithic and Quaternary (PQ) zone polygons (PQ 1-12, 13a-b, 14-21, 22a,b and 23-24, see **Figures 7**-**12**) since some areas of similar character are not directly contiguous, (full details below, **Section 9**).

Each zone was defined as a unique polygon in a GIS project, overlain on the A12 project footprint so as to allow a 100m buffer beyond the edge of the proposed impact area. Unfortunately, the scheme's impact area was revised after the project brief was issued, so part of the project's proposed impact footprint now extends slightly beyond the southeast edge of one of the zones (PQ-16, see **Figure 9**). However, there is no change in deposit character in this direction, so the small unattributed part of the project's proposed footprint can be included under zone PQ-16.

A range of key information was systematically collated for each zone (**Table 8**), and a preliminary assessment was made of its Palaeolithic and geo-archaeological potential. This latter was assessed as one of four broad categories, as outlined below (**Table 9**). This assessment then guides the pathway for field evaluation (see below, **Section 5.5**), and then possibly targeted mitigation (or other appropriate safeguarding measures) depending on the results of field evaluation.

Zone	PQ-no. Name of PQ zone
- Topography/ geomorphology **- Bedrock geology**	- Summary description of topography (including ground surface elevation) and geomorphology - Solid (pre-Quaternary) bedrock geology
Quaternary sediments	Summary description of Quaternary sediment sequences
Geological interpretation	Current geological interpretation, including presumed depositional process and stratigraphic attribution (for instance to a particular Lower Thames terrace or gravel body)
Palaeoenvironmental potential	Review of palaeo-environmental potential, so far as known
Palaeolithic remains	Review of Palaeolithic artefact finds from zone, and potential based on recoveries from similar deposits, with specific sites referenced to Palaeolithic site-list (**Appendix F**)
Palaeolithic assessment	One of four categories: HIGH, MODERATE, LOW, or UNCERTAIN (see criteria below, **Table 9)**
Stage 1 evaluation priorities	Priorities and scope of stage 1 Palaeolithic/geo-archaeological evaluation
Stage 2 evaluation priorities	Likely scope, but tbc after stage 1 evaluation results
Key reference/s	Most important sources for up-to-date information on zone

Table 8. Information collated for PQ zones.

Palaeolithic assessment	*Explanation, and approaches to field evaluation*
HIGH	Likely to contain sites with High-Very High Palaeolithic potential (see **Appendix E** for criteria for Palaeolithic potential), and requiring a phased approach to evaluation involving preliminary stage 1 work, followed by further stage 2 Palaeolithic/geo-archaeological evaluation in light of the stage 1 results
MODERATE	Likely to contain sites with Moderate Palaeolithic potential (see **Appendix E** for criteria for Palaeolithic potential), and requiring a moderate level of stage 1 Palaeolithic evaluation, with the possibility that stage 2 evaluation work will not be required
LOW	Likely to contain sites with Negligible-Low Palaeolithic potential (see **Appendix E** for criteria for Palaeolithic potential), and requiring minimal-moderate stage 1 Palaeolithic evaluation, with the expectation that stage 2 work will not be required
UNCERTAIN	Too little primary information on Quaternary sequence for an informed assessment to be made; requires preliminary (stage 1) Palaeolithic/geo-archaeological evaluation to gather more information, before assessing whether/what stage 2 work

Table 9. Categories of Palaeolithic assessment for PQ zones, and consequent approaches to field evaluation.

5.5. Approaches to Palaeolithic evaluation: GI monitoring and phased field investigations

Bearing in mind the large scale of the A12 improvement project and the consequent wide scope of potential Palaeolithic remains that might be present, a phased approach is recommended for Palaeolithic/geo-archaeological evaluation. Previous experience on various larger development projects - such as for phase 2 of HS1 in northwest Kent (Wenban-Smith *et al.* 2020), and for the subsequent redevelopment of Eastern Quarry (Wessex Archaeology 2009) and other housing developments in the Ebbsfleet International station area (MOLA 2017) - has shown that a phased approach (a) is highly cost effective, and (b) provides a better and more reliable identification of areas of higher Palaeolithic potential, leading to better mitigation of any unavoidable impact of a development upon significant Palaeolithic remains. A phased approach reduces the likelihood of, due to inaccurate geological mapping, carrying out great swathes of field evaluation on areas lacking Pleistocene deposits. It also avoids the risk, again due to inaccurate or insufficiently detailed geological mapping, of failing to identify and evaluate areas of high Palaeolithic potential. And it allows the potential for more-detailed evaluation of the quality and variety of Palaeolithic remains in areas known to be of greater potential.

Additional cost benefits can be obtained by completing a Palaeolithic desk-based assessment in advance of the programme of geo-technical Ground Investigation

(GI) work, and identifying where important Palaeolithic and geo-archaeological information can be gained from archaeological monitoring of the GI work. Clearly the requirements and objectives of the GI investigations will be different from those of the archaeological investigations, so there is no suggestion that archaeological needs should influence planning of the location and scope of GI work.

However, when GI work is located in areas of high Palaeolithic potential, there is a need for archaeological monitoring (by a person with suitable specialist skills in Palaeolithic archaeology and Pleistocene geo-archaeology) to monitor for any impact upon Palaeolithic remains, and carry out suitable mitigation work on the spot if any are encountered. Furthermore, the test pit and borehole investigations often done for GI work may duplicate those that would be required for Palaeolithic evaluation in certain areas. In these cases, it would be cost effective to use the same test pit or borehole for Palaeolithic evaluation and for GI work, with on-site co-operation of the various specialist teams involved.

And additionally, bearing in mind that land access can be a problematic issue for early phases of project investigation, there would be logistical (and also cost) benefits if the first stage of Palaeolithic evaluation could be undertaken at the same time as GI work, for areas where both are required.

The scope and aims of each phase of Palaeolithic evaluation work would be contingent upon:

- the assessed potential of each zone;
- its landscape situation;
- the degree of impact;
- the Pleistocene deposits likely to be present
- and the nature of the Palaeolithic evidence that is anticipated as likely to be present.

For poorly-known PQ zones categorised as of UNCERTAIN potential (as defined above, **Table 9**), it is recommended that a preliminary (stage 1) phase of field evaluation takes place. This would not seek to provide comprehensive coverage of a zone; rather it would be widely-spread across it, and targeted in certain key areas, to try and develop an initial picture of the types of Quaternary sediments present, their distribution, and their Palaeolithic archaeological potential. The results of this initial work would then inform development of a more-thorough second phase (stage 2) of evaluation.

For PQ zones categorised as of HIGH potential (as defined above, **Table 9**), it is likewise recommended that a preliminary (stage 1) phase of field evaluation takes place. Although these zones (which may be of substantial size - see below, **Table 13**) are likely to contain important Palaeolithic remains, there is major uncertainty as to their quality, range and prevalence/distribution. These zones would likewise benefit from a phased approach to evaluation. Preliminary stage 1 work would be aimed at developing a general picture of the distribution of higher potential sediments, with investigation of their artefactual and palaeo-environmental

potential. This initial work would then inform development of a more-thorough second phase (stage 2) of evaluation, targeted at areas of greatest scheme impact.

For PQ zones categorised as of MODERATE potential (as defined above, **Table 9**), it is recommended that a moderately-thorough stage 1 phase of field evaluation takes place. These zones (which are sometimes of substantial size - see below, **Table 13**) may contain important Palaeolithic remains, but this is not thought especially likely, and they are thought to be relatively-well understood. The stage 1 work would be aimed at confirming the prior picture of the distribution and nature of Pleistocene sediments, with standard investigation of their artefactual and palaeo-environmental potential. This initial work would then inform whether or not further (stage 2) evaluation is required. The expectation would be that in most cases it wouldn't be required, although a further phase of evaluation work might in some cases be required to resolve any uncertainties arising from the first stage of work.

Finally, several zones have been categorised as of LOW potential. For these zones, there is high confidence on known information that they do not have HIGH potential. It is therefore likely that a single phase of evaluation work will suffice to confirm the nature of Quaternary sediments present (if any), and their lack of Palaeolithic potential.

It always needs to be remembered that the aim of the evaluation work is to understand the site sufficiently to inform development of an appropriate mitigation strategy, rather than to reach the end of the mitigation process itself. As well as integrating evaluation work with GI work as outlined above, the range of methods suitable for Palaeolithic evaluation could include any, or all, of geophysical investigation, cable-and-percussion boreholes, plastic-sleeved window-samples, and machine-dug test pits. The details of which combination of methods should be applied would be dependent upon the characteristics of each area to be investigated.

5.6. Staffing and Health-and-Safety

Work for this Palaeolithic desk-based assessment was carried out at University of Southampton by the two specialists commissioned for this purpose: Francis Wenban-Smith (Palaeolithic archaeology) and Tim Sly (GIS). The work done was mostly desk-based (apart from the walk-over survey - see above, **Section 5.3**), and was carried out at in the Department of Archaeology at University of Southampton, although much was done under "working-from-home" limitations due to the impact of Coronavirus at the time of this report's preparation. The University has well-developed Health and Safety protocols for work on its premises, or carried out as "working-from-home". Thus a separate specific Risk Assessment was deemed unnecessary for this desk-based phase of work. Existing workplace practices and protocols were adhered to, and normal care was taken when travelling and going about business away from the University's work premises. On the walk-over survey, apart from the visit to Mr Brice (and to Colemans Quarry at the invitation of Mr Brice, and escorted by him), the survey adhered to publicly-accessible locations. It also took place with all regard for Health and Safety, with careful attention to safe parking, and the use of PPE when on foot.

6. Pleistocene deposits in the project area

The wider geological context of the project area has been outlined above (**Section 3.2**), and geological mapping of the project area is shown (**Figure 3**). All of the Quaternary deposits that are known in the project area are reviewed below (**Table 10**), cross-referenced with the Lithological Units (LUs) defined in the *Managing the Essex Pleistocene* project (Essex County Council 2015). In addition to the actual deposits, there are also two significant landscape structures that relate to, or strongly affect, the Quaternary mapping: the Danbury-Tiptree ridge, and the buried sub-glacial channel that underlies the Blackwater valley.

The Danbury-Tiptree ridge. This is a band of London Clay bedrock that forms a broadly southwest-northeast ridge of higher ground between Danbury and Tiptree, broadly parallel to the course of the Blackwater and about 3km to its southeast. It seems to have formed a barrier to the southeast-ward expansion of the Anglian ice-sheet, and also the southeast bank of a lake between it and the edge of the glacial ice. Thus it is capped by substantial and irregular spreads of outwash sands and gravels - mapped as “Glacial Sand and Gravel” - and these are mingled in places with remnants of terminal moraine deposits.

The Blackwater valley buried channel. This is a deeply-incised buried channel feature that underlies the course of the Blackwater between Kelvedon and Witham, running broadly from northeast to southwest. It has been incised through the Kesgrave Sands and Gravels into the London Clay bedrock, and its base lies up to 50m below the surrounding surface of the London Clay. The formation of this channel is likely inter-related with the blockage of the south-eastward expansion of the ice-sheet by the Danbury-Tiptree ridge. The channel is thought to have formed by hydrostatic pressure below the ice-sheet (Bristow 1985: 36), and to have been filled by flowing water (no doubt carrying a heavy silt/sand/gravel sediment load) draining the underside of the ice-sheet. The base of the channel is lined with Boulder Clay and a variable presence of Glacial Sand and Gravel, and the channel is primarily infilled with sand/gravel deposits attributed as Blackwater Terrace 3. These therefore have a very variable depth, reaching a substantial thickness (20-30m) in the deepest parts of the channel but are much shallower nearer the sides of the buried channel. The top surface of T3 is broadly level, although descending (a) transverse to the valley axis from its valley-side margin towards the central valley axis, and (b) downstream from Kelvedon towards Witham.

Deposit	*Essex LU*	*Distribution (BGS sheet/s)*	*Age (MI Stage)*	*Formation process and sediment character*
Alluvium	-	Floor of river valleys (Blackwater, Brain Roman River, Colne), and in smaller tributaries and dry valleys (223, 241)	Holocene (MIS 1)	Settling of clayey silt out of quiet water during episodes of overbank flooding

Head Brickearth	-	Infilling dry valleys incised into Boulder Clay to west of Witham (241)	Devensian LGM (MIS 2)	Gentle downslope movement of fine-grained deposits to infill low-lying areas such as dry valleys
Head	-	Infilling the heads of minor dry valleys, and as larger spreads on sides of Blackwater, Colne, Roman and Domsey Brook valleys (223, 241)	Holocene (MIS 1), Devensian (MIS 5d-2), and perhaps earlier	Downslope movement of varied/mixed deposits (usually clay/silt/sand with a subordinate gravel content), infilling dry valleys and often forming substantial spreads along valley sides
Glacial Brickearth	LU 13	Small patches over Boulder Clay to west of Witham (241)	Devensian LGM (MIS 2), and perhaps earlier	Wind-deposited silt, generally preserved on higher plateau and interfluves
River terrace deposits: T1 loam	-	Small patch overlying T3 on the west side of the Blackwater at Wiitham (241)	Uncertain - post-Anglian to Holocene (MIS 11-1)	Settling of clayey silt out of quiet water during episodes of overbank flooding
River terrace deposits: T2-T1	LU 11	Small outcrops flanking the alluvial floodplain of the rivers Brain and Blackwater (223, 241), larger spreads flanking the Colne (223)	Post-Anglian through to Devensian (MIS 11-2)	Fluvial deposition of variably silty/sandy gravel-dominated deposits during high-energy fluvial flow, often interspersed with quieter episodes during which lenses of finer-grained silt/sand form
River terrace deposits: T3	LU 11	Wider spreads in the Blackwater valley (223, 241), and smaller/higher valley-side outcrops in the Colne valley (223)	Post-Anglian to early Hoxnian (MIS 12-11)	Water-borne glacial outwash during ice-sheet melting at the end of the Anglian glaciation, transitioning to fluvial flow along the Blackwater valley at the start of the Hoxnian interglacial
River terrace deposits: T4-T5	-	Small outcrops high up on the southeast side of the Blackwater valley and the Domsey Brook (223, 241)	Anglian to early Hoxnian (MIS 12-11)	Water-borne sand/gravel glacial outwash during periods of ice-sheet melting, thought to have occurred towards the end of the Anglian glaciation, draining into a lake that filled the Blackwater valley between the edge of the Anglian ice sheet and the high ground of the Danbury-Tiptree ridge
Lacustrine silts - interglacial	LU 8	A substantial spread at Marks Tey flanking the Roman River (223), and smaller outcrops at Witham and Rivenhall End (241)	Hoxnian (MIS 11)	Clayey silt, sandy in places and often rich in organic remains (sometimes manifesting as a white marl), that accumulated at the base of a post-Anglian lake

Lacustrine silts - glacial	LU 8	One small patch outcropping on the west side of the current A12 near Rivenhall End (241) - although these deposits often occur in boreholes at the base of lacustrine silts and the top of Boulder Clay	Anglian (MIS 12)	Clayey silt, sandy in places and sometimes with organic remains, that accumulated at the base of standing water bodies during the Anglian glaciation
Boulder Clay	LU 7	Substantial spreads to the northwest of the Blackwater (223, 241) and between the Blackwater and the Roman River (223); and also an irregular linear band above the southeast side of the Blackwater valley (223, 241)	Anglian (MIS 12)	Silty/sandy clay, with common chalk pebbles and clasts of widely-varying size (1cm-1m) of varied hard rock lithologies (such as quartzite, flint, limestone and sandstone); this deposit formed at the base of the Anglian ice-sheet, grinding and compressing the ground below it into a clayey fluid "mush" that retained various clasts gathered from the ground covered by the ice-sheet as it expanded
Glacial Sand and Gravel *	LU 7	Numerous irregular patches on higher ground to the southeast of the Blackwater (223, 241), and a major spread between Marks Tey and Colchester (223)	Anglian (MIS 12)	Water-borne sand/gravel glacial outwash, occurring as the Anglian ice-sheet grew, during the period of its maximum extent, and also as it retreated; therefore these deposits can occur all of: under Boulder Clay, within it, above it, and abutting it
Kesgrave Sands and Gravels *	LU 3 LU 2	Extensive linear outcrops along the valley-sides of the Blackwater, Roman River and Colne (223)	Pre-Anglian (MIS 30?-13)	Substantial beds of gravelly sand and sandy gravel, laid down by high energy fluvial activity by a precursor of the Thames draining from western England and the west Midlands; the top of these deposits is often eroded by deposition of Boulder Clay or Glacial Sand and Gravel, but, where uneroded, an interglacial palaeosol has been identified in the top part of the Kesgrave Sands and Gravels, possibly relating to the warm episode of MIS 13

* Some deposits below Boulder Clay exposed along the sides of the northwest-bank tributary valleys of the Blackwater, and mapped as "Glacial Sand and Gravel" on Sheet 241, are better attributed as "Kesgrave Sands and Gravels" - as on Sheet 223

Table 10. Quaternary deposits in the project area: distribution, date, character and formation processes

7. Walk-over survey: results

7.1. General overview

The walk-over survey was conducted on 23rd-24th June 2020, in accordance with the methods and objectives outlined above (**Section 5.3**). Three specific objectives were identified in advance - WO1 through to WO3 - and the outcomes in relation to these objectives are reviewed below (**Section 7.2**). A selection of relevant photos from the survey are given as an appendix (**Appendix H**). These are referenced below as "**photo H-nn**", with "nn" representing the numeric order in Appendix H.

7.1.1. Day 1: Coleman's Farm and Quarry

The first day of the survey was spent liaising with Mr Simon Brice of Coleman's Farm. The road scheme passes through a substantial area of Coleman's Farm land between Witham and Rivenhall End from which numerous Palaeolithic finds are known. Many Palaeolithic artefacts - including several Middle Palaeolithic *bout coupé* handaxes - have been found on field surfaces by Mr Brice between *c.* 1980 and the present day. In addition to these, several artefacts were found *in situ* during a research test pit investigation on Mr Brice's land (by F Wenban-Smith and M Bates) in June 2006, which also identified the presence of Hoxnian lake deposits rich in a range of palaeo-environmental remains. The HER is a bit vague on exactly what Palaeolithic artefacts have been found, and when and where - although it referenced a map of findspots around Coleman's Farm (MEX10366) - so it was thought worthwhile to liaise directly with Mr Brice. He also reported that he had recently recovered several mammoth teeth and other mammal bones from Colemans Quarry, also affected by the road scheme, as well as further Palaeolithic implements from within the gravel being extracted. Therefore it was also arranged to visit the quarry site with Mr Brice, in order to try and ascertain the horizon/s from which these finds had originated.

The first part of the day was spent examining Mr Brice's previous finds. He produced the above-mentioned map (**photo H-1a**), which showed the exact find-spots of all his Palaeolithic finds since *c.* 1980, numbered from 1-14, with a list describing each find. He also laid out the finds themselves, and provided additional verbal information on their circumstances of recovery. Thus all his Palaeolithic find-spots were integrated into the overall list for the project study area and given a unique UID. Most of his finds had been recovered from field surfaces, although three of them had been recovered directly from deposits. These latter were: a handaxe from within the gravel when digging Coleman's Reservoir (UID P-77a), a *bout coupé* handaxe from gas pipeline spoil at the north corner of Durwards Park field (P-77d; **photo H2b**, right of the three shown), and a large bifacial implement found within the gravel being extracted at Colemans Quarry (P-78d; **photo H4a**).

Other notable flint finds included:

- handaxes from the previous field Long Burghy, where there is now a golf course complex, including one of twisted-ovate form (P-78a; **photo H1b**)

- two similar pointed handaxes in very similar condition, although found at different places (P- 78b, 78c; **photo H1c**)
- confirmation of the locations of some material specifically referenced in the HER, namely: the *bout coupé* handaxe illustrated by Martingell (1982: Figure 1.9) (HER MEX28333 - UID P-77, Durwards Park; **photo H2b**, middle of three), the flake-tool illustrated by Martingell (1982: Figure 1.10) (HER MEX28333 - UID P-77b, Fen-and Loews), and the small white-patinated ovate handaxe reported by Major (1993) (UID P-77c, Ashman's Farm, on east side of the Blackwater)
- various flint artefacts of Upper Palaeolithic character, including: a tanged point (UID P-77f, Rose Cottage field; **photo H2e**), two curve-backed points (UID P-77e, Durwards Park, and the other more-generally located; **photos H2c**, left, and **H2d**, right, respectively), a substantial end-scraper on a robust blade (generally located; **photo H2d**, left), and some substantial blade debitage of Final Upper Palaeolithic Long Blade character (UID P-77e, Durwards Park, and the other more-generally located; **photos H2c**, right, and **H2d**, middle, respectively)

As well as Mr Brice's collection of previous flint finds, he also had a substantial collection of mammal remains from Colemans Quarry, Witham, including several large mammoth molars. These had been recovered relatively recently, since gravel extraction only began in *c.* 2016, and some finds had been made in the first half of 2020. The mammal finds were all recovered from the grading "reject pile", where oversize items for the gravel grades were automatically discarded by the grading machine. However, it was always possible to work back and identify the part of the quarry from which an item had originated, and its broad depth within the sequence. The gravel being worked at the quarry is mapped as Terrace 2, and all the finds were thought to come either from the basal part of the T2 deposits, or from pockets of underlying finer-grained deposits sealed below the base of the gravel. It wasn't possible to be sure which of these scenarios was correct, since these parts of the sequence were below the water table when excavated.

The mammal finds came from two distinct parts of the quarry. One group of material had been recovered from the phase 1 extraction area (UID P-78f, centred on NGR 583630 215720); and the other had been recovered from the phase 2 extraction area (UID P-78e, centred on NGR 583445 216000). The finds from the phase 1 area included several elephant/mammoth teeth (or parts of). One of these is shown (**photo H4f**), and it is quite abraded, suggesting that it came from fluvial gravel and had been at-least-slightly transported, rather than from a minimally-disturbed fine-grained sediment.

Mammal finds from the phase 2 extraction area were more abundant. They comprised a mixture of large and heavily-abraded pieces of elephant/mammoth limb bone, substantially mineralised by groundwater impregnation, and other fresher teeth and bones, including several more elephant/mammoth teeth (or parts of), and other remains such as pieces of antler and other bones of medium-sized mammals. Several of these are illustrated in Appendix H, with three different ?mammoth teeth in fresher condition being shown (**photos H4b**, **c** and **e**) as well

as a selection of some of the other bone/antler pieces (**photo H4d**). Several of these fresher pieces were also mineralised by groundwater impregnation.

