Curating the Palaeolithic: Guidance (Consultation Draft)

Rob Hosfield¹, Chris Green², Hannah Fluck³ & Rob Batchelor²

¹Department of Archaeology, University of Reading
²QUEST (Quaternary Scientific), School of Archaeology, Geography & Environmental Science, University of Reading
³Historic England

1. Executive summary

Purpose: Explaining the importance of the English Palaeolithic record, with reference to the nature and extent of geological (Pleistocene) deposits, the distribution and character of archaeological and palaeoenvironmental remains, and best practices for their effective and appropriate curation, illustrated through the use of site-specific case studies.

Scope: The English Palaeolithic (c. 1mya–11.6kya) in its Pleistocene and development context, illustrated by guidance and site-specific case studies from the Southeast, Southwest, West Midlands and the North, and East Midlands and East Anglia.

Intended audience: Curators (i.e. local authority archaeologists and those working as advisors to Planning Authorities; HER Officers); consultants; archaeological units; developers; Regional Science Advisors; Palaeolithic and Pleistocene specialists.

Level of detail: The guidance and the case studies are intended to be concise rather than exhaustive. The methodologies outlined in the guidance and the case studies are illustrative of the range of options that are available. They are not intended to be a comprehensive list of all available approaches. It is essential that contractors consult with Palaeolithic/Pleistocene specialists.
2. Table of contents

Sections

3. Why are Pleistocene and Palaeolithic remains important?
   3.1 The importance of our earliest prehistory
   3.2 Finding and understanding the evidence
4. Curating the Palaeolithic
   4.1 Palaeolithic archaeology, Scheduled Monuments and SSSIs
   4.2 National Planning Policy Framework
   4.3 Historic Environment Records (HER)
5. Pleistocene deposits – Origin, archaeological and palaeoenvironmental potential
   5.1 Palaeolithic and palaeoenvironmental potential
   5.2 River deposits
      5.2.1 River terrace formation
      5.2.2 Sand and gravel
      5.2.3 Fine-grained deposits
      5.2.4 Peat
   5.3 Windblown sands and silts
      5.3.1 Coversands
      5.3.2 Loess
      5.3.3 ‘Brickearth’
   5.4 Glacial deposits
      5.4.1 Till
      5.4.2 Glacial sand and gravel
   5.5 Slope deposits
   5.6 Raised beach deposits
   5.7 Lacustrine deposits
   5.8 Clay-with-flints
   5.9 Tufa and Travertine
   5.10 Cave, solution pipe and fissure deposits
      5.10.1 Cave deposits
      5.10.2 Solution pipe deposits
      5.10.3 Fissure deposits
   5.11 Palaeosols
5. Key stages of the Pleistocene
   6.1 The environmental evidence
   6.2 Dating the Pleistocene
7. The Palaeolithic occupation of Britain
   7.1 The British Palaeolithic record
   7.2 The Lower Palaeolithic
   7.3 The Middle Palaeolithic
   7.4 The Upper Palaeolithic
8. Assessing the importance of Pleistocene and Palaeolithic remains
9. Pre-development investigation of Pleistocene and Palaeolithic remains – Requirements and Procedures
   9.1 Overview
   9.2 Desk-Based Assessment
9.3 Field investigation
  9.3.1 Field assessment
  9.3.2 Field mitigation
9.4 Off-site/post-excavation analysis
9.5 Reporting
10. References
11. Case Studies
12. Glossary

Panels

Panel A: Key organisations engaged with Palaeolithic & Pleistocene remains
Panel B: Palaeolithic archaeology – the contributions of primary and secondary context sites
Panel C: Britain is not an island…
Panel D: Palaeolithic climates – a world apart?
Panel E: Diagnostic artefacts – a blend of technology and typology
Panel F: Palaeolithic mapping projects
Panel G: Suggested sample sizes for sediments