Having examined these flint and faunal finds, Mr Brice very kindly escorted me on a visit to Colemans Quarry, to observe the quarrying in progress and to examine any exposed sediments. Extraction had been completed in the phase 1 area. This was bounded by unquarried banks that had been graded to a slope (**photo H3d**). The floor of the phase 1 area was partly-filled by a shallow pond (**photo H3e**), but unquarried gravel remnants were present and exposed in places, as well as piles of dug-out gravel, and the torn-up surface of the underlying deposits. These were often formed of a solid blue-grey clay (most-likely the top of Anglian Boulder Clay infilling the underlying buried channel feature), but in places they were a moderately-soft and friable brown organic-rich silt/sand. This latter deposit proved (after careful cleaning of some retrieved lumps) to be finely-laminated (**photo H3f**), and also contained visible beetle remains (the hardened, slightly pearlescent elytra, or forewings).

Extraction was ongoing in the phase 2 area. The working method involved firstly removing and stockpiling the topsoil and subsoil (*c.* 50-80cm of deposits) to expose the gravel surface. The gravel (which was *c.* 4-5m thick, and contained sub-horizontal beds of finer-grained clayey silts/sands - **photo H3a**) was then progressively extracted in two layers, each of *c.* 2m thick. The top part of the gravel (**photo H3a**) was clean and sub-horizontally-bedded, and slightly yellow/orange-stained. The lower part of the gravel (**photo H3b**) was paler, and slightly sandier, although also horizontally-bedded and containing horizontal beds of finer-grained material. The base of the gravel was slightly uneven (**photo H3c**), and came down onto a pale blue-grey silty clay deposit that did not appear to have any pebble or cobble clasts. This was probably Anglian Boulder Clay, although could also be a late Anglian lacustrine clay-silt.

It wasn't possible to clarify from this visit the horizon from which any of the mammalian remains came - although as noted above, the degree of abrasion on at least one elephant/mammoth tooth from the phase 1 extraction area suggests it came from a gravel bed.

7.1.2. Day 2: rest of scheme (Palaeolithic area)

The second day of the walk-over survey involved driving by the rest of the A12 improvement route between Witham and Junction 25 at Copford, on the west outskirts of Colchester. The main objectives were to:

- to observe the current ground at various points along the proposed options footprint;
- to see if there were any exposures or landforms that would inform interpretation of the sub-surface deposits
- to identify any major constraints or potentials for future evaluation;
- and to situate these locations within their wider landscape context.

The survey-route started at Copford Place, to the east of J25, and then progressed southwest towards Witham. The impact of the present J25 cutting was clearly visible (**photo H5a**). The lower deposits of this cutting are pre-Anglian Kesgrave Sands/Gravels, but the upper deposits are likely to be Hoxnian lake and lake-margin sediments, especially further east along the A12 where the cutting becomes shallower.

The Boulder Clay landscape to the west of Copford Green and towards Easthorpe was generally flat and undulating, with a mixture of woodland and arable fields. The areas of greatest potential impact (vicinity of Potts Green and Singlewell Farm - see **Figure 11**) were inaccessible from public roads, but a view of the typical impacted landscape was taken looking south from the Roman Road across fields to the east of Badcock's Farm (**photo H5b**).

Further southwest, the landscape to the southwest of J24 was examined, where the road options footprint crosses the head of a dry valley complex infilled with Head deposits to the northwest of Prested Hall (=Chase House - **Figure 10**). Here again, the current landscape was broadly level and undulating, with an arable crop on the east side of the road to Prested Hall, and a hay meadow to the west (**photo H5c**).

The opportunity was then taken to examine the landscape in the vicinity of the proposed Borrow Pit J. This is a substantial proposed pit (*c.* 75ha) to the southeast of the current A12, between the A12 and Inworth (**Figure 9**). Current geological mapping shows the area of the pit as Boulder Clay, with scatter outcrops of T4 and T5 terrace gravels. The landscape here was an arable field in very light crop, very slightly undulating, and sloping shallowly down to the northwest towards the A12 (**photo H5d, e**). It was hard to see why the terrace outcrops had been identified without ground-truthing - perhaps Geological Survey workers had observed gravelly patches in ploughed fields, or perhaps they represent high-points that become apparent in detailed topographic mapping.

After this, it was attempted to examine the footprint of the proposed Borrow Pit I. however this proved to be in a publicly-inaccessible spot between the railway and the A12 (**Figure 8**), so no observations were possible. The last part of the second day of the walk-over survey involved passing down the southeast side of the Blackwater between Ashman's Farm and Hill Broad Farm, to try and gain a view of the landscape and topography northwest across the Blackwater valley towards Rivenhall End. The floor of the valley was substantially wooded here, obscuring the topography on the far side (**photo H5f**), so no good views were obtained.

7.2. Key outcomes

In relation to the issues identified at the outset of the survey (see above, **Section 5.3**, WO1-WO3):

WO1 - Palaeolithic finds and palaeo-environmental remains in vicinity of Coleman's Farm. As reported above (*Section 7.1.1*), contact was made with Mr Brice of Coleman's Farm. His map of previous Palaeolithic find-spots was examined (**Appendix H**: **photo H1a**), as were the finds themselves. This led to

a substantial improvement in understanding of the nature, locations and provenance of previous Palaeolithic finds. The nearby Colemans Quarry was also visited with Mr Brice, where he has recently recovered some Palaeolithic flint artefacts, as well as numerous mammalian fossils, including several mammoth teeth. It was possible to establish the location of these finds, and their likely stratigraphic horizon, towards the base of the Blackwater T2 terrace gravels. The presence of brown organic-rich laminated sand/silt was also noted below the T2 gravels in the phase 1 gravel extraction area, a short distance to the south of the road options footprint (**Figure 8**, P-78f).

WO2 - Borrow Pits I, J and K. As reported above (*Section 7.1.2*), the proposed locations of Borrow Pits J and K were visited. Borrow Pit J was currently a wide open arable field, generally level, very slightly undulating and dipping shallowly to the northwest (**Appendix H**: **photo H5d**). There were no particular surface features that reflected the location of underlying terrace outcrops rather than Boulder Clay. The land at Borrow Pit K, to the west of Prested Hall (**Figure 9**), was mostly a more overgrown meadow with some trees (**Appendix H**: **photo H5c**). It wasn't possible to get a view of the location of the proposed Borrow Pit I.

WO3 - Northeast of A12 Junction 25, Hoxnian lake sediments. Here, there was an open field (a backfilled previous pit, used for a car-boot sale space) on the south side of the A12 between J25 and Copford Place. Otherwise the land was substantially wooded on the north side of the B1408 London Road, but arable fields on the south side. No exposures or topography were seen that could help establish the extent of Hoxnian lake and lake-margin sediments; this will require field evaluation.

8. Palaeolithic sites: review

In total, having investigated all the desk-based sources, removed duplicate entries, and incorporated new information from the walk-over survey, 68 separate Palaeolithic sites were identified within, and near, a 3km buffer around the A12 project footprint. An overview of these is provided here below (**Table 11**), and full details are collated as an appendix (**Appendix F**). Their locations are shown in relation to the A12 footprint and the surrounding landscape topography in two project overview maps, A and B (**Figures 4**-**6**).

The general abundance of Palaeolithic sites in the project area confirms the A12 scheme as taking place within an important area for the Palaeolithic in Britain. Prior to consideration of relevant factors such as varying histories of investigation and geological context, there are five main groups of sites:

- a spread of sites to the west and southwest of the part of the scheme footprint targeted for Palaeolithic consideration, in and around Witham, many of them from areas mapped as Boulder Clay or Glacial Sand and Gravel;
- a cluster of sites to the northeast of Witham, between Coleman's Farm and Durwards Hall, in an area of varied deposits including Blackwater

Terrace 3 sand/gravel, Hoxnian lacustrine deposits overlying Blackwater Terrace 3, and Blackwater Terrace 2 sand/gravel deposits, including several sites were palaeo-environmental and artefactual remains have been found *in situ* (sites P- 77d, 78d,e,f, and P88a);

- a dense and tightly-clustered group of sites, mostly associated with the intensive excavations of Roman remains on Blackwater Terrace 3 gravel at Kelvedon, but also including a notable record of human skull fragments that could be Final Upper Palaeolithic from the base of the Holocene alluvium where it abuts Blackwater Terrace 1-2 (site P-53);
- a cluster of sites in and near the Hoxnian interglacial lacustrine sediments at Marks Tey, including several records of artefactual finds as well as of the palaeoenvironmental records for which the locality is internationally significant (including records of molluscan and mammalian fossils, as well as pollen and plant macro-fossil remains);
- a spread of sites to the east of the northeast end of the area of the A12 scheme, mostly from a wide spread of deposits mapped as Glacial Sand and Gravel, which are likely to represent a mixture of reworked artefacts from pre-Anglian deposits and residual finds from post-Anglian activity in this flint-rich and well-draining landscape.

In terms of the A12 project impact, 12 known sites are directly affected by the development footprint, and a further 10 (two of which only generally located) have their locations very near to it (**Table 12**, below). However, this cannot be taken as a direct prediction of impact by the works. The historic discovery of Palaeolithic sites can be a very haphazard affair, strongly influenced by areas of previous quarrying (or other works, such as the intensive history of Roman excavations in Kelvedon) and by whether or not avid local collectors were active in an area (as is the case here in the vicinity of Coleman's Farm and Durwards Hall). Rather, historic patterns of discovery can be used to model likely potential on the basis of the similarity of deposits in an area of interest to those that have previously produced material in the same general region. This is why the desk-based review has collated information up to (and in some cases, slightly beyond) a 3km buffer around the scheme's impact footprint.

The attribution of specific sites to specific Palaeolithic-and-Quaternary character zones of the scheme's footprint is discussed further below (**Section 9**). Pending that, the sites identified in the desk-based review highlight the following general themes of interest for the Palaeolithic in and around the A12 scheme footprint:

1 - evidence of pre-Anglian hominin activity from the Kesgrave Sands and Gravels, where these are liable to be impacted by the project scheme, or by associated works such as aggregate extraction from Borrow Pits;

2 - Pleistocene palaeo-environmental remains associated with the transition from the Anglian glaciation to the Hoxnian interglacial, as represented in lacustrine deposits that developed in this area as the Anglian ice-sheet melted during this climatic transition;

3 - hominin activity at this time, that is likely to be concentrated around the margins of this lake and on other parts of the surface of Blackwater Terrace 3, and where there might be good depositional environments for the discovery of minimally-disturbed evidence, possibly in association with dietary faunal and palaeoenvironmental remains;

4 - evidence of hominin activity that is contained within Terrace 3 deposits;

5 - evidence of hominin activity in, or on, Blackwater Terrace 1 and 2 deposits, including possibly of Neanderthal occupation in the Devensian glacial period;

6 - palaeo-environmental remains including mammoth, other mammals, pollen and insects from Blackwater Terrace 2 deposits near Witham;

7 - evidence of Final Upper Palaeolithic activity (and possibly of very rare human skeletal remains from this period - note record P-53) at the base of the Holocene alluvium, where its edges overlie and abut Blackwater Terrace 1 and/or 2 deposits.

Site-type	Acc.	Est.	Gen	*Total*	*Key sites, comments*
Mon	2	2	-	**4**	**P-64** - flake recovered from Blackwater T3 terrace gravel **P-77d** – *bout coupé* handaxe found in spoil from gas pipeline trench **P-88a** - three flakes recovered from sieving Blackwater T3 gravel **P-92** - report of a handaxe found “stratified in Boulder Clay”
Mon/PE	1	1	-	**2**	**P-50a** - flint flakes and a deer bone recovered during test pit investigation in *c.* 2003 of lake margin deposits near WH Colliers brickworks, Marks Tey **P-53** - fragments of human skull found with deer and horse bones at base of Holocene alluvium in 1977 (likely to be Final Upper Palaeolithic or Early Mesolithic)
F-spot	20	13	10	**43**	**P-24, 24a** - handaxes found at WH Colliers brickworks, Marks Tey: a large ovate found in 1929, and another found in *c.* 1970s **P-65** - handaxe from base of Roman pit, possibly from undisturbed Palaeolithic landsurface on surface of Blackwater T3 terrace gravel **P- 77, 78** - surface finds of two *bout coupé* handaxes in field to SW of Durwards Hall **P-78d** – huge bifacial flint implement from T2 gravel at Colemans Quarry, Witham
F-spot?	4	-	2	**6**	None of these sites are close to the A12 scheme, and it is uncertain whether they are Palaeolithic without more information on the recovered artefacts

PEFS	6	2	-	**8**	**P-3** - 19th century finds of mammalian fossils in mollusc-rich interglacial deposits at Copford brickworks **P-50** - interglacial lake deposits (Hoxnian) at WH Colliers brickworks, Marks Tey **P-78e,f** – mammalian fossils (mammoth, deer, bovid?) from organic-rich deposits below T2 terrace at Colemans Quarry, Witham **P-88** - interglacial lake deposits (Hoxnian) in field to SW of Durwards Hall, with diverse palaeoenvironmental remains, including pollen, molluscs and ostracods **P-89** - 19th century finds of mammalian fossils and insect-rich interglacial deposits at Lexden brickpit, on the west outskirts of Colchester
Geo	5	-	-	**5**	**P-3a** - borehole records showing continuation of fossiliferous interglacial sediments at Copford towards current A12 **P-90** - Hoxnian interglacial lake deposits in A12 cutting at Coleman's Bridge, Witham **P-91** - substantial patch of Hoxnian interglacial lake deposits at Rivenhall End, Witham
Totals	**38**	**18**	**12**	**68**	

Table 11. Overview of all Palaeolithic sites within the 3km buffer around the A12 footprint.

	In A12 scheme footprint				*Near A12 scheme footprint*			
Site-type	Acc.	Est.	Gen	*Key sites*	Acc.	Est.	Gen	*Key sites*
Mon	2	-	-	**P-77d** - *bout coupé* handaxe from Durwards Park field (to SW of Durwards Hall) **P-88a** - three flakes recovered from sieving Blackwater T3 gravel	-	-	-	-
F-spot	5	1	-	**P-77, 78** - surface finds of two *bout coupé* handaxes, lake-tools and debitage in Durwards Park field **P-77e** - surface finds of Upper Palaeolithic flake-tools and debitage in Durwards Park field **P-78d** – huge bifacial flint tool from T2 gravel at Colemans Quarry	2	1	2	**P-26** - handaxe from presumed Hoxnian lake margin area at Marks Tey **P-77a** - sub-cordate handaxe from Colemans Farm Reservoir **P-77b** – surface finds of flake-tool and a flake from field to SE of Durwards Hall (Fen-and-Loews)

PEFS	2	-	-	**P-78e** - mammalian fossils (mammoth, deer, bovid?) from deposits below T2 terrace at Colemans Quarry **P-88** - interglacial lake deposits (Hoxnian) in field to SW of Durwards Hall, with diverse palaeoenvironmental remains, including pollen, molluscs and ostracods	3	-	-	**P-3** - 19th C finds of mammalian fossils in mollusc-rich interglacial deposits at Copford brickworks **P-24b** - 19th century finds of mammalian fossils in mollusc-rich interglacial deposits at WH Colliers brickworks, Marks Tey **P-78f** - mammalian fossils (mammoth, deer, bovid?) from organic-rich deposits below T2 terrace at Colemans Quarry
Geo	2	-	-	**P-90, 91** - Hoxnian interglacial lake deposits in A12 cutting at Coleman's Bridge, and at Rivenhall End	2	-	-	**P-3a** - borehole records showing continuation of fossiliferous interglacial sediments at Copford towards current A12
Totals	**11**	**1**	**-**		**7**	**1**	**2**	

Table 12. Known Palaeolithic sites directly affected by, or near to, the A12 scheme footprint.

9. Palaeolithic and Quaternary (PQ) zones

Based on the information and approaches outlined above (**Section 5**), the A12 project footprint was divided into 24 character areas. These are represented in the landscape (**Figures 4**-**6**) as 26 actual Palaeolithic and Quaternary (PQ) zones (PQ 1-12, 13a-b, 14-21, 22a-b, and 23-24) since several areas of similar character are not directly contiguous.

A preliminary assessment was made for each zone of its Palaeolithic and geo-archaeological potential, attributed to one of four categories (UNCERTAIN, HIGH, MODERATE, or LOW) on the basis of the rationale outlined above (**Table 9**). As also outlined above (**Section 5.5**) different evaluation approaches are recommended for each zone according to this preliminary assessment. A zone-by-zone summary of the preliminary assessments and recommendations for evaluation is provided below (**Table 13**); this table also includes the size in hectares of the area of the proposed scheme footprint (and thus potentially requiring evaluation) within each PQ character zone.

This is complemented by an overview of the number of zones and the area of land (in hectares - Ha) attributed to different categories of potential (**Table 14**). Note that several PQ zones do not intersect the proposed scheme options footprint or Borrow Pit locations, so no evaluation work is suggested for these.

Full details of each PQ zone are provided as an appendix (**Appendix G**), and a series of larger-scale maps are also provided, showing each zone in relation to known Palaeolithic sites, landscape topography and the footprint of the proposed A12 improvement scheme (**Figures 7**-**12**).

PQ zone	*Name - summary description*	*Area - Ha*	*Palaeolithic assessment*	*Recommendation for Pal. evaluation*	
				Stage 1	*Stage 2*
PQ-1	Blackwater alluvium - Blackwater alluvial floodplain, including right-bank tributaries	12.51	MODERATE	Yes	? - tbc after Stage 1
PQ-2	Sewells Farm - Lower valley-side on east side of Blackwater	-	LOW	-	-
PQ-3	Witham sewage works - river terrace deposits and overlying alluvial loam	6.62	HIGH	Yes	Yes
PQ-4	Witham, east of B1018 - Blackwater Terrace 3	-	MODERATE	-	-
PQ-5	Rivenhall End - Blackwater Terrace 3 and Hoxnian lake deposits	78.01	HIGH	Yes	Yes
PQ-6	Witham Junction - Head deposits over the valley-side edge of Blackwater Terrace 3	-	MODERATE	-	-
PQ-7	Rivenhall Oaks - eastern edge of Anglian Boulder Clay	-	LOW	-	-
PQ-8	Witham NE rail cutting - eastern edge of Anglian Boulder Clay	Borrow pit I - 13.10	LOW	Yes	Not anticipated
PQ-9	Durwards Hall - Blackwater Terrace 3 and Hoxnian lake deposits, partly overlain by Head deposits	* Footprint - 26.52 ** Borrow pit I - 4.10	HIGH	Yes	Yes
PQ-10	Kelvedon, Crabb's Farm - Blackwater Terrace 3 (and possibly unmapped Hoxnian lake deposits), partly overlain by Head deposits	12.95	MODERATE	Yes	? - tbc after Stage 1
PQ-11	Great Braxted Mill, northwest of - Blackwater Terrace 1, partly overlain by Head	8.90	MODERATE	Yes	? - tbc after Stage 1
PQ-12	Brickhouse/Ashman's Farms - Blackwater Terraces 1-2	0.41	MODERATE	Yes	? - tbc after Stage 1
PQ-13a	The Glebe House - Blackwater Terraces 3 and 4	-	MODERATE	-	-
PQ-13b	Kelvedon, Ewell Hall - Blackwater Terraces 3 and 4	* Footprint - 12.88 ** Borrow pit J - 4.59	MODERATE	Yes	? - tbc after Stage 1
PQ-14	Appleford Farm - Blackwater Terraces 3 and T1/T2	-	MODERATE	-	-
PQ-15	Coleman's Reservoir - Blackwater Terraces 1 and 2	5.71	MODERATE	Yes	? - tbc after Stage 1

PQ zone	*Name - summary description*	*Area - Ha*	*Palaeolithic assessment*	*Recommendation for Pal. evaluation* *Stage 1*	*Stage 2*
PQ-16	Inworth - Blackwater Terraces 4 and 4/5, southeast side of valley	** Footprint - 99.58 ** Borrow pit J - 49.49	UNCERTAIN	Yes	? - tbc after Stage 1
PQ-17	Gore Pit - Blackwater Terrace 3	** Footprint - 46.40 ** Borrow pit K - 0.05	MODERATE	Yes	? - tbc after Stage 1
PQ-18	Messing Grove - Blackwater Terrace 3, small patch on south side of Domsey Brook	1.50	MODERATE	Yes	? - tbc after Stage 1
PQ-19	Chase House (formerly Prested Hall) - Head, north side of Domsey Brook	** Footprint - 12.91 ** Borrow pit K - 0.03	LOW	Yes	Not anticipated
PQ-20	Easthorpe Road - wide expanse of Boulder Clay, with incision into Kesgrave Sands/Gravels at northern edge	250.49	LOW	Yes	Not anticipated
PQ-21	West of Fan Wood - small area of Boulder Clay south of east end of Domsey Brook	-	UNCERTAIN	-	-
PQ-22a	Main Domsey Brook alluvium - alluvial floodplain of main part of Domsey Brook	5.21	UNCERTAIN	Yes	? - tbc after Stage 1
PQ-22b	Upper Domsey Brook alluvium - - alluvial floodplain of head of Domsey Brook, through the racecourse	0.74	UNCERTAIN	Yes	? - tbc after Stage 1
PQ-23	Marks Tey Hoxnian lake - wide spread of lacustrine silts/clays, richly fossiliferous and much-exploited for brick-making since the mid-19th century	18.91	HIGH	Yes	Yes
PQ-24	Little Braxted - Blackwater Terrace 3, on its east side at Witham	-	HIGH	-	-

* Area including parts of “Borrow Pits” that are inside the scheme options footprint.
** Areas of “Borrow Pits” that are outside the scheme options footprint.