Figures

Figure 1: Happisburgh footprints
Figure 2: Boxgrove handaxe scatter
Figure 3: Distribution of main Pleistocene deposit types
Figure 4: Limits of British Glaciations and locations of case studies
Figure 5: River terrace schematic for the Middle and Lower Thames
Figure 6: Raised beach sequence
Figure 7: Project regions
Figure 8: Key Palaeolithic periods & Pleistocene stages
Figure 9: Distribution of Lower and Middle Palaeolithic sites and findspots
Figure 10: Distribution of ‘large’ Lower and Middle Palaeolithic sites and findspots
Figure 11: Distribution of primary context Lower and Middle Palaeolithic sites
Figure 12: Typical Lower Palaeolithic core and flake artefacts
Figure 13: Pre-MIS 12 palaeogeography of Britain
Figure 14: Typical Lower Palaeolithic handaxes
Figure 15: Britain’s fluctuating geographical status
Figure 16: Early Middle Palaeolithic artefacts
Figure 17: Middle Palaeolithic bout coupé handaxe
Figure 18: Middle Palaeolithic leaf-point
Figure 19: Typical blade-based Upper Palaeolithic artefacts
Figure 20: Schematic river floodplain and terrace landscape.
Figure 21: Project stages pro-forma, as used in the case studies

Tables

Table 1: Sources of guidance
Table 2: Approximate distribution of Pleistocene deposits in England
Table 3: Geoarchaeological and palaeoenvironmental reconstruction techniques
Table 4: Geochronological techniques
Table 5: Checklist of key questions and associated approaches and issues relevant to a DBA evaluation of Palaeolithic potential
Table 6: Commonly used field investigation techniques
Table 7: Keyword summaries of project case studies
3. Why are Pleistocene and Palaeolithic remains important?

3.1 The importance of our earliest prehistory

Pleistocene and Palaeolithic remains are the evidence that enables us to understand our earliest prehistory – how the landscape of Britain was shaped, patterns of past climate, the changing composition of animal and plant communities, what our ancestors looked like and how they lived, and where, when and how our earliest ancestors fitted into those landscapes and ecosystems. They provide us both with breathtaking glimpses into brief moments of our Palaeolithic past, such as the Happisburgh footprints (Figure 1) or the perfectly preserved remains of 15 minutes of handaxe-making (Figure 2), and with an overarching, 1 million year perspective on our shared origins. For example, ‘ice age’ animal remains have repeatedly proved to be an effective means for stimulating wider media and public interest in our Pleistocene and Palaeolithic past (e.g. https://www.bbc.co.uk/news/uk-england-cambridgeshire-45905645).

Figure 1: Happisburgh footprints (left; Ashton et al. 2014: fig. 5; photograph ©: Martin Bates; CC BY 4.0).
Figure 2: Boxgrove handaxe scatter (Roberts & Parfitt 1999: fig. 239; source: Archaeology Data Service; https://archaeologydataservice.ac.uk/advice/termsOfUseAndAccess.xhtml).

3.2 Finding and understanding the evidence

Pleistocene remains are the geological and biological deposits laid down by various agents — water, wind and ice between 2.6 million and 11,600 years ago. There is a wide range of Pleistocene geological deposits (Section 5), including river-lain gravels and sands, glacial tills, wind-blown sands and silts, and slope deposits. In some places, artefacts and/or plant and animal remains are contained in these deposits. Palaeolithic remains therefore form part of the Pleistocene record and include stone tools and the debris (flakes) produced when making them (Figure 2), and, much more rarely, artefacts of wood, bone and other organic materials, bones bearing marks of butchery, rudimentary structures and the remains of primitive humans (hominins).