Table 13. PQ zones: Palaeolithic assessments, and recommendations for approach to evaluation

Category of Pal. Assessment	*Recommended evaluation approach*	*Aspect - PQ zones*	*Area - Ha*
UNCERTAIN	Phased - Stage 1, then possibly stage 2, depending on results of stage 1	Scheme footprint - PQ- 16, 22a, 22b (n=3)	105.53
		Borrow pit J - PQ-16 (n=1)	49.49
	None needed, no overlap with scheme footprint	PQ-21 (n=1)	-

HIGH	Phased - Stages 1 and 2, with scope/scale of stage 2 following from results of stage 1	Scheme footprint - PQ- 3, 5, 9, 23 (n=4)	130.07
		Borrow pit I - PQ-9 (n=1)	4.10
	None needed, no overlap with scheme footprint	PQ-24 (n=1)	-
MODERATE	Phased - Stage 1, then may proceed to stage 2, depending on results of stage 1	Scheme footprint - PQ- 1, 10, 11, 12, 13b, 15, 17, 18 (n=8)	101.26
		Borrow pit J - PQ-13b (n=1) Borrow pit K - PQ-17 (n=1)	4.59 0.05
	None needed, no overlap with scheme footprint	PQ- 4, 6, 13a, 14 (n=4)	-
LOW	Phased - Stage 1, then possibly stage 2, depending on results of stage 1	Scheme footprint - PQ- 19, 20 (n=2)	263.39
		Borrow pit I - PQ-8 (n=1) Borrow pit K - PQ-19 (n=1)	13.10 0.03
	None needed, no overlap with scheme footprint	PQ- 2, 7 (n=2)	-
Totals	PQ zones needing evaluation	Scheme footprint (n=17)	600.24
		Borrow pit impacts (n=6)	71.36
	Total area to evaluate		**671.60**
	PQ zones without any work	**n=8**	**-**

Table 14. Overview of Palaeolithic assessments and evaluation recommendations

10. Conclusions, priorities and next steps

10.1. Key conclusions

The main conclusion of this Palaeolithic desk-based assessment is that there is a rich history of previous Palaeolithic discoveries and investigations along the A12 corridor, and there are very likely to be some, or several, sites of high Palaeolithic importance affected by the proposed scheme.

As outlined above (**Section 8**), Palaeolithic investigations for the project are likely to engage with seven key themes, ranging from early pre-Anglian occupation of Britain to re-occupation at the very end of the Palaeolithic, at the end of the last ice age and the start of the present Holocene interglacial.

The greatest focus of work is likely to be on evaluating for, and then investigating if present, lake-margin sediments of the Hoxnian lake (or lakes) that was/were present at Marks Tey and Rivenhall End. These lake deposits are internationally important for their record of the Hoxnian interglacial. Turner's (1970) investigation provided a template for vegetational change through this period, in conjunction with a unique estimate of its duration based on the manual counting of many thousands of annually-deposited layers. However, there remain many

unanswered questions about this important period in the British Palaeolithic, relating to the details of hominin cultural development and changing mammalian fauna through the period, and how these changes relate to the chronological and vegetational template established by Turner's work.

Remains of early human activity are most likely to be found in lake-margin zones away from the thick and well-developed lake-bed sediments that have been the focus of previous investigations. These deposits are most likely to be thin and intermittently preserved, and most likely will be outside the bounds of the well-developed lake-bed deposits that have been geologically mapped and exploited for industrial purposes. Particular attention will need to be paid to investigating for unmapped lake-margin deposits beyond the mapped areas, and evaluating their archaeological and palaeo-environmental potential. In particular, attention will need to be given to considering the presence of palaeo-landsurfaces with potential for recovery of undisturbed activity.

The dating of the post-Hoxnian terrace sequence (Terraces T2 and T1) in the Blackwater valley is also poorly understood, so any information that can be gathered that helps with that will be a valuable contribution to the regional Palaeolithic framework. Several *bout coupé* handaxe finds suggest that parts of the terrace sequence were laid down in the last (Devensian) glacial, and so might contain rare evidence of Neanderthal presence in Britain. Mammoth and other palaeoenvironmental remains from T2 deposits at Colemans Quarry, Witham, have important potential to contribute to palaeo-environmental reconstruction and dating of these deposits.

Finally, one notable and unexpected record in the Essex HER records the discovery in 1977 of fragments of an adult female human skull during a watching brief on excavation of a sewer trench near Kelvedon station (**Appendix F**, P-53). These were found in association with deer and horse bones, and well-provenanced to *c.* 2m below the ground surface at the base of Holocene alluvium and on the surface of a Pleistocene gravel terrace. Puzzlingly, no work was done to investigate this further, apparently since "the lack of artefacts precluded dating" (Eddy 1977). If this represents a late Upper Palaeolithic or Mesolithic human, away from a cave, then this would be a find of national importance. Although this find is not close to the proposed scheme footprint, it nonetheless flags up the potential for recovery of material of this nature from the base of the Holocene alluvium where impacted by the scheme.

10.2. Priority areas and next steps

This desk-based assessment has divided the area covered by the scheme into 26 deposit character zones (**Figures 7-12**, PQ 1-12, 13a-b, 14-21, 22a-b, and 23-24). It has also provided an assessment of the varying Palaeolithic potential of each zone (**Tables 13**, **14**) on the basis of (a) previous finds from each zone, (b) previous finds from other zones and nearby areas of similar deposit character, and (c) landscape situation and the consequent likelihood of their being unmapped deposits of Palaeolithic potential.

Four zones - PQ- 3, 5, 9 and 23 - were identified as of HIGH potential, with a total combined area of 134.17Ha overlapping with the scheme footprint (including 4.10Ha that is part of Borrow Pit I in zone PQ-9, but which is not otherwise impacted by the scheme options). It is recommended that these zones undergo a phased 2-stage Palaeolithic evaluation programme, with an initial deposit-scoping stage followed by a more detailed evaluation in areas of greater interest.

Three zones - PQ- 16, 22a and 22b - were identified as of UNCERTAIN potential, with a total combined area of 155.02Ha overlapping with the scheme footprint (including 49.49Ha that is part of Borrow Pit J in zone PQ-16, but which is not otherwise impacted by the scheme options). It is recommended that these zones undergo a phased 2-stage Palaeolithic evaluation programme, with an initial deposit-scoping stage followed by a further evaluation if/where necessary.

Eight zones - PQ- 1, 10, 11, 12, 13b, 15, 17 and 18 - were identified as of MODERATE potential, with a total combined area of 105.90Ha overlapping with the scheme footprint (including 4.64Ha that are parts of Borrow Pits J and K in zones PQ-13b and PQ-17 respectively, but which are not otherwise impacted by the scheme options). It is recommended that these zones undergo an initial phase of stage 1 evaluation, with the expectation that further stage 2 evaluation is likely to be required in places, but only if/where necessary.

And three zones - PQ- 8, 19 and 20 - were identified as of LOW potential, with a total combined area of 276.52Ha overlapping with the scheme footprint (including 13.13 Ha that are parts of Borrow Pits I and K in zones PQ-8 and PQ-9 respectively, but which are not otherwise impacted by the scheme options). It is recommended that these zones undergo an initial phase of stage 1 evaluation, with the expectation that further stage 2 evaluation is unlikely to be required, but may nonetheless be necessary in places.

For all zones, a vital next step is to take account of any new additional information from ongoing geotechnical Ground Investigation work, when available. Information from the GI work may improve understanding of the nature and potential of sub-surface deposits, and can help target the scope and location of subsequent archaeological evaluation effectively. It may also in some circumstances provide sufficient information to obviate or reduce the need for further archaeologically-specific evaluation work.

It is proposed to review the GI databases, and focus attention on the zones of “high” and “uncertain” potential, to establish presence/absence of sediments of interest within the scheme footprint only. This will help to determine depths and thicknesses of deposits, and determine which interesting strata will actually be impacted by the scheme, and which will simply be buried/preserved below the scheme and thus require no further investigation. Once the GI results have been reviewed, Method Statements need to be prepared for the Stage 1 Palaeolithic evaluation of each zone, in light of the GI results.

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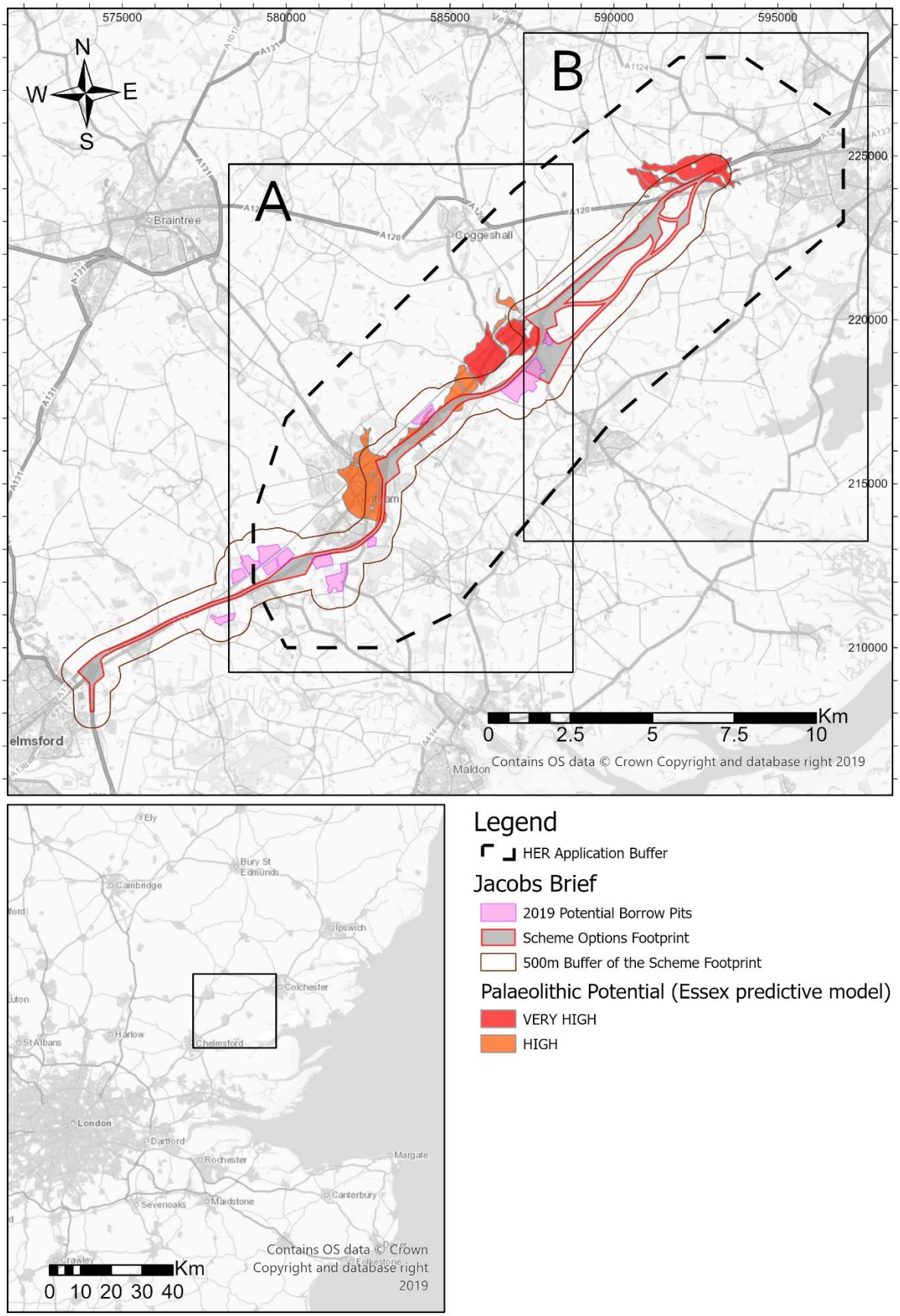

Figure 1. A12 Chelmsford to A120, whole project area: scheme footprint (with 500m buffer), and areas of higher Palaeolithic potential (with 3km buffer). [Crown copyright OS mapping data reproduced under HE Licence 100030649]

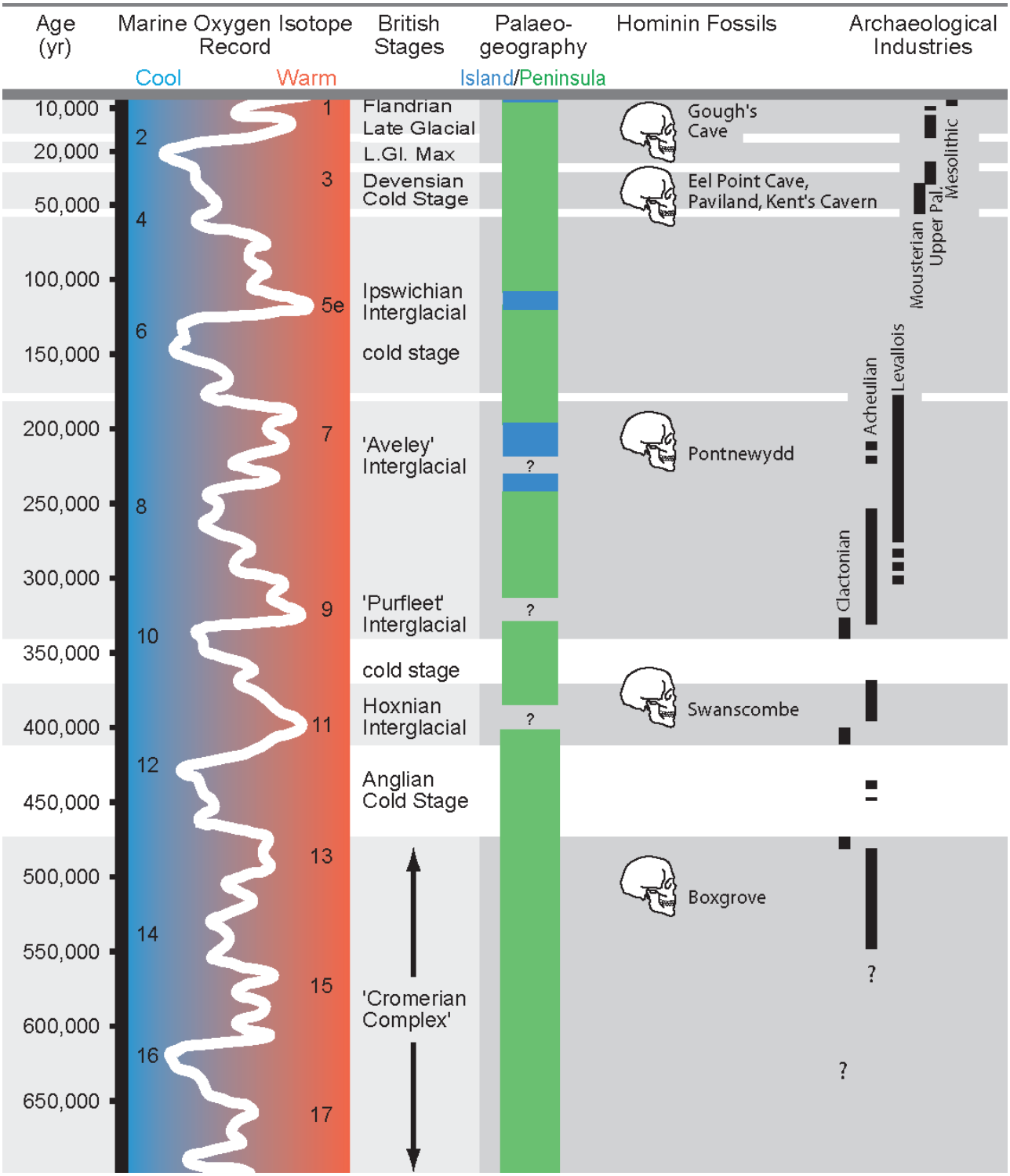

Figure 2. Pleistocene framework for the British Palaeolithic.

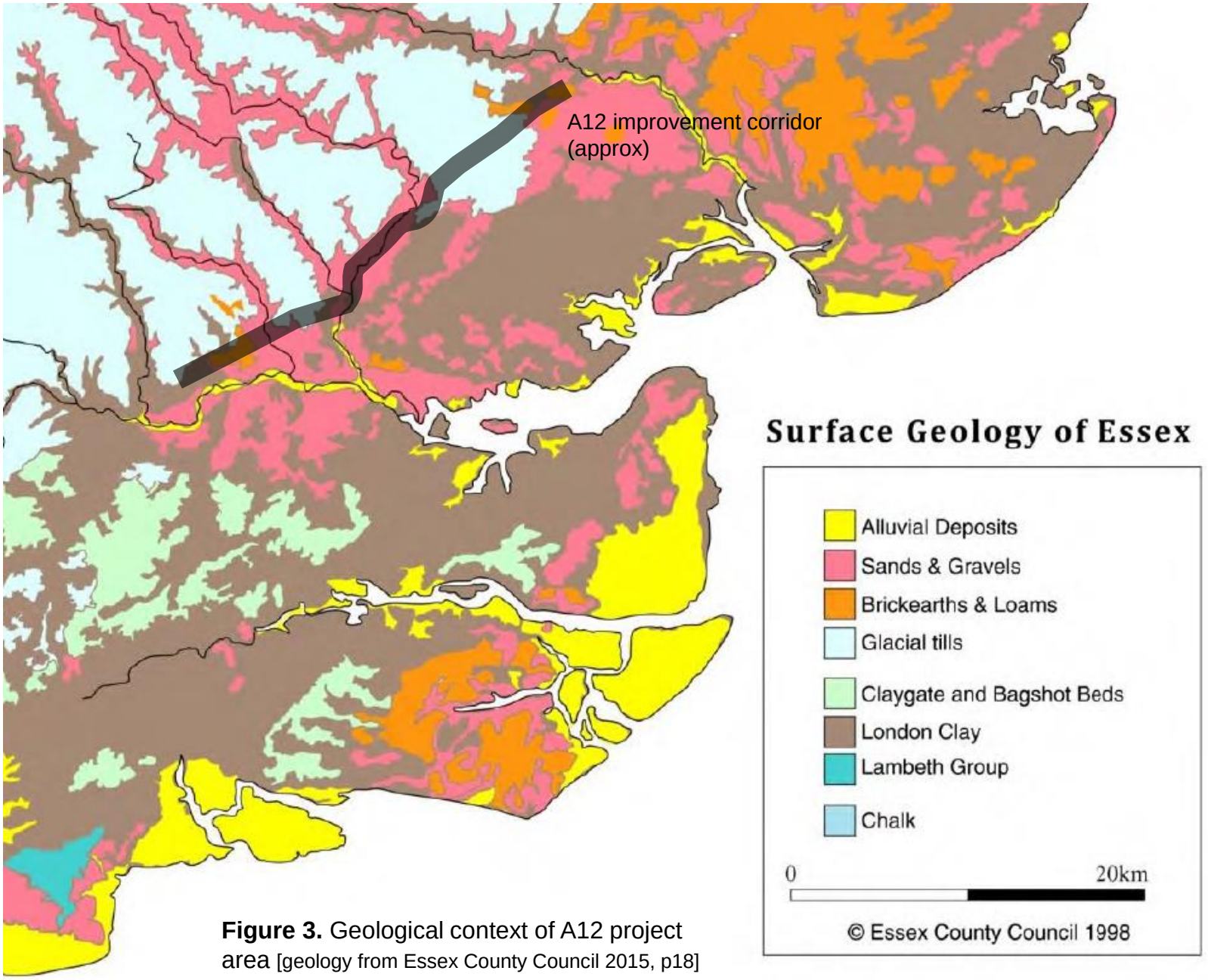

Figure 3. Geological context of A12 project area [geology from Essex County Council 2015, p18]

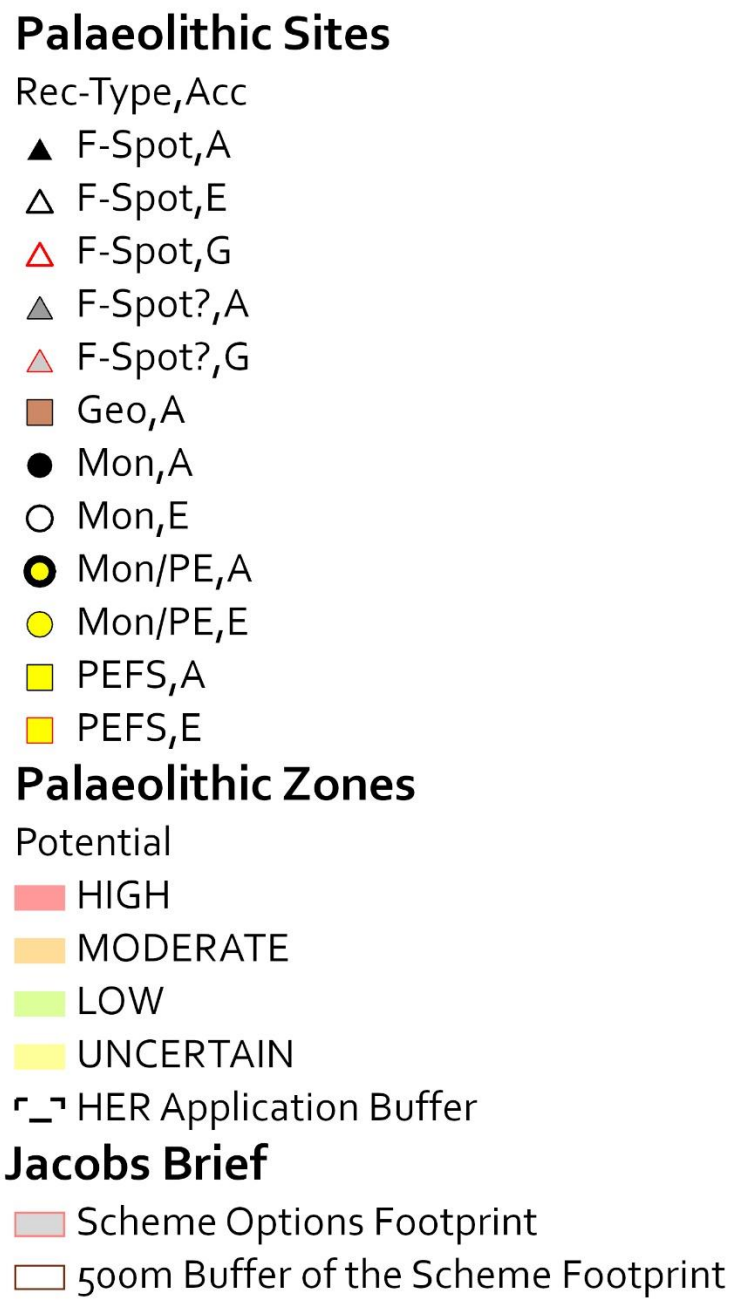

Figure 4. Legend for PQ zone overview maps A and B (**Figures 5**, **6**).

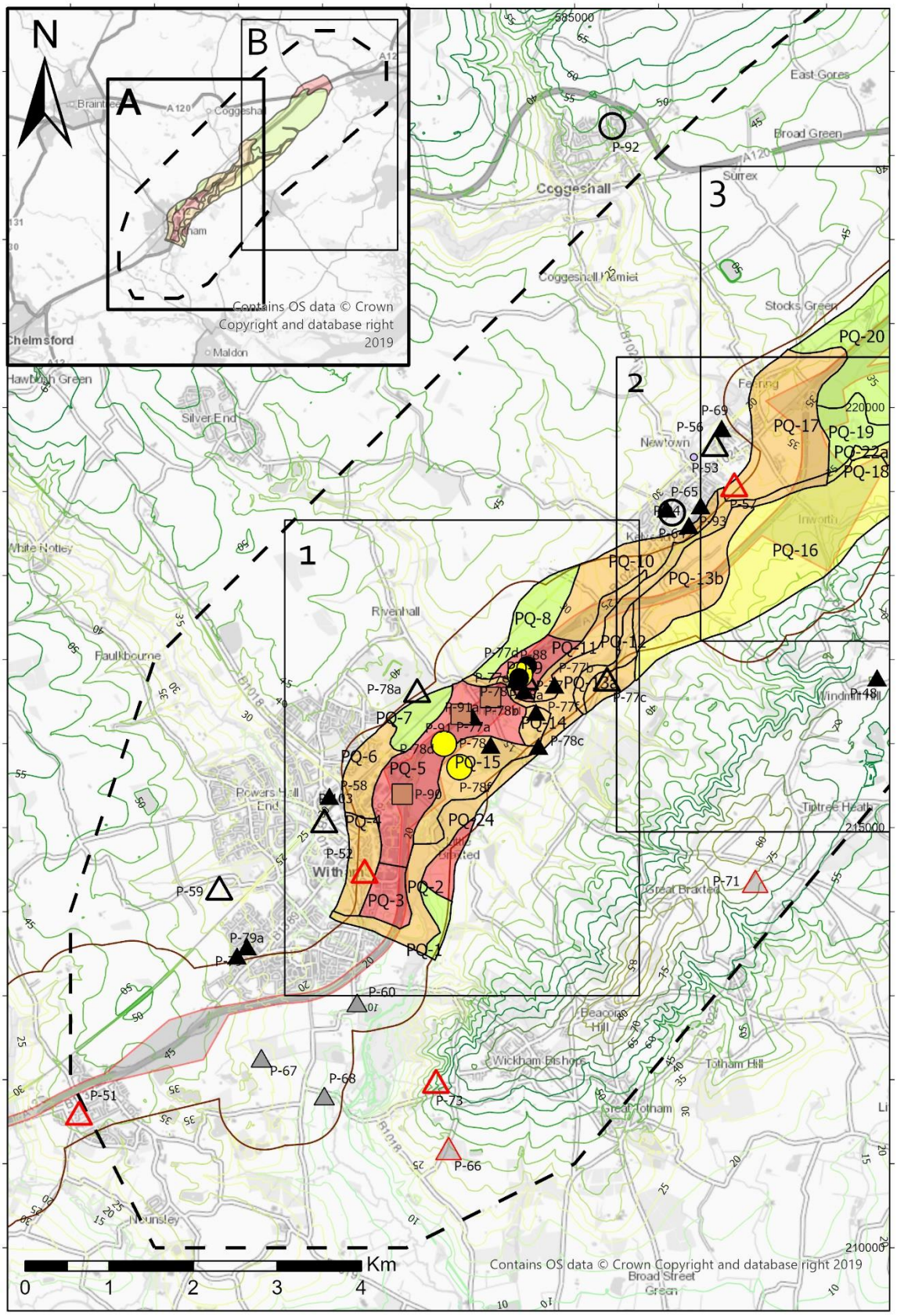

Figure 5. PQ zones overview southwest (Map A), with scheme footprint, topography and Palaeolithic sites. [Crown copyright OS mapping data reproduced under HE Licence 100030649]

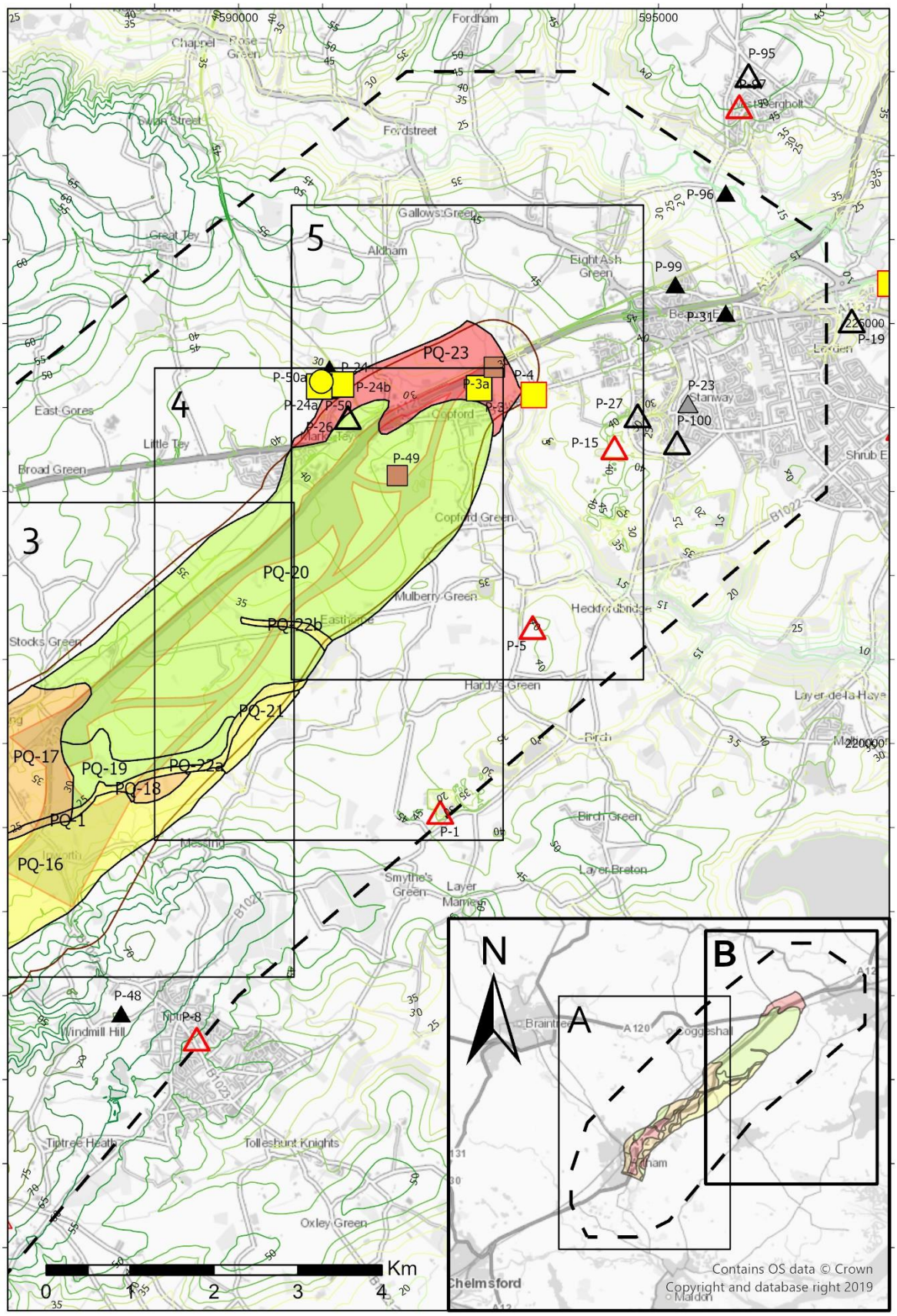

Figure 6. PQ zones overview northeast (Map B), with scheme footprint, topography and Palaeolithic sites. [Crown copyright OS mapping data reproduced under HE Licence 100030649]

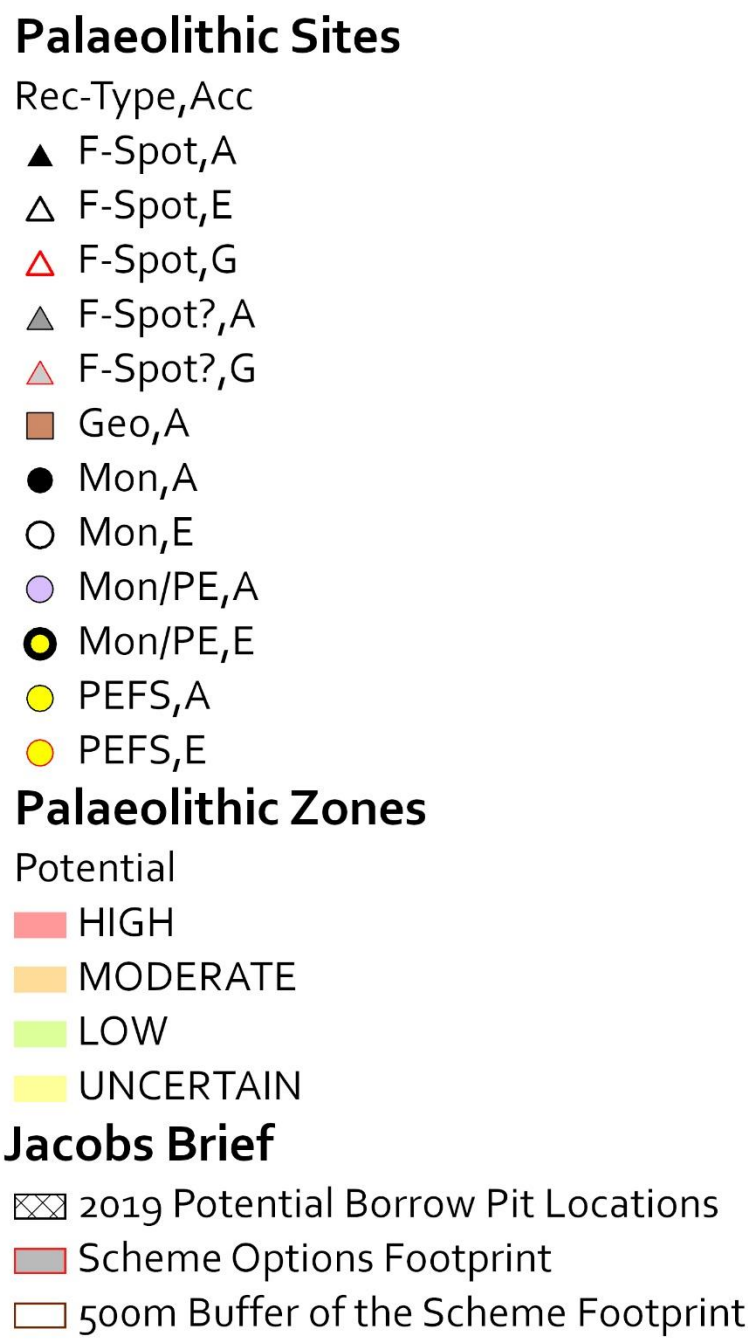

Figure 7. Legend for PQ zone maps 1-5 (**Figures 8-12**). [Crown copyright OS mapping data reproduced under HE Licence 100030649]

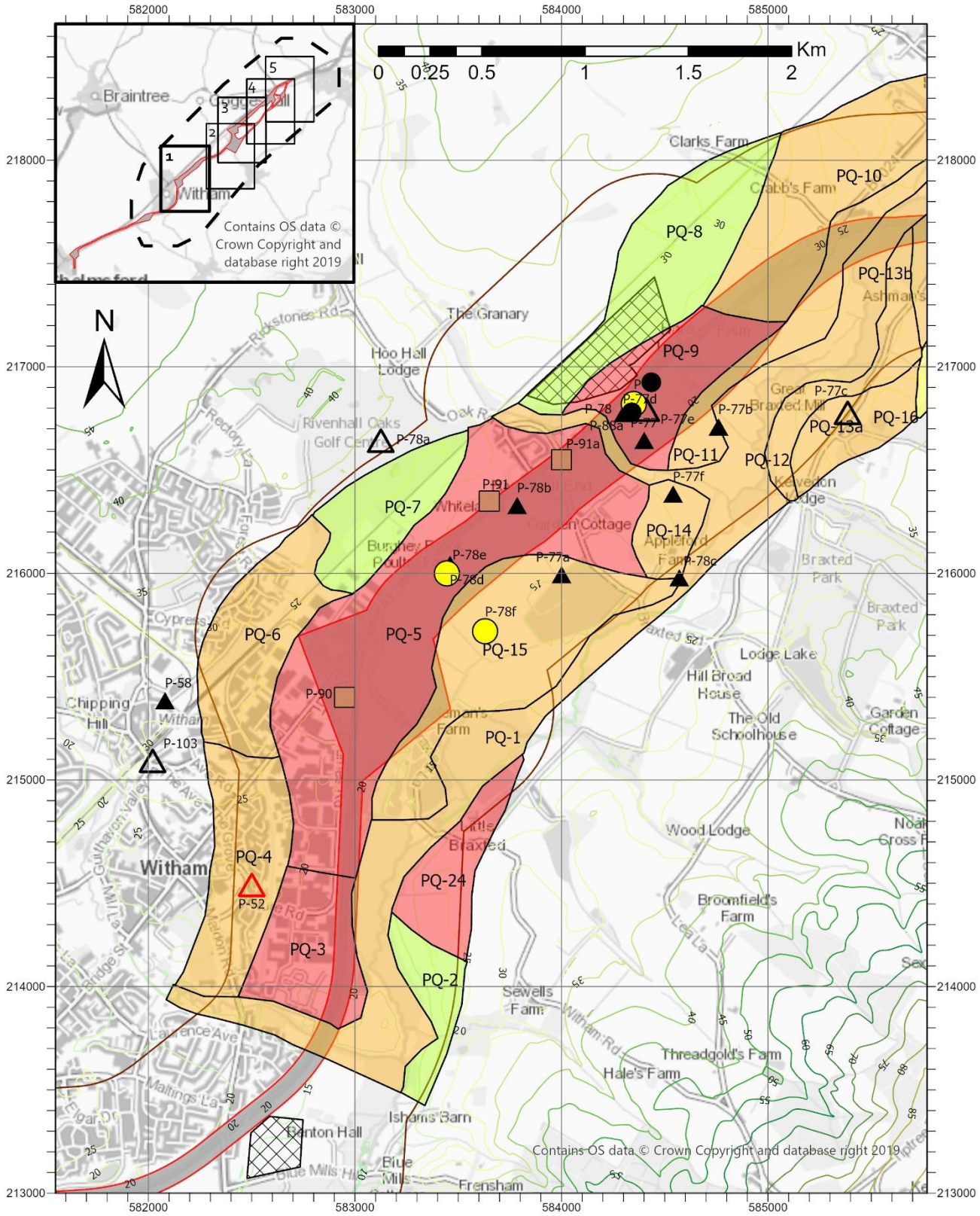

Figure 8. PQ zones, Map 1. [Crown copyright OS mapping data reproduced under HE Licence 100030649]

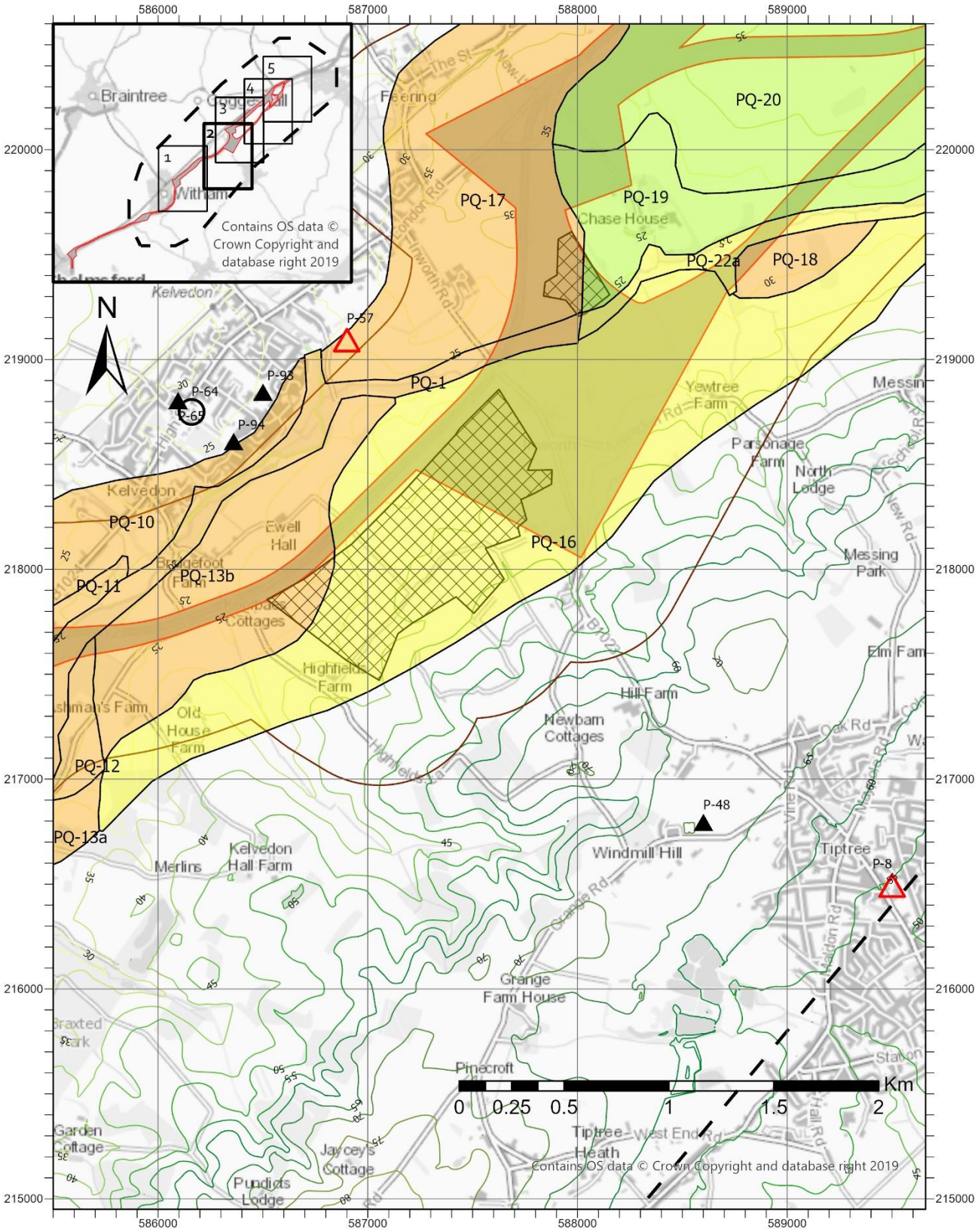

Figure 9. PQ zones, Map 2. [Crown copyright OS mapping data reproduced under HE Licence 100030649]

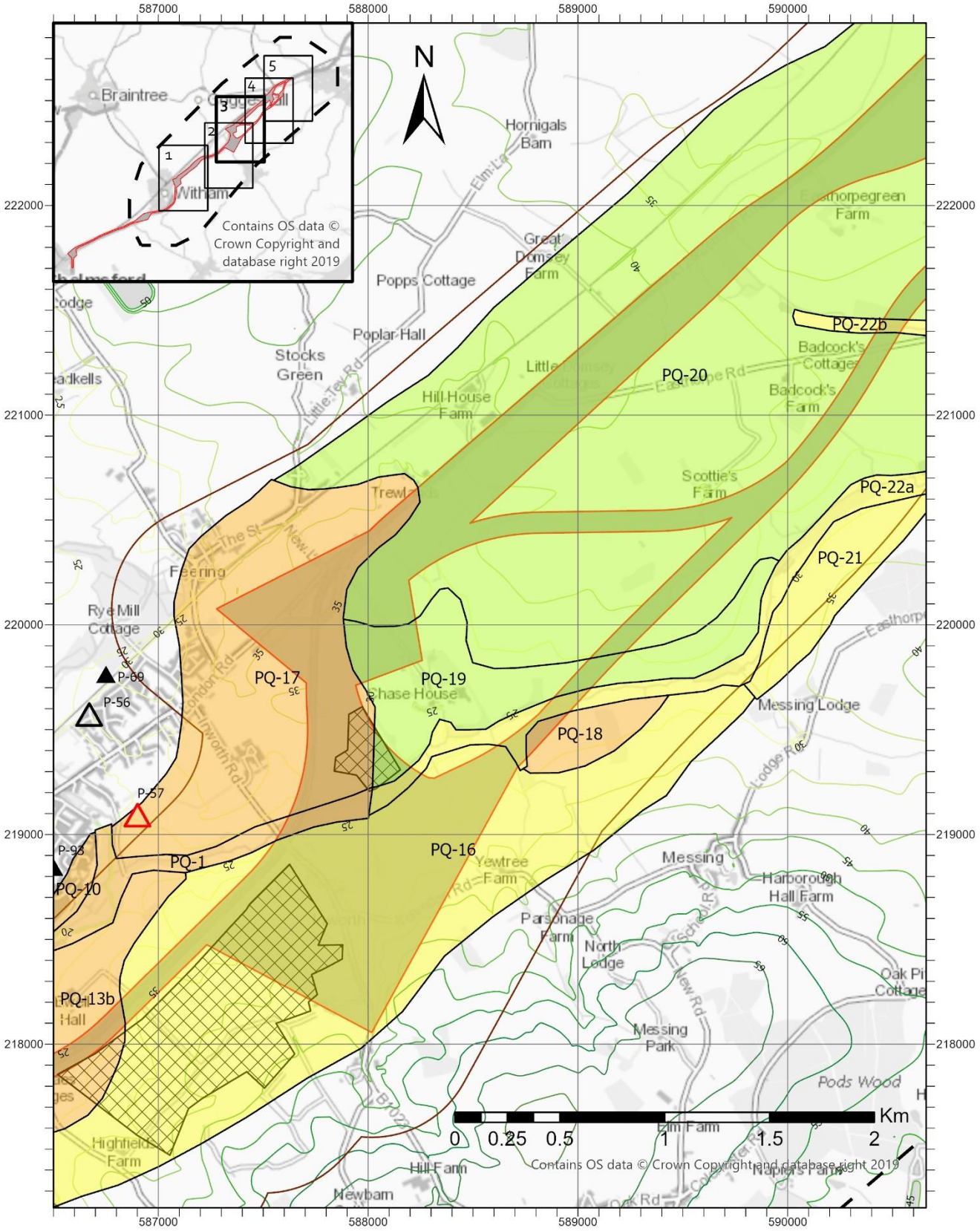

Figure 10. PQ zones, Map 3. [Crown copyright OS mapping data reproduced under HE Licence 100030649]

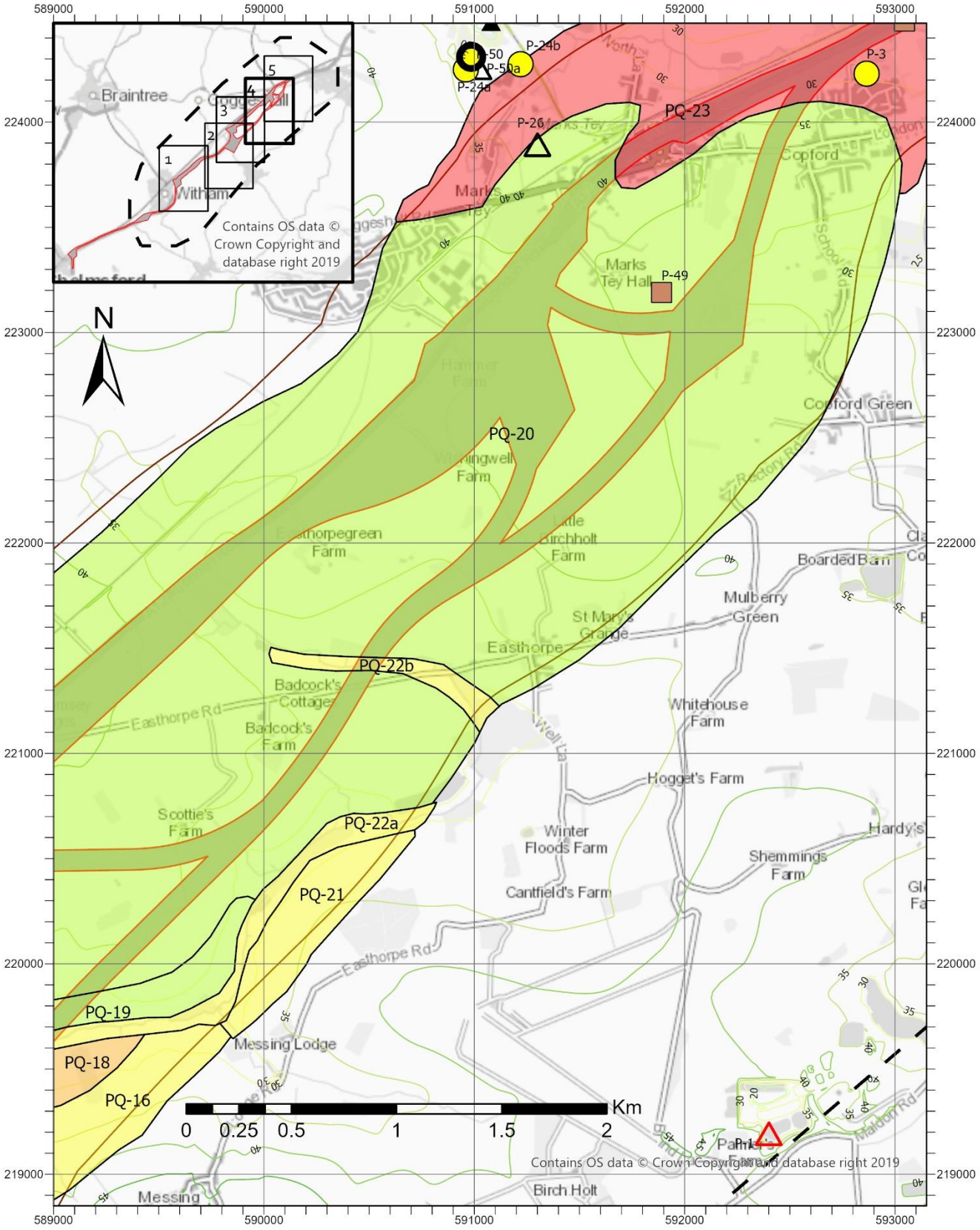

Figure 11. PQ zones, Map 4. [Crown copyright OS mapping data reproduced under HE Licence 100030649]

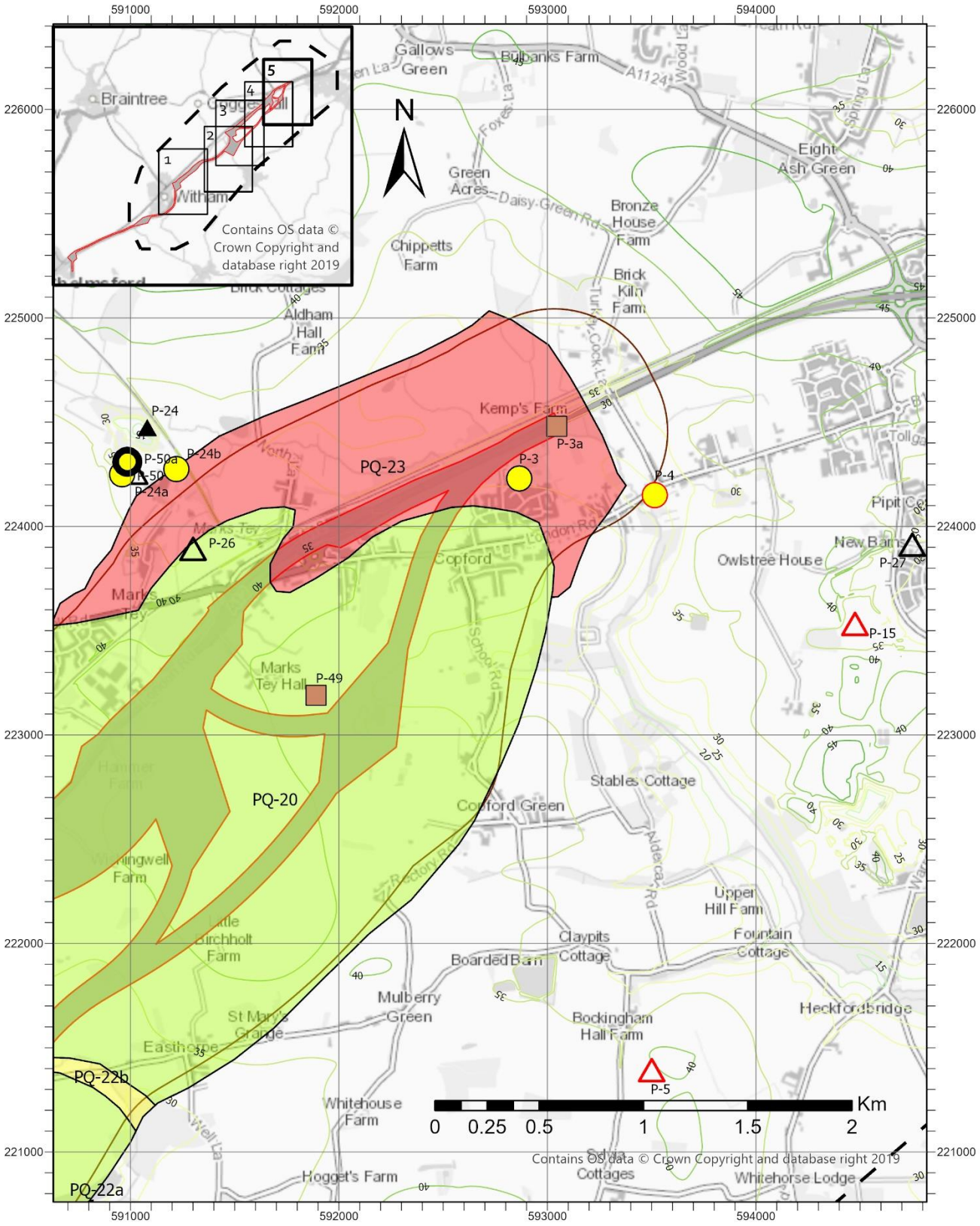

Figure 12. PQ zones, Map 5. [Crown copyright OS mapping data reproduced under HE Licence 100030649]

Appendix A.

Glossary of acronyms and technical terms

A.1. Glossary, and acronyms

AAR - acronym for *amino acid dating* (qv)

Amino acid dating - a form of *chronometric dating* (qv) that relies on identifying chemical changes (racemisation) in snail shell during sustained burial

BP - years Before Present; the "present" is technically defined as being in 1950 AD, but precision between AD and BP is mostly unnecessary in the Palaeolithic (apart from in its younger Upper Palaeolithic stage) since its timescales are mostly in the 10s and 100s of thousands of years

Bio-stratigraphy, Bio-stratigraphic dating - dating correlation based on faunal remains, either by a distinctive assemblage of species, with key indicator species present or absent; or by distinctive characteristics of a species, such as changing root-length of water-vole molars or changing spacing of mammoth tooth enamel plates

CBC - Colchester Borough Council

Chronometric dating - methods of dating that rely directly upon measuring a quantifiable attribute or characteristic, such as proportions of certain chemical compounds (C14 dating or *AAR* - qv), or red light emitted when heated (*OSL dating* - qv)

Clast - a larger-sized constituent in a generally fine-grained deposit, such as a flint pebble in a silty/sandy matrix

DBA - Desk-based Assessment

DCO - Development Consent Order [Act of Parliament that supports delivery of a major infrastructure project]

Designated - when not being used in a non-specific way, this refers to particular heritage assets that have been designated as having some particular important status, such as being a Scheduled Monument or Site of Special Scientific Interest

ECC - Essex County Council

Epoch - technical term for sub-divisions of the geological record; *Pleistocene* (qv) and *Holocene* (qv) are properly epochs of the *Quaternary Period* (qv)

ES - Environmental Statement [document produced to support the DCO (qv)]

Fluvial - river-related

Glacial - a distinctly cold episode in the climatic oscillations of the *Quaternary* (qv); this is the correct term for a cold *stage* (qv), and is not synonymous with *glaciation* (qv), which specifically relates to ice-sheet development

Glaciation - ice-sheet development; this typically occurs during cold *stages* or *glacials* (qv), but is not strictly synonymous with these broader terms

HE - Highways England

HER - acronym for *Historic environment record* (qv)

Historic environment record - lists maintained by local authorities of heritage assets in their area; these underpin curatorial decision-making, so their maintenance with up-to-date records and house-keeping for their accuracy and the inclusion of Palaeolithic remains are essential

Holocene - the warm climatic stage (MIS 1) that has continued since the end of the last glacial (the Devensian) approximately 11,700 BP (years Before Present) up to the present day

Hominin - the branch of the human family tree that includes all species, living or extinct, since its divergence from the line that leads to the living apes that are our closest evolutionary relatives (chimpanzees and gorillas)

Interstadial - a warm oscillation within a prolonged and predominantly cool, or cold, stage of the *Pleistocene* (qv), but not so warm or so long as to qualify for full *interglacial* (qv) status

Knap, Knapping - making stone tools by direct percussion, such as with a hammerstone

Lithic - stone, or made of stone; most common raw material for Palaeolithic stone tools in the UK is flint, but other lithic raw material such as chert, quartzite and volcanic tuff were also used, so should not be overlooked

LGS (Local Geological Site) - a site that is considered worthy of protection/recognition for its Earth Science or landscape importance, but is not already protected as SSSI (qv)

Marine isotope stage - numbered peaks and troughs of the global climate curve for the last two million years derived from continuous sedimentary records from the sea-bed; odd numbers represent warm episodes, and even numbers represent cold ones

MIS - acronym for *marine isotope stage* (qv)

NSIP - Nationally Significant Infrastructure Project

Optically stimulated luminescence - form of *chronometric dating* (qv) applicable to buried sand grains; natural background radiation causes changes in buried sand grains that lead to variation in how brightly they glow when given a controlled optical stimulus

OSL - acronym for *optically stimulated luminescence* (qv)

Quaternary, Quaternary Period - The most recent period of geological time, starting *c.* 2.6 million years ago, and containing two epochs, the *Pleistocene* (qv) and the *Holocene* (qv)

Palaeolithic, the "Old Stone Age" - the oldest cultural stage of human, or *hominin* (qv), cultural history, characterised by the manufacture of *lithic* (qv) artefacts; clearly this will occur (and in particular, start) at different times in different parts of the world, depending upon the spread of early artefact-making hominins - the Palaeolithic has been sub-divided into Lower, Middle and Upper phases in Britain and western Europe

Pleistocene - the older part (or *epoch* - qv) of the Quaternary Period, lasting from *c.* 2.6 million years BP through to the end of the Last Glacial *c.* 11,700 BP; the Pleistocene is distinguished by a series of cold and warm climatic oscillations, leading to alternating *glacials* (qv) and *interglacials* (qv), marked (in higher latitudes and more mountainous regions) by expansion and retraction of glaciers and more widespread ice-sheets

SSSI (Site of Special Scientific Interest) - designation by Natural England, of sites that have special scientific interest, usually for geological or environmental reasons; from an archaeological heritage perspective this designation does not have the same statutory weight as being a Scheduled Monument, but it can include important Quaternary sites, and these are almost always of national Palaeolithic importance

Stadial - a cold oscillation within a prolonged and predominantly warm stage of the *Pleistocene* (qv), but not so cold or so long as to qualify for full *glacial* (qv) status

Stage - when not being used in a non-specific way, generally refers to one of the numbered *marine isotope stages* (qv)

Terrace - in the context of Pleistocene (qv) geology, a broadly horizontal landform occurring as a visible feature in the side of a river valley; some larger river valleys (such as the Thames, the Trent, the Wiltshire Avon, and the Hampshire Test) can have a “staircase” of terraces down their valley sides, with each terrace representing a

separate series of cold/warm/cold stages of the *Pleistocene* (qv), and with higher terraces being older

Thermoluminescence dating - a form of *chronometric dating* (qv) whereby the time elapsed since a crystalline mineral (such as flint or sediment) was heated can be calculated from the amount of light emitted during controlled heating

TL - acronym for *Thermoluminescence dating* (qv)

Appendix B.

Research Framework and Guidance documents: national and regional

National Palaeolithic guidelines and research frameworks

English Heritage. 1998. *Identifying and Protecting Palaeolithic Remains: Archaeological Guidance for Planning Authorities and Developers*. English Heritage, London.

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Regional frameworks: Eastern England (including Essex)

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Pleistocene and Palaeolithic Guidance: Essex

Essex County Council, 2015. *Managing the Essex Pleistocene: Final Project Report*. Essex County Council Place Services [English Heritage Project 6639, final report by T O'Connor, issued September 2015].

Appendix C.

Geological sources: mapping and memoirs

Geological mapping for the project area

Sheet, 1:50,000 (Solid and Drift)	*BGS reference*	*Memoir reference/s*
223	British Geological Survey, 1982. Braintree*. England and Wales Sheet 223, Solid and Drift Geology, 1:50,000 Series*. British Geological Survey, Keyworth, Nottingham.	Ellison & Lake 1986
241	British Geological Survey. 1975. *Chelmsford: England and Wales Sheet 241, Solid and Drift Geology, 1:50,000*. British Geological Survey, Keyworth, Nottingham.	Bristow 1985

Geological memoirs and key sources for the project area

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Appendix D.

Palaeolithic sites: key sources and "grey" literature

Key published sources

Evans J, 1872 (1st ed). *The Ancient Stone Implements, Weapons, and Ornaments, of Great Britain*. Longmans, Green, Reader and Dyer, London.

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"Grey" literature and sources

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Appendix E.

Matrix and criteria for assessment of Palaeolithic potential

Categories for *Likelihood* and *Importance* of Palaeolithic remains

Attribution	*Likelihood*	*Importance*
VERY HIGH	Certain knowledge of Pleistocene deposits with lithic or palaeo-environmental remains	Internationally important remains: undisturbed or minimally-disturbed remains; abundant remains from deposits of good stratigraphic and chronological integrity, with biological associations and lithostratigraphic relationships
HIGH	High likelihood of Pleistocene deposits with lithic or palaeo-environmental remains	Nationally important remains: undisturbed or minimally disturbed concentrations; deposits with abundant remains (artefactual and/or faunal); important lithostratigraphic sequences and relationships
MEDIUM	Reasonable likelihood of deposits with remains	Assets that contribute to regional research objectives: less abundant and disturbed artefactual and/or faunal remains from units of reasonable stratigraphic and chronological integrity; deposits with moderately valuable lithostratigraphic sequences and relationships
LOW	Remains are known to occur, but rare	Disturbed and poorly preserved remains from deposits of low stratigraphic and chronological integrity; deposits with minimal lithostratigraphic sequences and relationships
NEGLIGIBLE	Deposits with remains very unlikely to occur	Any remains found will be residual and reworked; assets with little or no potential to contribute to research objectives
UNKNOWN	Insufficient information on which to assess likelihood	Insufficient information on which to assess importance

Table E-1. Criteria for categories for *Likelihood* and *Importance* of Palaeolithic remains, mapped onto levels of importance in relation to international, national and regional research frameworks.

Assessment of Palaeolithic potential

Palaeolithic potential	*Likelihood*	*Likely importance*
VERY HIGH	Very high	High
	High	Very high
HIGH	High	High, Medium
	Medium	High, Very high
MODERATE	High	Low
	Medium	Medium
	Low	Very high, High
LOW	Medium	Low
	Low	Medium
	Negligible	Very high, High, Medium,
NEGLIGIBLE	Medium	Negligible
	Low, Negligible	Low, Negligible
UNCERTAIN	Unknown	High, Medium, Low or Negligible
	High, Medium, Low or Negligible	Unknown

Table E-2. Matrix for assessment of Palaeolithic potential, combining categories of *Likelihood* and *Importance* as defined in Table E-1 above.

Appendix F.

Palaeolithic site-list

Contents:

F.1. Introductory tables

Column heading	*Explanation*
P-no.	Unique identifier for Palaeolithic sites, used/assigned by Palaeolithic Lead (Francis Wenban-Smith, University of Southampton) in form P-nn
Site - finds	Site name, and summary information on finds
Geo attribution	Interpretation of likely geological context for Palaeolithic finds - see below, **Table F-2**, for details
CBC HER no.	Unique identifier for sites/findspots within Colchester Borough Council Historic Environment Records list, if applicable
ECC MonUID	Unique identifier for sites/findspots within Essex County Council Historic Environment Records list, if applicable
ERPP 3 - map, site	Site identification (if applicable) within the *English Rivers Palaeolithic Project* survey (Wessex Archaeology 1997), where sites are identified firstly by a specific map, and then each map has its own numbering sequence
Rec-Type	Record type, one of: Mon - flint artefact/s well-provenanced to a known context Mon/PE - flint artefact/s well-provenanced to a known context, in association with faunal or other palaeoenvironmental remains F-spot - location of Palaeolithic flint artefact find/s, with less-reliable info on its/their provenance F-spot? - location of Prehistoric (possibly Palaeolithic) flint artefact find/s, with less-reliable info on its/their provenance PEFS (Pleistocene Environmental Find-spot) - site with faunal or other palaeoenvironmental remains Geo - a significant geological sequence or feature, but lacking artefactual or palaeoenvironmental remains
NGR-E	OS grid easting, to nearest metre
NGR-N	OS grid northing, to nearest metre
Acc	Accuracy of OS grid location, one of: A (Accurate) - site is accurately located based on reliable primary sources E (Estimated) - site location can be estimated with reasonable confidence based on primary sources G (General) - sites and finds from a general area, lacking good information on location and provenance

Table F-1. Explanation of Palaeolithic site-list table entries.

Geo attribution	*More-detailed explanation*
Boulder Clay/Lake-margin?	"Boulder Clay" - edge of Hoxnian interglacial lacustrine silts?
Boulder Clay/Unmapped?	"Boulder Clay" (Anglian) - residual, or possibly from unmapped overlying Head Brickearth or minor pond infill deposits
Boulder Clay	Boulder Clay, overlain by Head Brickearth infilling dry valleys and surface depressions
Glacial Sand/Gravel - east edge	Glacial Sand/Gravel (sht 223) - outcrop at West Bergholt, at E edge of Boulder Clay (Anglian till)
Glacial Sand/Gravel - Colchester spread	Glacial Sand/Gravel (sht 223) - wide spread between E edge of Anglian till and Colchester
Glacial Sand/Gravel - Hatfield Peverel	Glacial Sand/Gravel (sht 241) - just beyond S edge of Anglian Boulder Clay at Hatfield Peverel, poss. equiv. to Kesgrave Sands/Gravels
Glacial Sand/Gravel - Tiptree ridge	Glacial Sand/Gravel (sht 241) - Tiptree ridge (moraine, outwash - or maybe pre-Anglian drainage??)
Glacial Sand/Gravel - Tiptree-Danbury	Glacial Sand/Gravel (sht 241) - Tiptree-Danbury "badlands" (mixed moraine, outwash and pre-Anglian Kesgrave S/G)
Head - over Blackwater T3 and lake deposits	Head - NW side of Blackwater valley, below SE edge of Boulder Clay, and overlying T3 and remnants of Hoxnian interglacial lacustrine deposits
Head - over Blackwater T3/T2 and lake deposits	Head - NW side of Blackwater valley, below SE edge of Boulder Clay, and overlying T3, T2, and remnants of Hoxnian interglacial lacustrine deposits
Head - valley-side through GSG and KSG (BGS sht 223)	Head - side of dry valley, cutting through Glacial Sand/Gravel above Kesgrave Sands/Gravels (sht 223)
Head - west side of Blackwater valley (BGS sht 241)	Head - W side of Blackwater valley, below area of mixed Glacial Sand/Gravel and Kesgrave Sands/Gravels overlying London Clay, and above valley-side edge of Blackwater T3 (sht 241)
Holocene alluvium, base of	Holocene alluvium (base of, overlapping edge of Blackwater T1-2 outcrop)
Hoxnian lake deposits	Interglacial lacustrine silts (Hoxnian)
T1, Blackwater	Blackwater Terrace 1
T1-2, Blackwater	Blackwater Terrace 1-2
T1-2, Colne	Colne Terrace 1-2
T2 Chelmer (or Devensian gravel under Chelmer alluvial floodplain)	Chelmer Terrace 2 (or Devensian gravel under Chelmer alluvial floodplain)
T3, Blackwater (stratified in situ)	Blackwater Terrace 3 (stratified in situ)
T3, Blackwater (surface, n-i-s)	Blackwater Terrace 3 (surface, not-in-situ)
T3, Colne (above S bank)	Colne Terrace 3 (above south bank)

Table F-2. Explanation of entries for column 3, “Geo attribution”.

F.2. Palaeolithic sites, in/near 3km buffer around consultation footprint

Site P-no.	Site- finds	Geo attribution	CBC HER no.	ECC MonUID	ERPP 3 - map, site	Rec-Type	NGR-E	NGR-N	Acc
P-1	Birch, farmland to east of airfield - broken ?handaxe, surface-find in mid-1990s	Boulder Clay/ Unmapped?	MCC4953	-	-	F-Spot	592400	219200	G
P-3	Copford, brick works - Pleistocene mammal fossils (interglacial) and molluscs from white shelly sand and marl	Hoxnian lake deposits	MCC5587	-	-	PEFS	592865	224230	A
P-3a	Copford, A12 cutting - borehole records with organic-rich clays/silts/sands [cf. P-3]	Hoxnian lake deposits	-	-	-	Geo	593045	224480	A
P-4	Stanway, south side of main road - numerous mammalian fossils found in 1764, "in stratum of sea-sand and small shells"	Hoxnian lake deposits	MCC5588	-	-	PEFS	593515	224150	E
P-5	Birch, general area - PAS record of handaxe (ref ESS-7DE464); no information on location and circumstances of discovery	Glacial Sand/Gravel - Colchester spread	MCC6290	-	-	F-Spot	593500	221400	G
P-8	Tiptree, general area - two Palaeolithic handaxes in Colchester Museum; one very abraded, the other mod. fresh	Glacial Sand/Gravel - Tiptree ridge	MCC6970	-	B&C3, 8	F-Spot	589500	216500	G
P-15	Stanway, near Oldhouse and Bellhouse Farms - at least one Palaeolithic handaxe found c. 1900	Glacial Sand/Gravel - Colchester spread	MCC7434	-	COL1, 5	F-Spot	594475	223540	G
P-19	Colchester, Lexden Park - small Palaeolithic handaxe, pobably a surface find	Head - valley-side through GSG and KSG (BGS sht 223)	MCC7451	-	COL1, 7	F-Spot	597300	225050	E
P-23	Stanway, near Juniper Close - "worked flints" found in 1963	Glacial Sand/Gravel - Colchester spread	MCC7599	-	-	F-Spot?	595350	224060	A
P-24	Marks Tey, WH Collier's Pit - Palaeolithic handaxe found in 1929	Hoxnian lake deposits	MCC7614	-	B&C1, 14	F-Spot	591080	224480	A
P-24a	Marks Tey, WH Collier's Pit - Palaeolithic handaxe found by path c. 1960-1980	Hoxnian lake deposits	-	-	B&C1, 14a	F-Spot	591020	224265	E
P-24b	Marks Tey, WH Collier's Pit - organic-rich sediments seen in late 19th century, with red deer bones and mollusc shells	Hoxnian lake deposits	-	-	B&C1, 14b	PEFS	591220	224275	A
P-26	Marks Tey, handaxe from "route of train line"	Boulder Clay/Lake-margin?	MCC7659	-	-	F-Spot	591300	223900	E
P-27	Lexden, Church Lane - Palaeolithic handaxe in Colchester Museum	Glacial Sand/Gravel - Colchester spread	MCC7701	-	COL1, 6	F-Spot	594750	223920	E

Site P-no.	Site- finds	Geo attribution	CBC HER no.	ECC MonUID	ERPP 3 - map, site	Rec-Type	NGR-E	NGR-N	Acc
P-31	Stanway, 4 Frenshaw Close - Palaeolithic handaxe, found in garden	Glacial Sand/Gravel - Colchester spread	MCC8065	-	COL1, 4	F-Spot	595800	225140	A
P-48	Tiptree, Grange Road water-pumping station - Palaeolithic handaxe, no info on circumstances of finding	Glacial Sand/Gravel - Tiptree ridge	MCC8267	-	B&C3, 7	F-Spot	588600	216800	A
P-49	Marks Tey Hall - burnt flint patch, noticed by farm agent in 1994, and of uncertain age/origin	Boulder Clay/Unmapped?	MCC8614	-	-	Geo	591890	223190	A
P-50	Marks Tey, WH Collier's Pit - Hoxnian interglacial lake sediments, deep sequence with good pollen preservation	Hoxnian lake deposits	MCC10145	-	B&C1, 14c	PEFS	590960	224250	A
P-50a	Marks Tey, WH Collier's Pit - flint flakes and a deer bone from lake margin deposits	Hoxnian lake deposits	MCC10145	-	B&C1, 14d	Mon/PE	590985	224310	E
P-51	Hatfield Peverel - Palaeolithic handaxe presented to Colchester Museum in 1938 (Mothersole collection)	Glacial Sand/Gravel - Hatfield Peverel	-	MEX20123	B&C3, 10	F-Spot	579100	211620	G
P-52	Witham, an unspecified quarry - small pointed ovate handaxe found early 1980s	T3, Blackwater (surface, n-i-s)	-	MEX25930	B&C3, 6	F-Spot	582500	214500	G
P-53	Kelvedon, northeast of station, at foot of north side of railway embankment - fragments of human skull, with deer and horse bones	Holocene alluvium, base of	-	MEX26119	-	Mon/PE	586420	219410	A
P-56	Kelvedon, railway cutting at Feering (Tiptree branch) - Palaeolithic flake found in 1903	T3, Blackwater (surface, n-i-s)	-	MEX26240	B&C1, 12a	F-Spot	586670	219580	E
P-57	Kelvedon, general area - two handaxes without more-specific provenance	T3, Blackwater (surface, n-i-s)	-	MEX26245	B&C1, 12	F-Spot	586900	219100	G
P-58	Witham, 24 Albert Road - Palaeolithic handaxe found here (no further information)	T3, Blackwater (surface, n-i-s)	-	MEX26344	B&C3, 3a	F-Spot	582080	215390	A
P-59	Witham, Blunts Hall - Palaeolithic handaxe found here c. 1860	Boulder Clay	-	MEX26399	B&C3, 4	F-Spot	580770	214300	E
P-60	Witham, east of Olivers Farm - small bifacially-worked flint artefact, found in 1949	T3, Blackwater (surface, n-i-s)	-	MEX26468	-	F-Spot?	582410	212930	A
P-64	Kelvedon, The Chase - Palaeolithic flakes found during Roman excavation in 1981, one in the natural underlying gravel, and the other residual in a ditch-fill	T3, Blackwater (stratified in situ)	-	MEX26703	B&C1, 11	Mon	586160	218750	E
P-65	Kelvedon, Sawyer's Yard - fresh condition Palaeolithic handaxe from base of a Roman pit, at junction with underlying natural sandy clay	T3, Blackwater (stratified in situ)	-	MEX26781	B&C1, 11a	F-Spot	586095	218810	A

Site P-no.	Site- finds	Geo attribution	CBC HER no.	ECC MonUID	ERPP 3 - map, site	Rec-Type	NGR-E	NGR-N	Acc
P-66	Wickham Bishops, Likely Wood - "flint implement" (no other information)	Glacial Sand/Gravel - Tiptree-Danbury	-	MEX26837	-	F-Spot?	583500	211200	G
P-67	Hatfield Peverel, Sandfords Farm - "flint implement" found by Brigadier "Grimson" [Gunison? - cf P-68]	Boulder Clay	-	MEX26854	-	F-Spot?	581270	212270	A
P-68	Wickham Bishops, near Wickham Place - "flint implements" found by Brigadier "Gunison" [Grimson? - cf P-67]	Head - west side of Blackwater valley (BGS sht 241)	-	MEX26861	-	F-Spot?	582020	211820	A
P-69	Feering, in field to south of Blackwater and north of railway embankment - surface find in 1981 of pointed handaxe	T3, Blackwater (surface, n-i-s)	-	MEX26888	B&C1, 9	F-Spot	586750	219770	A
P-71	Great Braxted, to east of Broadfield Fruit Farm - flint flakes, found in 1930	Glacial Sand/Gravel - Tiptree ridge	-	MEX26957	-	F-Spot?	587150	214380	G
P-73	Wickham Bishops, near Hill Place - SMR record of a Palaeolithic handaxe from here	Glacial Sand/Gravel - Tiptree-Danbury	-	MEX27022	B&C3, 9	F-Spot	583350	212000	G
P-77	Rivenhall End, Durwards Park (field to SW of Durwards Hall), southern sector - surface finds of handaxe (bout coupe) and two flakes	Head - over Blackwater T3 and lake deposits	-	MEX28333	B&C3, 1	F-Spot	584400	216650	A
P-77a	Coleman's Farm Reservoir, north side - sub-cordate handaxe	T1-2, Blackwater	-	MEX10366	-	F-Spot	584000	216000	A
P-77b	Rivenhall End, Fen-and-Loews (field to SE of Durwards Hall), near Scheduled Monument - surface finds of one flake-tool and one flake	T1, Blackwater	-	MEX28333	B&C3, 2	F-Spot	584760	216715	A
P-77c	Fields on east side of Blackwater floodplain (Ashmans Farm) - surface find of a Palaeolithic handaxe	T3, Blackwater (surface, n-i-s)	-	MEX10366	-	F-Spot	585385	216785	E
P-77d	Rivenhall End, Durwards Park (field to SW of Durwards Hall), north corner - small, fresh and neat handaxe (bout coupe)	Head - over Blackwater T3 and lake deposits	-	MEX10366	-	Mon	584435	216925	A
P-77e	Rivenhall End, Durwards Park (field to SW of Durwards Hall) - flake-tools and debitage of Upper Palaeolithic character	Head - over Blackwater T3 and lake deposits	-	MEX10366	-	F-Spot	584410	216800	E
P-77f	Rivenhall End, Rose Cottage Field (field to west of Appleford Farm) - tanged point (Upper Palaeolithic?)	T3, Blackwater (surface, n-i-s)	-	MEX10366	-	F-Spot	584540	216390	A

Site P-no.	Site- finds	Geo attribution	CBC HER no.	ECC MonUID	ERPP 3 - map, site	Rec-Type	NGR-E	NGR-N	Acc
P-78	Rivenhall End, Durwards Park (field to SW of Durwards Hall), northwest corner - surface finds of handaxe (bout coupe, broken), a convex side-scraper and two flakes	Head - over Blackwater T3 and lake deposits	-	MEX10366	-	F-Spot	584300	216780	A
P-78a	Colemans Farm tree-planting and golf course - two handaxes, two flakes and a remnant Upper Palaeolithic blade core re-purposed as a burin	Boulder Clay	-	MEX28350	-	F-Spot	584300	216700	E
P-78b	Rivenhall End, Matchyns (field to SE of A12) - surface find of small pointed handaxe	T3, Blackwater (surface, n-i-s)	-	MEX10366	-	F-Spot	583785	216335	A
P-78c	Stud Chase (field to S of Appleford Farm) - surface find of small pointed handaxe	T3, Blackwater (surface, n-i-s)	-	MEX10366	-	F-Spot	584570	215985	A
P-78d	Colemans Quarry, phase 2 gravel extraction - huge bifacial implement from "reject pile", thought to come from lower part of gravel	T1-2, Blackwater	-	MEX10366	-	F-Spot	583460	216050	A
P-78e	Colemans Quarry, phase 2 gravel extraction - mammoth (?) teeth and other bones, thought to come from bottom part of gravel, or maybe below it	T1-2, Blackwater	-	MEX10366	-	PEFS	583445	216000	A
P-78f	Colemans Quarry, phase 1 gravel extraction - mammoth (?) teeth and other bones, thought to come from bottom part of gravel, or organic-rich deposit below it	T1-2, Blackwater	-	MEX10366	-	PEFS	583630	215720	A
P-79	Witham, Ivy Chimneys - numerous Palaeolithic handaxes incorporated in gravelled floor of Roman shrine, excavated c. 1980	Boulder Clay	-	MEX38611	B&C3, 5	F-Spot	581100	213600	A
P-79a	Witham, Witham Lodge - Palaeolithic handaxe recovered during topsoil strip in July 1970, in advance of Roman excavation	Boulder Clay	-	-	B&C3, 5a	F-Spot	580980	213490	A
P-88	Rivenhall End, field to SW of Durwards Hall - Hoxnian interglacial lacustrine deposits with varied palaeo-environmental remains	Hoxnian lake deposits	-	MEX10381	-	PEFS	584350	216820	A
P-88a	Rivenhall End, field to SW of Durwards Hall - Palaeolithic flint flakes recovered by sieving Pleistocene gravels	T3, Blackwater (stratified in situ)	-	MEX10381	-	Mon	584340	216780	A
P-89	Lexden brickpit - mammalian fossils and insects (beetles) from peat/clay sequence filling truncated channel in south part of brickfield	T3, Colne (above S bank)	-	-	-	PEFS	597760	225475	E

Site P-no.	Site- finds	Geo attribution	CBC HER no.	ECC MonUID	ERPP 3 - map, site	Rec-Type	NGR-E	NGR-N	Acc
P-90	Witham, A12 cutting at Coleman's Bridge - Hoxnian interglacial lacustrine deposits, present on both sides of the cutting	Hoxnian lake deposits	-	-	-	Geo	582950	215400	A
P-91	Rivenhall End - Hoxnian interglacial lacustrine deposits, a substantial, broadly east-west oriented, patch c. 600m long by 150m wide	Hoxnian lake deposits	-	-	-	Geo	583650	216350	A
P-91a	Rivenhall End, BGS borehole record	Hoxnian lake deposits				Geo	584000	216550	A
P-92	Coggeshall, pit behind church - one handaxe, in the British Museum	Boulder Clay/Unmapped?	-	-	B&C1, 8	Mon	585450	223350	E
P-93	Kelvedon, playing field to SE of old town centre - handaxe recovered from pit in Roman shrine	T1-2, Blackwater	-	-	B&C1, 10	F-Spot	586500	218850	A
P-94	Kelvedon "Beanfields" (Area J) - residual abraded artefacts (two cores and 12 flakes), presumed Palaeolithic	T3, Blackwater (surface, n-i-s)	-	-	B&C1, 10a	F-Spot	586360	218615	A
P-95	Coggeshall, Heathlands School - Palaeolithic handaxe found in school gardens in 1915	Glacial Sand/Gravel - east edge	-	-	COL1, 1	F-Spot	596070	227970	E
P-96	West Bergholt, Chitts Hill - Palaeolithic handaxe found during rescue excavation of Bronze Age cemetery in 1973	T1-2, Colne	-	-	COL1, 2	F-Spot	595800	226570	A
P-97	West Bergholt, general area - two handaxes (both "sl. rolled") and a flake in Colchester Museum, probably collected in late 19th century	Glacial Sand/Gravel - east edge	-	-	COL1, 3	F-Spot	595960	227600	G
P-99	Stanway, Great Eastern Railways pit - a small irregular ?handaxe in Colchester Museum	Glacial Sand/Gravel - Colchester spread	-	-	COL1, 5a	F-Spot	595200	225480	A
P-100	Stanway, "Stanway Pit" - a very rolled handaxe in Nottingham Museum	Glacial Sand/Gravel - Colchester spread	-	-	COL1, 5b	F-Spot	595220	223600	E
P-102	Colchester, "All Saints Road" - handaxe in Colchester Museum	Glacial Sand/Gravel - Colchester spread	-	-	COL1, 8	F-Spot	597870	223770	G
P-103	Witham, Witham Railway Station - "flint implement" from gravel at Witham station	T3, Blackwater (surface, n-i-s)	-	-	B&C3, 3b	F-Spot	582020	215100	E
P-104	Woodham Walters, Hoemill Gravel Pit - one handaxe found in 1980, in gravel consignment traced back to pit	T2 Chelmer (or Devensian gravel under Chelmer alluvial floodplain)	-	-	B&C3, 11	F-Spot	580750	208600	E

Appendix G.

Palaeolithic-Quaternary (PQ) zones: tabular summaries

Contents:

G.1. Introductory tables

Zone	PQ-no. Name of PQ zone
- Topography/ geomorphology **- Bedrock geology**	- Summary description of topography (including ground surface elevation) and geomorphology - Solid (pre-Quaternary) bedrock geology
Quaternary sediments	Summary description of Quaternary sediment sequences
Geological interpretation	Current geological interpretation, including presumed depositional process and stratigraphic attribution (for instance to a particular Lower Thames terrace or gravel body)
Palaeoenvironmental potential	Review of palaeo-environmental potential, so far as known
Palaeolithic remains	Review of Palaeolithic artefact finds from zone, and potential based on recoveries from similar deposits, with specific sites referenced to Palaeolithic site-list (**Appendix F**)
Palaeolithic assessment	One of four categories: HIGH, MODERATE, LOW, or UNCERTAIN (see criteria below, **Table 9)**
Stage 1 evaluation priorities	Priorities and scope of stage 1 Palaeolithic/geo-archaeological evaluation
Stage 2 evaluation priorities	Likely scope, but tbc after stage 1 evaluation results
Key reference/s	Most important sources for up-to-date information on zone

Table G-1. Explanation of PQ zone summary table entries.

Palaeolithic assessment	*Explanation, and approaches to field evaluation*
HIGH	Likely to contain sites with High-Very High Palaeolithic potential (see **Appendix E** for criteria for Palaeolithic potential), and requiring a phased approach to evaluation involving preliminary stage 1 work, followed by further stage 2 Palaeolithic/geo-archaeological evaluation in light of the stage 1 results
MODERATE	Likely to contain sites with Moderate Palaeolithic potential (see **Appendix E** for criteria for Palaeolithic potential), and requiring a moderate level of stage 1 Palaeolithic evaluation, with the possibility that stage 2 evaluation work will not be required
LOW	Likely to contain sites with Negligible-Low Palaeolithic potential (see **Appendix E** for criteria for Palaeolithic potential), and requiring minimal-moderate stage 1 Palaeolithic evaluation, with the expectation that stage 2 work will not be required
UNCERTAIN	Too little primary information on Quaternary sequence for an informed assessment to be made; requires preliminary (stage 1) Palaeolithic/geo-archaeological evaluation to gather more information, before assessing whether/what stage 2 work

Table G-2. Categories of Preliminary Palaeolithic/geo-archaeological assessment for PQ zones.

G.2. Palaeolithic-Quaternary zones, PQ-1 to PQ-24 (including PQ-13a,b and PQ-22a,b)

Zone	PQ-1 Blackwater alluvium
- Topography/ geomorphology	- Alluvial floodplain in base of Blackwater valley and its right-bank tributaries
- Bedrock geology	- Mostly London Clay, but (according to current BGS mapping) (a) a small patch of Thanet Sand near Junction 22 of the A12, and (b) a small patch of undifferentiated Thanet Sand/Lambeth Group deposits east of Junction 23 of the A12; these may represent particularly deep incision of the buried sub-glacial channel, or it may be mistaken interpretation of glacial outwash or lacustrine sediments
Quaternary sediments	Fine-grained clayey silt, sometimes peaty, and often more sandy/gravelly at base
Geological interpretation	Holocene alluvium from overbank flooding, forming since the end of the last ice age, with younger deposits spreading further up the valley sides, and potentially sealing earlier evidence of bank-side occupation
Palaeoenvironmental potential	High - likely to contain various palaeo-environmental remains, and also provides good preservational conditions for any organic archaeological remains within/below it
Palaeolithic remains	Fragments of a human were skull were found with deer and horse bones, well-stratified at the base of the Holocene alluvium in Kelvedon [P-53]
Palaeolithic assessment	MODERATE
Stage 1 evaluation priorities	- Thickness and distribution of alluvium - Presence, variety and quality of palaeo-environmental remains - Presence/significance of any archaeological remains (and in particular, whether a sealed palaeo-landsurface with Final Upper Palaeolithic evidence at the base of any alluvium)
Stage 2 evaluation priorities	Tbc in light of stage 1 evaluation results
Key reference/s	Eddy 1977

Zone	PQ-2 Sewells Farm
- Topography/ geomorphology **- Bedrock geology**	- Lower valley-side on east side of Blackwater - London Clay
Quaternary sediments	Minor outcrops of Boulder Clay, Glacial Sand and Gravel, and alluvial infill of minor left-bank tributary valley
Geological interpretation	Erosionally-truncated remnants of glacial till and glacial outwash deposits, with Holocene alluvium in lowest-lying ground
Palaeoenvironmental potential	Maybe within Holocene alluvium
Palaeolithic remains	None known
Palaeolithic assessment	LOW
Stage 1 evaluation priorities	Na - outside the scheme footprint
Stage 2 evaluation priorities	Na - outside the scheme footprint
Key reference/s	-

Zone	PQ-3 Witham sewage works
- Topography/ geomorphology **- Bedrock geology**	- Broadly flat surface (c. 20m OD) of river terrace deposits on the west bank of the Blackwater - London Clay
Quaternary sediments	Silt/sand, above sandy gravel
Geological interpretation	Alluvial overbank flood deposits, overlying Blackwater Terrace 3 deposits; BGS interpretation is that the alluvium is most-likely Holocene(Blackwater Terrace 1 loam). However, it could be a continuation of the Hoxnian lacustrine deposits that are present closely nearby to the north
Palaeoenvironmental potential	None known, but very likely to be present in the alluvium
Palaeolithic remains	None known, but likely to be present in the T3 gravel, or on its surface sealed under the overlying alluvium; in the latter case, they may be relatively undisturbed
Palaeolithic assessment	HIGH
Stage 1 evaluation priorities	- Depth and distribution of alluvium - Date of alluvium (and in particular, whether it represents unrecognised Hoxnian lake deposits) - Presence, variety and quality of palaeo-environmental remains in/under alluvium - Presence/significance of any archaeological remains in/under alluvium - Presence/prevalence and condition of any artefacts in the Terrace 3 gravel below the alluvium
Stage 2 evaluation priorities	Tbc in light of stage 1 evaluation results
Key reference/s	-

Zone	PQ-4 Witham, east of B1018
- Topography/ geomorphology **- Bedrock geology**	- Broadly level land (c. 20-25m OD) to west of Blackwater, built-up - London Clay
Quaternary sediments	Sands/gravels
Geological interpretation	Blackwater Terrace 3
Palaeoenvironmental potential	Low within the T3 sands/gravels, although unmapped Hoxnian lacustrine deposits with rich and varied palaeo-environmental remains may be present
Palaeolithic remains	One report of a handaxe from T3 deposits in the general area (P-52), and numerous finds from T3 deposits in the vicinity of Witham, including some fresher material from the surface of T3 (P-65)
Palaeolithic assessment	MODERATE
Stage 1 evaluation priorities	Na - outside the scheme footprint
Stage 2 evaluation priorities	Na - outside the scheme footprint
Key reference/s	-

Zone	PQ-5 Rivenhall End
- Topography/ geomorphology **- Bedrock geology**	- An extensive spread of broadly level ground between c. 18m and 23m OD along the northwest side of the Blackwater valley, abutting the higher ground of the chalky Boulder Clay further to the northwest - Mostly London Clay, but (according to current BGS mapping) a small patch of Thanet Sand at J22 of the A12; this may represent particularly deep incision of the buried sub-glacial channel, or it may be mistaken interpretation of glacial outwash or lacustrine sediments
Quaternary sediments	Patches of fine-grained organic-rich clayey silts/sands, overlying sands/gravels, which in turn overlie chalky/gravelly clay. The organic-rich clayey silts/sands occur (where present) close beneath the ground surface in many places, but are buried beneath 1-2m of sandy/gravelly deposits along the northwest side of this area, where the ground surface slopes up.
Geological interpretation	This zone is situated along the northwest side of a buried sub-glacial channel infilled with Anglian Boulder Clay and sands/gravels mapped as Blackwater Terrace 3, which are overlain in places by (sometimes very thick) Hoxnian lake sediments. The sandy/gravelly deposits forming the higher ground along the northwest side of this zone are slopewash sediments that have come in over the lacustrine sediments from the even higher ground further to the northwest. Younger sand/gravel sediments attributable to Blackwater Terrace 2 may also be present along the SE side of this zone.
Palaeoenvironmental potential	High - Hoxnian lake sediments are widely distributed within this zone, and rich in a variety of organic remains, including pollen, molluscs and ostracods (P-88, P-90, P-91, P-91a); mammalian fossils including deer, ?bovid and ?elephant/mammoth have also been found, possibly associated with the base of T2 deposits (P-78e)
Palaeolithic remains	High - Palaeolithic artefacts have frequently been found in this zone and in other nearby spreads of Terrace 3, mostly as out-of-context surface finds (P-77, 77d, 78, 78b, 88), some in fresh condition, but some have been found *in situ* in the Terrace 3 deposits (P-88a) or presumed Terrace 2 deposits (P-78d)
Palaeolithic assessment	HIGH
Stage 1 evaluation priorities	- More widely-spaced scoping investigations to identify general presence, nature and thickness/distribution of Quaternary sediments - In particular, to establish presence/likelihood of lake margin palaeo-landsurfaces - Presence, variety and quality of palaeo-environmental remains - Presence, prevalence and significance of any archaeological remains
Stage 2 evaluation priorities	More closely-spaced evaluation investigations in areas identified as of interest in phase 1 scoping investigations
Key reference/s	Dalton (in Whitaker et al.) 1878: 67; Turner 1970: 377, 433; Bristow 1985: 67-68; Bates (with Wenban-Smith) 2014; Bates 2015.

Zone	PQ-6 Witham Junction
- Topography/ geomorphology **- Bedrock geology**	- Built-up area around rail line to NE of Witham station, ground sloping down from west to east, from c. 30m to c. 25m OD - London Clay
Quaternary sediments	Silty/sandy gravel, overlying chalky/gravelly clay in places
Geological interpretation	Northwest side of Blackwater valley, where Anglian Boulder Clay dips steeply into the sub-glacial buried channel, and where the channel is then infilled with Blackwater Terrace 3 deposits, and the northwest side of these deposits wedges out against the sloping Boulder Clay, with this junction being buried by overlying Head deposits that have washed down from higher ground to the northwest
Palaeoenvironmental potential	Moderate - Hoxnian lake deposits may be present in places, between the T3 deposits and the Head deposits
Palaeolithic remains	Moderate - if Hoxnian lake deposits are present, they may be associated with Palaeolithic artefacts; and artefacts might also be present in the T3 sands/gravels
Palaeolithic assessment	MODERATE
Stage 1 evaluation priorities	Na - outside the scheme footprint
Stage 2 evaluation priorities	Na - outside the scheme footprint
Key reference/s	-

Zone	PQ-7 Rivenhall Oaks
- Topography/ geomorphology **- Bedrock geology**	- Higher ground (c. 30-35m OD) on northwest side of Blackwater valley - London Clay
Quaternary sediments	Chalky/gravelly clay
Geological interpretation	Boulder Clay - sub-glacial lodgement till
Palaeoenvironmental potential	Very low
Palaeolithic remains	Surface finds of two Palaeolithic handaxes and prehistoric flakes from golf course and tree-planting (P-78a)
Palaeolithic assessment	LOW
Stage 1 evaluation priorities	Na - outside the scheme footprint
Stage 2 evaluation priorities	Na - outside the scheme footprint
Key reference/s	-

Zone	PQ-8 Witham NE rail cutting
- Topography/ geomorphology **- Bedrock geology**	- Higher ground (c. 30-35m OD) on northwest side of Blackwater valley - London Clay
Quaternary sediments	Mostly chalky/gravelly clay; this is overlain by a small patch of sand/gravel to west of Hare Lodge, and by a slightly larger area of clay/silt/sand/gravel a little further west. Sands and gravels are likely to underlie the clay, but are not exposed at the surface.
Geological interpretation	The chalky/gravelly clay is Boulder Clay formed below the Anglian ice-sheet. The small patch of sand/gravel has been attributed to Blackwater Terrace 3, but more-likely represents a remnant of Glacial Sand/Gravel formed by glacial outwash as the ice-sheet melted at the end of the Anglian. And the clay/silt/sand/gravel is a Head deposit formed at the southeast edge of the wide spread of Anglian Boulder Clay, as it slopes down into the Blackwater valley. The deeper-lying sands/gravels can be attributed to the pre-Anglian Kesgrave Sands and Gravels.
Palaeoenvironmental potential	None known, and unlikely
Palaeolithic remains	None known, and unlikely
Palaeolithic assessment	LOW
Stage 1 evaluation priorities	- Establish variety, depth and thickness/distribution of Quaternary sediments - Investigate presence, prevalence and significance of any archaeological remains
Stage 2 evaluation priorities	Not anticipated, but tbc after stage 1 results
Key reference/s	-

Zone	PQ-9 Durwards Hall
- Topography/ geomorphology **- Bedrock geology**	- Undulating ground between *c.* 20m and 25m OD along the northwest side of the Blackwater valley, sloping up to the north - London Clay
Quaternary sediments	Patches of fine-grained organic-rich clayey silts/sands, overlying sands/gravels, which in turn overlie chalky/gravelly clay. The organic-rich clayey silts/sands occur (where present) close beneath the ground surface in many places, but are buried beneath 1-2m of sandy/gravelly deposits along the northwest side of this area, where the ground surface slopes up.
Geological interpretation	This zone is situated along the northwest side of a buried sub-glacial channel infilled with Anglian Boulder Clay and sands/gravels mapped as Blackwater Terrace 3. These are overlain in places by (sometimes very thick) Hoxnian lake sediments. The sandy/gravelly deposits forming the higher ground along the northwest side of this zone are slopewash sediments that have come in over the lacustrine sediments from the slightly higher ground further to the northwest.
Palaeoenvironmental potential	High - the Hoxnian lake sediments, which are widely distributed within this zone, are rich in a variety of organic remains, including pollen, molluscs and ostracods (P-88, P-90, P-91, P-91a)
Palaeolithic remains	High - Palaeolithic artefacts have frequently been found in this zone and in other nearby spreads of Terrace 3, mostly as out-of-context surface finds (P- 77, 77e, 78, 88), some in fresh condition, but some have been found *in situ* in the Terrace 3 deposits (P- 77d, 88a)
Palaeolithic assessment	HIGH
Stage 1 evaluation priorities	- More widely-spaced scoping investigations to identify general presence, nature and thickness/distribution of Quaternary sediments - In particular, to identify presence/likelihood of lake margin palaeo-landsurfaces - Presence, variety and quality of palaeo-environmental remains - Presence, prevalence and significance of any archaeological remains
Stage 2 evaluation priorities	More closely-spaced evaluation investigations in areas identified as of interest in phase 1 scoping investigations
Key reference/s	Dalton (in Whitaker et al.) 1878: 67; Turner 1970: 377, 433; Bristow 1985: 67-68; Wenban-Smith 2006a,b.

Zone	PQ-10 Kelvedon, Crabb's Farm
- Topography/ geomorphology **- Bedrock geology**	- Northwest side of Blackwater valley, western outskirts of Kelvedon, partly built-up, and ground-surface sloping down to the southeast from c. 30m to <25m OD - Mostly London Clay, but (according to current BGS mapping) a small patch of undifferentiated Thanet Sand/Lambeth Group deposits east of Junction 23 of the A12; this may represent particularly deep incision of the buried sub-glacial channel, or it may be mistaken interpretation of glacial outwash or lacustrine sediments
Quaternary sediments	Sand/gravel deposits, dissected by narrow south-east-draining channels that are either dry-draining and filled with clayey silt/sand/gravel, or which have minor current streams in them, and filled with alluvial silt
Geological interpretation	Blackwater Terrace 3 deposits mostly, overlain in dry valleys by Head deposits originating from higher ground to the northwest, or by Holocene alluvial silts in the stream channels
Palaeoenvironmental potential	Hoxnian lake deposits may be present in places, overlying the T3 deposits; and palaeo-environmental remains may be present in and below any Holocene alluvial deposits
Palaeolithic remains	Moderate - if Hoxnian lake deposits are present, they may be associated with Palaeolithic artefacts. Finds from the T3 gravel surface are common in the nearby area (P-64, 65, 94), and some finds have also been recovered from sieving T3 gravel (P-88a).
Palaeolithic assessment	MODERATE
Stage 1 evaluation priorities	- Depth and distribution of Holocene alluvium - Presence, nature and thickness/distribution of Pleistocene sediments (and in particular, whether there are any unmapped Hoxnian lake deposits) - Presence, variety and quality of palaeo-environmental remains - Presence/prevalence and significance of any archaeological remains
Stage 2 evaluation priorities	Tbc in light of stage 1 evaluation results
Key reference/s	Eddy 1982; Clarke 1986; Martingell 1986.

Zone	PQ-11 Great Braxted Mill, northwest of
- Topography/ geomorphology	- Narrow strip along the northwest side of the Blackwater, between Durwards Hall and the centre of Kelvedon
- Bedrock geology	- Mostly London Clay, but (according to current BGS mapping) a small patch of undifferentiated Thanet Sand/Lambeth Group deposits east of Junction 23 of the A12; this may represent particularly deep incision of the buried sub-glacial channel, or it may be mistaken interpretation of glacial outwash or lacustrine sediments
Quaternary sediments	Sands/gravels, overlain by spreads of sandy/gravelly clay-silt in places
Geological interpretation	Blackwater Terrace 1, overlain by Head deposits in places; the date of the T1 deposits is unknown, but they are fluvially deposited, and may well be Devensian (MIS 5d-2)
Palaeoenvironmental potential	None known, but potential for palaeo-environmental remains from within and below the T1 deposits, and also from unmapped Holocene alluvial deposits that may extend into the zone from the adjacent Blackwater floodplain
Palaeolithic remains	Several findspots known from Blackwater terraces T1-T2, including surface finds of a handaxe and a flake-tool (P-77b, 78c)
Palaeolithic assessment	MODERATE
Stage 1 evaluation priorities	- Presence, nature and thickness/distribution of Quaternary sediments - Presence, variety and quality of palaeo-environmental remains - Presence/prevalence and significance of any archaeological remains
Stage 2 evaluation priorities	Tbc in light of stage 1 evaluation results
Key reference/s	Martingell 1982

Zone	PQ-12 Brickhouse/Ashman's Farms
- Topography/ geomorphology	- Narrow strip along the southeast side of the Blackwater, between Kelvedon Lodge and Ashman's Farm
- Bedrock geology	- Mostly London Clay, but (according to current BGS mapping) a small patch of undifferentiated Thanet Sand/Lambeth Group deposits east of Junction 23 of the A12; this may represent particularly deep incision of the buried sub-glacial channel, or it may be mistaken interpretation of glacial outwash or lacustrine sediments
Quaternary sediments	Sands/gravels
Geological interpretation	Blackwater Terrace 2; the date of the T2 deposits is unknown, but they are fluvially deposited, and are likely to be Devensian (MIS 5d-2), or perhaps earlier
Palaeoenvironmental potential	None known, but potential for palaeo-environmental remains from within and below the T2 deposits, and also from unmapped Holocene alluvial deposits that may extend into the zone from the adjacent Blackwater floodplain
Palaeolithic remains	Several findspots known from Blackwater terraces T1-T2, including surface finds of two *bout coupé* handaxes and a flake tool near Durwards Hall (P-77, 77a)
Palaeolithic assessment	MODERATE
Stage 1 evaluation priorities	- Presence, nature and thickness/distribution of Quaternary sediments - Presence, variety and quality of palaeo-environmental remains - Presence/prevalence and significance of any archaeological remains
Stage 2 evaluation priorities	Tbc in light of stage 1 evaluation results
Key reference/s	Martingell 1982

Zone	PQ-13a The Glebe House
- Topography/ geomorphology **- Bedrock geology**	- Lower slopes of southeast side of Blackwater valley, ground sloping down to northwest from c. 35m to 25m OD - London Clay
Quaternary sediments	Patches of sand/gravel overlying chalky/gravelly clay
Geological interpretation	Outcrops of Blackwater terrace deposits T3 and (higher up the slope) T4, overlying till formed at the base of the Anglian ice-sheet; the gravel terrace outcrops are not thought to be laid down by normal fluvial processes, but to relate to meltwater outwash into a lake at the end of the Anglian glaciation
Palaeoenvironmental potential	None known; although it is possible that unmapped deposits from near the margins of the lake that was known to have formed in this area in the early Hoxnian, and these could contain rich and varied organic remains
Palaeolithic remains	None known, although there is potential for their recovery from unmapped Hoxnian lake margin sediments
Palaeolithic assessment	MODERATE
Stage 1 evaluation priorities	Na - outside the scheme footprint
Stage 2 evaluation priorities	Na - outside the scheme footprint
Key reference/s	-

Zone	PQ-13b Kelvedon, Ewell Hall
- Topography/ geomorphology **- Bedrock geology**	- Lower slopes of southeast side of Blackwater valley, ground sloping down to northwest from c. 35m to 25m OD - London Clay
Quaternary sediments	Patches of sand/gravel overlying chalky/gravelly clay
Geological interpretation	Outcrops of Blackwater terrace deposits T3 and (higher up the slope) T4, overlying till formed at the base of the Anglian ice-sheet; the gravel terrace outcrops are not thought to be laid down by normal fluvial processes, but to relate to meltwater outwash into a lake at the end of the Anglian glaciation
Palaeoenvironmental potential	None known; although it is possible that this area could contain unmapped deposits from the lake that was known to have formed in this area in the early Hoxnian, and these could contain rich and varied organic remains
Palaeolithic remains	None known, although there is potential for their recovery from unmapped Hoxnian lake margin sediments. Finds from the T3 gravel surface are common in the nearby area (P-64, 65, 94), and some finds have also been recovered from sieving T3 gravel (P-88a).
Palaeolithic assessment	MODERATE
Stage 1 evaluation priorities	- Depth and thickness/distribution of Blackwater terrace T3 and T4 deposits - Presence of unmapped Hoxnian lake deposits - Presence, variety and quality of palaeo-environmental remains - Presence/prevalence and significance of any archaeological remains
Stage 2 evaluation priorities	Tbc in light of stage 1 evaluation results
Key reference/s	Eddy 1982; Clarke 1986; Martingell 1986.

Zone	PQ-14 Appleford Farm
- Topography/ geomorphology **- Bedrock geology**	- Broadly flat land on northwest side of Blackwater, sloping down towards the river from c. 22m to c. 17m OD - London Clay
Quaternary sediments	Sands/gravels
Geological interpretation	Lower-lying deposits immediately beside the Blackwater are mapped as terrace T1, and higher deposits slightly further away from the river are mapped as T3
Palaeoenvironmental potential	None known, although unmapped Hoxnian lake deposits could be present, and these could contain rich and varied organic remains
Palaeolithic remains	Several prehistoric surface finds from fields in this zone and nearby, including a broken ?Upper Palaeolithic tanged point (P-77f) and a handaxe (P-78c); some finds have also been recovered from sieving T3 gravel (P-88a)
Palaeolithic assessment	MODERATE
Stage 1 evaluation priorities	Na - outside the scheme footprint
Stage 2 evaluation priorities	Na - outside the scheme footprint
Key reference/s	-

Zone	PQ-15 Coleman's Reservoir, and surrounds
- Topography/ geomorphology **- Bedrock geology**	- Spread of broadly level ground at 16-18m OD on northwest side of Blackwater, including a reservoir that probably relates to recent (post-1990s) gravel extraction - London Clay
Quaternary sediments	Sands/gravels
Geological interpretation	Mostly Blackwater Terrace 2 deposits, but a small lower-lying area at the southwest end of this zone is mapped as Blackwater Terrace 1
Palaeoenvironmental potential	Several mammalian fossils (?mammoth/elephant molars, and bones of other medium-sized mammals - P-78f) have been recovered from the bottom part of the T2 terrace gravels, or from an underlying deposit below the gravel base. A laminated brown organic-rich deposit at this horizon contains insects and probably also pollen). Unmapped Holocene alluvial deposits may also extend into the zone from the adjacent Blackwater floodplain.
Palaeolithic remains	A flat-butted sub-cordate handaxe (approaching *bout coupé*) was found in the T2 gravel when digging Colemans Reservoir (P-77a), and a broken tanged point that is ?Upper Palaeolithic was found on the field surface at the far east corner of this zone, where it abuts zones PQ-14 and PQ-1.
Palaeolithic assessment	MODERATE
Stage 1 evaluation priorities	- Presence, nature and thickness/distribution of Quaternary sediments - Presence, variety and quality of palaeo-environmental remains - Presence/prevalence and significance of any archaeological remains
Stage 2 evaluation priorities	Tbc in light of stage 1 evaluation results
Key reference/s	Martingell 1982; Bates (with Wenban-Smith) 2014; Bates 2015.

Zone	PQ-16 Inworth
- Topography/ geomorphology **- Bedrock geology**	- Strip of higher ground above the southeast side of the Blackwater, sloping down to the northwest from c. 45-25m OD - London Clay
Quaternary sediments	Numerous patches and some wider spreads of sandy gravel, overlying a wide spread of chalk/gravelly clay that slopes down to the northwest, and with London Clay bedrock outcropping at the higher southeast side of this zone
Geological interpretation	The chalk/gravelly clay is Anglian Boulder Clay, dipping down to the northwest to fill the bottom part of the buried sub-glacial channel that underlies the Blackwater river here; the sandy gravel patches are mostly mapped as Blackwater Terrace 4. Some slightly higher gravelly areas in the northeast part of the zone are mapped as T4-T5. And some even higher gravelly spreads are mapped as Glacial Sand and Gravel. The T4 and T4-T5 sand/gravel patches are interpreted as late Anglian meltwater outwash into a lake, rather than conventional fluvial deposits, and the Glacial Sand and Gravel deposits are likewise interpreted as glacio-fluvial outwash deposits.
Palaeoenvironmental potential	No remains are known, but this area is poorly investigated, so unmapped deposits (perhaps Anglian or Hoxnian lake deposits) with palaeo-environmental remains may be present
Palaeolithic remains	No finds known from this specific zone, but numerous Palaeolithic finds have been made from the wide spreads of Glacial Sand and Gravel to the southeast of the Blackwater (P-8, 48, 66, 71, 73), and from similar deposits to the west of Colchester (P-23, 27, 31, 99, 100). Unmapped Anglian or Hoxnian lake-margin deposits may be present, and these could contain artefactual remains
Palaeolithic assessment	UNCERTAIN
Stage 1 evaluation priorities	- Presence, nature and thickness/distribution of Quaternary sediments (and in particular, whether there are any unmapped Hoxnian lake deposits) - Presence, variety and quality of palaeo-environmental remains - Presence/prevalence and significance of any archaeological remains
Stage 2 evaluation priorities	Tbc in light of stage 1 evaluation results
Key reference/s	-

Zone	PQ-17 Gore Pit
- Topography/ geomorphology **- Bedrock geology**	- Wide spread of ground between the Blackwater and the Domsey Brook, rising from c. 25m OD around its southern and western edges where abuts these water courses to >35m OD in the northeast part of this area - London Clay
Quaternary sediments	The dominant deposit is sand/gravel, overlain in places by gravelly/sandy clay-silt infilling minor dry valleys and depressions, and with outcrops of chalky/gravelly clay at the higher northern and western edges of the area
Geological interpretation	The dominant sand/gravel deposit is mapped as Blackwater Terrace 3, representing late Anglian and early Hoxnian meltwater outwash. This is overlain in places by later Head deposits infilling minor dry valleys and depressions in the surface of the T3 spread. And the chalky/gravelly clay at the higher northern and western edges of the area is Anglian Boulder Clay.
Palaeoenvironmental potential	None known; although it is possible that unmapped deposits from near the margins of the lake that was known to have formed in this area in the early Hoxnian, and these could contain rich and varied organic remains
Palaeolithic remains	None known, although there is potential for their recovery from unmapped Hoxnian lake margin sediments. Finds from the T3 gravel surface are common in the nearby area (P-57, 69), a flake was found in the rail cutting near Feering (P-56) and some finds have also been recovered from sieving T3 gravel (P-88a).
Palaeolithic assessment	MODERATE
Stage 1 evaluation priorities	- Presence, nature and thickness/distribution of Quaternary sediments (and in particular, whether there are any unmapped Hoxnian lake deposits) - Presence, variety and quality of palaeo-environmental remains - Presence/prevalence and significance of any archaeological remains
Stage 2 evaluation priorities	Tbc in light of stage 1 evaluation results
Key reference/s	Holmes 1904; Whitaker 1904; Bonner 1981

Zone	PQ-18 Messing Grove
- Topography/ geomorphology **- Bedrock geology**	- Small area on the south side of Domsey Brook, sloping down northward from c. 30m to c. 25m OD, and forming the southern bank of the buried sub-glacial channel that stretches to the southwest from here, underlying the Blackwater river as far as Witham - London Clay
Quaternary sediments	Mostly chalky/gravelly clay, but overlain by an east-west oriented linear strip of sandy gravel towards the bottom of the slope
Geological interpretation	The chalky/gravelly clay is Boulder Clay, laid down under the Anglian ice-sheet; the linear strip of sandy gravel is mapped as Blackwater Terrace 3, taken to represent meltwater outwash into a Late Anglian lake
Palaeoenvironmental potential	None known; although it is possible that this area could contain unmapped deposits from the lake that was known to have formed in this area in the early Hoxnian, and these could contain rich and varied organic remains
Palaeolithic remains	None known, although there is potential for their recovery from unmapped Hoxnian lake margin sediments. Finds from the T3 gravel surface are common not too far away in Kelvedon (P-64, 65, 94), and some finds have also been recovered from sieving T3 gravel near Rivenhall End (P-88a).
Palaeolithic assessment	MODERATE
Stage 1 evaluation priorities	- Presence, nature and thickness/distribution of Quaternary sediments (and in particular, whether there are any unmapped Hoxnian lake deposits) - Presence, variety and quality of palaeo-environmental remains - Presence/prevalence and significance of any archaeological remains
Stage 2 evaluation priorities	Tbc in light of stage 1 evaluation results
Key reference/s	-

Zone	PQ-19 Chase House (formerly Prested Hall)
- Topography/ geomorphology **- Bedrock geology**	- Ground to the north of Domsey Brook, sloping down to the south from c. 30-25m OD, including lower-lying area occupied by Chase House (formerly Prested Hall) - London Clay
Quaternary sediments	Chalky/gravelly clay at the higher areas forming the north and western edges of this zone; and gravelly/sandy clay-silt in the lower-lying central area occupied by Chase House, and along the northern side of Domsey Brook
Geological interpretation	This area is within the buried/infilled sub-glacial channel that stretches southwest towards Witham, and parallel with its southeast bank. The chalky/gravelly clay at the higher north and western edges is Boulder Clay laid down under the Anglian ice-sheet. The gravelly/sandy clay-silt in the lower-lying central area, and along the northern side of Domsey Brook, is a Head deposit.
Palaeoenvironmental potential	None known. It is possible that unmapped Hoxnian lake deposits occur in the area; if so, they could contain varied palaeo-environmental remains
Palaeolithic remains	None known. It is possible that unmapped Hoxnian lake margin deposits occur in the area; if so, they could contain relatively-undisturbed Palaeolithic artefactual remains
Palaeolithic assessment	LOW
Stage 1 evaluation priorities	- Presence, nature and thickness/distribution of Quaternary sediments (and in particular, whether there are any unmapped Hoxnian lake deposits) - Presence, variety and quality of palaeo-environmental remains - Presence/prevalence and significance of any archaeological remains
Stage 2 evaluation priorities	Tbc in light of stage 1 evaluation results
Key reference/s	-

Zone	PQ-20 Easthorpe Road
- Topography/ geomorphology **- Bedrock geology**	- wide undulating plain, with the landsurface dipping shallowly down from c. 40-30m OD from northwest to southeast - London Clay
Quaternary sediments	Chalky/gravelly clay, with occasional areas where variably gravelly/sandy clay-silt infills minor depressions and the heads of dry valleys. The clay is underlain by a major body up to 10m thick of sands and gravels.
Geological interpretation	Boulder Clay laid down under the Anglian ice-sheet, overlain by Head deposits in places. The substantial sands/gravels under the Boulder Clay are Kesgrave Sands and Gravels, laid down by eastward flow of a major river system originating from western England or the west Midlands.
Palaeoenvironmental potential	Low - none are known from this zone and palaeo-environmental remains would not normally be expected associated with wide areas of Boulder Clay such as this. However the northern edge of the zone abuts an area of high potential (PQ-23) with Hoxnian lake sediments; unmapped lake sediments may be present in the northern part of this zone, and if so would be of high potential.
Palaeolithic remains	Moderately low - quite numerous Palaeolithic artefacts have been found across the wide expanse of Boulder Clay that covers much of Essex; however, the chances of finding something in any particular area are low. If unmapped Hoxnian lake sediments are present in the northern part of this zone, they would be of high potential. Palaeolithic artefacts have also been quite often found in Kesgrave Sands/Gravels, so any exposure of these would also have potential.
Palaeolithic assessment	LOW
Stage 1 evaluation priorities	- Presence, nature and thickness/distribution of Quaternary sediments (and in particular, any pockets of unmapped Hoxnian lake deposits overlying Boulder Clay in the northern part of this zone) - Presence, variety and quality of palaeo-environmental remains - Presence/prevalence and significance of any archaeological remains
Stage 2 evaluation priorities	Tbc in light of stage 1 evaluation results
Key reference/s	Essex County Council 2015 (pp14-17)

Zone	PQ-21 West of Fan Wood
- Topography/ geomorphology	- Ground on the south side of the upper part of Domsey Brook, sloping down to the north from c. 35m to c. 30m OD
- Bedrock geology	- London Clay
Quaternary sediments	Chalky-gravelly clay
Geological interpretation	Boulder Clay, formed under the Anglian ice-sheet
Palaeoenvironmental potential	Very low
Palaeolithic remains	None known here, although occasional finds are known from the surface of the wide spread of Boulder Clay that covers much of East Anglia, and these may represent unmapped deposits with good Palaeolithic potential
Palaeolithic assessment	UNCERTAIN
Stage 1 evaluation priorities	Na - outside the scheme footprint
Stage 2 evaluation priorities	Na - outside the scheme footprint
Key reference/s	-

Zone	PQ-22a Main Domsey Brook alluvium
- Topography/ geomorphology **- Bedrock geology**	- Narrow alluvial floodplain in base of valley containing the Domsey Brook - London Clay
Quaternary sediments	Fine-grained clayey silt, sometimes peaty, and often more sandy/gravelly at base
Geological interpretation	Holocene alluvium from overbank flooding mixed with slopewash from valley sides, forming since the end of the last ice age, with younger deposits spreading further up the valley sides, and potentially sealing earlier evidence of bank-side occupation
Palaeoenvironmental potential	High - likely to contain various palaeo-environmental remains, and also provides good preservational conditions for any organic archaeological remains within/below it
Palaeolithic remains	None known, but no investigations of the Domsey Brook alluvium have taken place. Larger alluvial bodies (such as associated with the Blackwater, and the lowest stretch of the Domsey Brook - PQ-1) have been shown to contain Final Upper Palaeolithic remains at their base in at least one place (P-53), so the presence of such remains cannot be ruled out.
Palaeolithic assessment	UNCERTAIN
Stage 1 evaluation priorities	- Thickness and distribution of alluvium - Presence, variety and quality of palaeo-environmental remains - Presence/significance of any archaeological remains (and in particular, whether a sealed palaeo-landsurface with Final Upper Palaeolithic evidence at the base of any alluvium)
Stage 2 evaluation priorities	Tbc in light of stage 1 evaluation results
Key reference/s	-

Zone	PQ-22b Upper Domsey Brook alluvium
- Topography/ geomorphology **- Bedrock geology**	- Narrow alluvial floodplain at the head of the valley containing the Domsey Brook - London Clay
Quaternary sediments	Fine-grained clayey silt, sometimes peaty, and often more sandy/gravelly at base
Geological interpretation	Holocene alluvium from overbank flooding mixed with slopewash from valley sides, forming since the end of the last ice age, with younger deposits spreading further up the valley sides, and potentially sealing earlier evidence of bank-side occupation
Palaeoenvironmental potential	High - likely to contain various palaeo-environmental remains, and also provides good preservational conditions for any organic archaeological remains within/below it
Palaeolithic remains	None known, but no investigations of the Domsey Brook alluvium have taken place. Larger alluvial bodies (such as associated with the Blackwater, and the lowest stretch of the Domsey Brook - PQ-1) have been shown to contain Final Upper Palaeolithic remains at their base in at least one place (P-53), so the presence of such remains cannot be ruled out.
Palaeolithic assessment	UNCERTAIN
Stage 1 evaluation priorities	- Thickness and distribution of alluvium - Presence, variety and quality of palaeo-environmental remains - Presence/significance of any archaeological remains (and in particular, whether a sealed palaeo-landsurface with Final Upper Palaeolithic evidence at the base of any alluvium)
Stage 2 evaluation priorities	Tbc in light of stage 1 evaluation results
Key reference/s	-

Zone	PQ-23 Marks Tey Hoxnian lake
- Topography/ geomorphology **- Bedrock geology**	- Undulating landscape either side of the small Roman River floodplain, mostly between c. 30m and 35m OD. - London Clay
Quaternary sediments	Wide spreads, often >10m deep, of fine silts and clays, usually organic-rich, and often with fine sandy laminations, and underlain by chalky/gravelly clay. The surface of the clay rises to the south, and the fine-grained silt/clay deposits fade out.
Geological interpretation	The deeper-lying chalky/gravelly clay is Boulder Clay laid down by the Anglian ice-sheet. The overlying fine-grained organic-rich silt/clay deposits are Hoxnian lake sediments, and detailed pollen analysis has shown that the lake persisted through the Hoxnian, having first formed late in the Anglian.
Palaeoenvironmental potential	The Hoxnian lake sediments are rich in organic remains, in particular pollen, and they have also produced mammalian fossils and mollusc remains (P-3, P-24b, P-50)
Palaeolithic remains	Despite the main body of lake sediments having formed at the base of the lake, and therefore not at a location suitable for human activity, Palaeolithic artefact finds have often been found in the area (P-24, 24a, 26, 50a). The most-promising area for Palaeolithic remains would be in the southern part of this zone, at the southern edge of the mapped spread of Hoxnian lake deposits, where Palaeolithic activity would likely occur at the lake edge, and then perhaps be preserved as the lake rose through the Hoxnian.
Palaeolithic assessment	HIGH
Stage 1 evaluation priorities	- Presence, nature and thickness/distribution of Quaternary sediments (and in particular, the presence of lake-margin sediments in the southern part of this zone) - Presence, variety and quality of palaeo-environmental remains - Presence/prevalence and significance of any archaeological remains (and in particular whether undisturbed remains are present associated with lake margin deposits in the southern part of this zone)
Stage 2 evaluation priorities	Tbc in light of stage 1 evaluation results
Key reference/s	Brown 1852; Dalton 1880: 4; Turner 1970.

Zone	PQ-24 Little Braxted
- Topography/ geomorphology **- Bedrock geology**	- East side of Blackwater, ground sloping down towards river from c. 30m to c. 15m OD - London Clay
Quaternary sediments	Sand/gravel, overlying chalky/gravelly clay, that outcrops at surface in higher eastern part of zone
Geological interpretation	Sand/gravel is attributed to Blackwater Terrace 3 in BGS mapping, probably formed as meltwater outwash at the end of the Anglian glaciation, and the chalky/gravelly clay is Anglian Boulder Clay
Palaeoenvironmental potential	None known, although unmapped Hoxnian lake margin deposits could be present, and these could contain rich and varied organic remains
Palaeolithic remains	None known from this zone, but artefact finds are common from, and on, Blackwater T3 (eg. P-77, 77a) and some finds have also been recovered from sieving T3 gravel (P-88a). This zone is an area where unmapped Hoxnian lake margin sediments could be preserved above the southeast side of buried sub-glacial channel feature that defines the likely position of the Hoxnian lake
Palaeolithic assessment	HIGH
Stage 1 evaluation priorities	Na - outside the scheme footprint
Stage 2 evaluation priorities	Na - outside the scheme footprint
Key reference/s	-

G.3. Key references for PQ zone summaries

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Appendix H.

Walk-over survey: photos

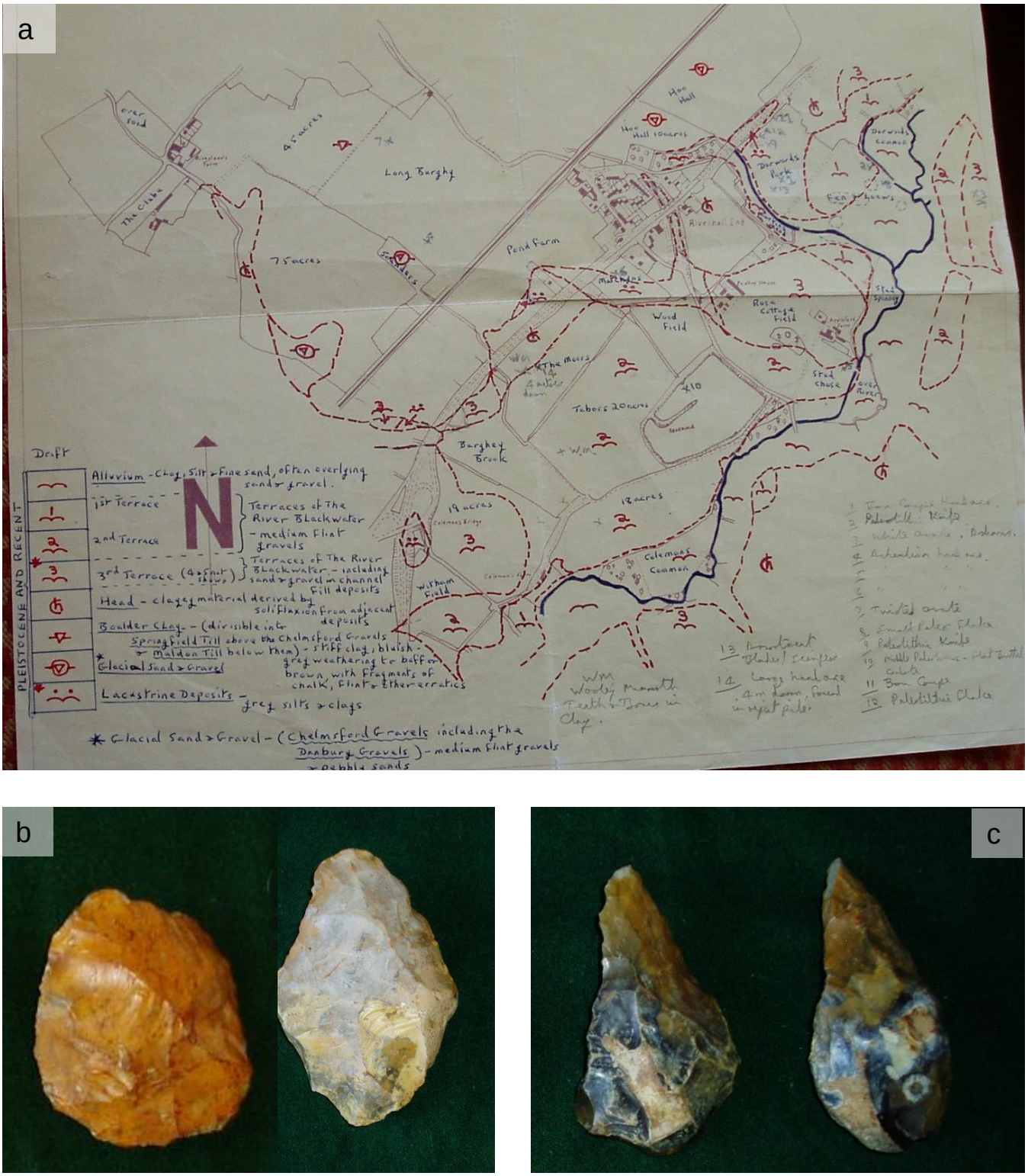

Figure H-1. Previous Palaeolithic finds from Coleman's Farm: **(a)** Simon Brice's master-map (HER MEX10366) showing find-spots since *c.*1980; **(b)** Lower Palaeolithic handaxes from field "Long Burghy", zone PQ-7 (Palaeolithic site UID P-78a); **(c)** Lower Palaeolithic handaxes from (left to right) fields "Matchyns" and "Stud Chase", zones PQ-5 and PQ-15 respectively (Palaeolithic site UIDs P-78b and P-78c).

Figure H-2. Previous Palaeolithic finds from Coleman's Farm: **(a)** Lower/Middle Palaeolithic finds from northwest corner of field "Durwards Park", zone PQ- 9 (Palaeolithic site UID P-78); **(b)** Middle Palaeolithic (*bout coupé*) handaxes from field "Durwards Park", zone PQ-9 (Palaeolithic site UIDs, left-to-right, P- 78, 77 and 77d); **(c)** ?Upper Palaeolithic finds from field "Durwards Park", zone PQ-9 (Palaeolithic site UID P-77e); **(d)** ?Upper Palaeolithic finds from general area between Coleman's Farm and Durwards Hall (left to right: end-scraper, broken piece of Long Blade debitage, broken curve-backed point; **(e)** ?Upper Palaeolithic tanged point from Rose Cottage field (zone PQ-14 (Palaeolithic site UID P-77f)

Figure H-3. Colemans Quarry, exposed deposits: **(a)** current (phase 2) extraction area, upper deposits (looking NW); **(b)** current (phase 2) extraction area, lower deposits (looking NNW); **(c)** current (phase 2) extraction area, base of gravel deposits (looking SW); **(d)** previous (phase 1) extraction area, gravel sequence (looking SE); **(e)** previous (phase 1) extraction area, floor of pit (looking E); **(f)** laminated organic-rich sediments from base of phase 1 extraction area.

Figure H-4. Flint find and mammal remains from Colemans Quarry, Witham: **(a)** Large bifacial flint implement from phase 2 gravels (P-78d) – note A4 paper sheet for scale; **(b, c)** ?mammoth teeth from phase 2 area (P-78e); **(d)** other mammalian bones from phase 2 area (?reindeer, ?horse, ?bovid); **(e)** ?mammoth/elephant tooth and vertebra from phase 2 area; **(f)** ?mammoth tooth from phase 1 area (note depositional/post-depositional abrasion).

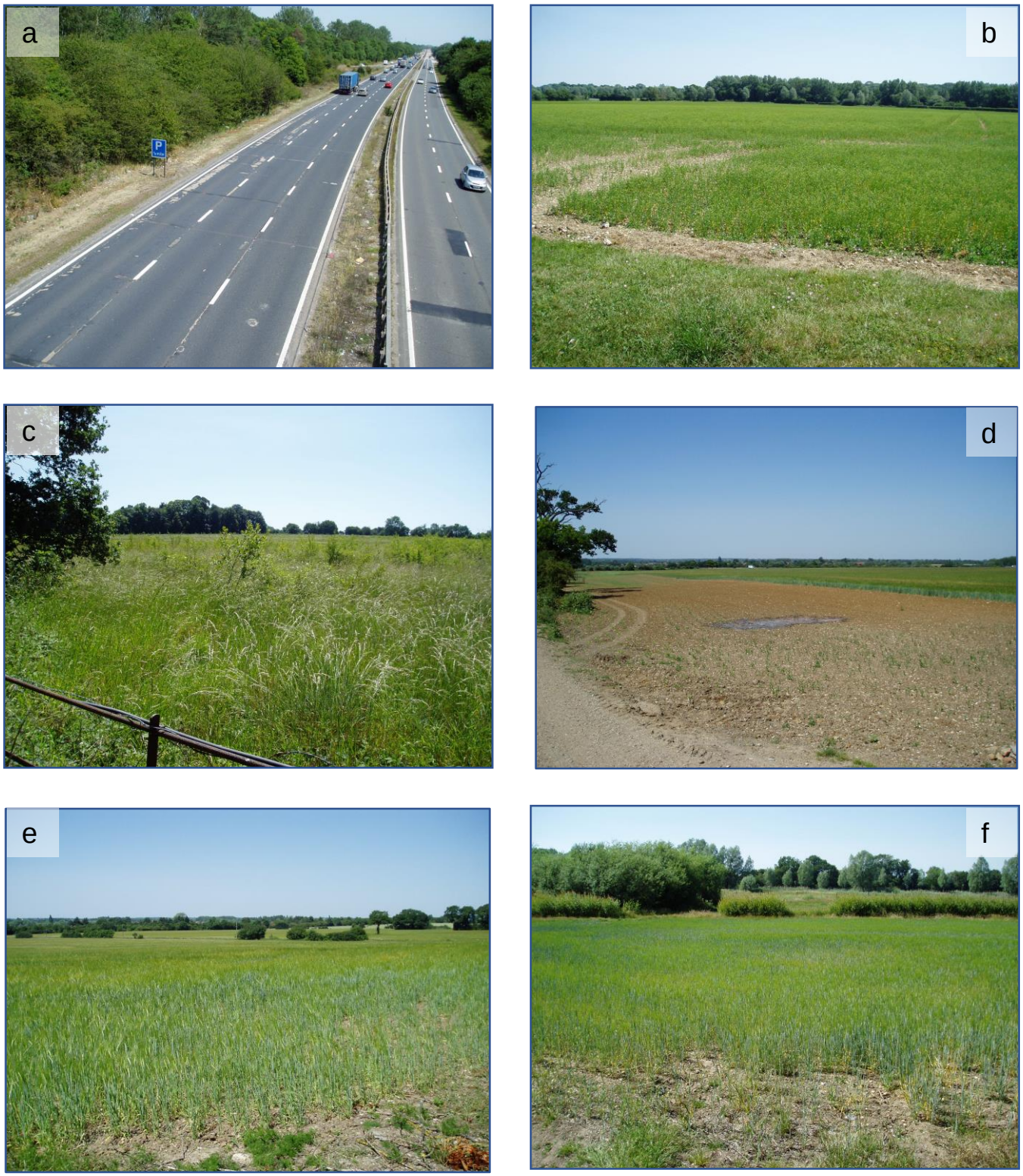

Figure H-5. General views of terrain along route options footprint between Witham and Colchester: **(a)** A12 Junction 25 (looking NE); **(b)** fields to south of Roman Road, Easthorpe (looking S); **(c)** field to northwest of Prested Hall (looking SW); **(d)** landscape towards A12 across footprint of Borrow Pit J (looking NW); **(e)** general view towards A12 across southwest end of Borrow Pit J (looking N, from Highfields Lane); **(f)** view across Blackwater valley towards Appleford Farm, Rivenhall End (looking W).