Since 1990, consideration of archaeology has been a material consideration in the planning process in England and this is currently articulated in the National Planning Policy Framework (NPPF). Since 1990 there has been an increase in pre-development archaeological assessment and investigation and the discovery and documentation of Pleistocene and Palaeolithic remains has involved close cooperation among archaeologists, planners and developers. Understanding of our earliest prehistory – the Palaeolithic past – and its Pleistocene context owes a particular debt to aggregate quarrying, both now and in the past. This reflects the Pleistocene origins of commercially valuable gravels and sands, brickearths and other deposits (e.g. lacustrine clays), and the nature of the British Palaeolithic record itself (c. 950,000–11,600 years ago). In particular, much (although not all) of the Lower and Middle Palaeolithic record is in the form of artefacts and environmental evidence associated with deeply buried Pleistocene landscape fragments, rather than the near-surface remains which characterise most later archaeological periods, including the Upper Palaeolithic. Understanding of our Palaeolithic past therefore requires not only artefact finds, but also a wider appreciation of Pleistocene geological deposits and their associated palaeoenvironmental evidence. Quarrying and other large-scale projects, such as the High Speed 1 rail project, have provided us with just that perspective. However, many
developments that potentially impinge on Palaeolithic and Pleistocene remains are on a much smaller scale, therefore raising the question of how pre-development assessment and evaluations should best be conducted to accommodate a variety of circumstances.
4. Curating the Palaeolithic

For post-Palaeolithic sites, methods of investigation are well-established and widely understood by all those involved in implementing the policies set out in statutory guidelines (NPPF: DCLG 2012). This includes developers, planning consultants, county archaeologists, local authority planning and conservation officers and managers of commercial archaeological companies. However, where Palaeolithic and associated Pleistocene remains are involved, conditions of preservation are often significantly different from those affecting the post-Palaeolithic record. They present distinctive practical and interpretative challenges. For example, it is often more difficult to establish even the approximate age of the deposits; the relationships between artefacts, sediments and biological remains are often uncertain; the relative importance of re-worked and in situ remains is a matter of judgement; and from the developers point of view there is the issue of balancing the recording and sampling of extensive and varied deposits, sometimes in the absence of archaeological remains, against the commercial demands of extraction and development (White 2015).

4.1 Palaeolithic archaeology, Scheduled Monuments and SSSIs

In England archaeological sites that are considered to be of national importance can be protected as Scheduled Monuments. Where archaeological sites are designated as Scheduled Monuments additional consent is required from the government before any works can take place. However, designation of archaeological sites as Scheduled Monuments is discretionary (i.e. not all sites that are of sufficient significance to be scheduled have to be designated as such) and currently those without structures (most Palaeolithic sites) are not eligible for scheduling. Consequently, apart from those located in caves, even those Palaeolithic sites recognised as being of national, or international, importance are not Scheduled Monuments.

Some Palaeolithic sites may be within locations identified as geological Sites of Special Scientific Interest (SSSIs), e.g. Happisburgh, in which case assent will be required from Natural England for certain activities. However, it is important to note that designation as a SSSI is for the geological interest and the archaeological interest may not always be recognised within that.

4.2 National Planning Policy Framework

Like all other archaeology, Pleistocene archaeology, regardless of designation, is a material consideration within the planning system in England (also referred to as ‘development management’). This means that the impact of any proposed development upon archaeology should be considered as part of the decision a planning authority makes about whether to grant planning permission for a particular development. The framework for this is set out in the National Planning Policy Framework (NPPF). The NPPF also recognises that not all nationally important archaeological sites are designated and states that ‘non-designated heritage assets of archaeological interest, which are demonstrably of equivalent significance to scheduled monuments, should be considered subject to the policies for designated heritage assets.’ (Footnote 63, p.56). The Historic England Sites of Early Human Activity, Scheduling Selection Guide should be used as a framework for assessing the significance of
Palaeolithic archaeology to determine whether the NPPF policies for designated heritage assets are applicable.

4.3 Historic Environment Records (HER)

The NPPF states that ‘Local planning authorities should maintain or have access to a Historic Environment Record’ (NPPF 187, p.54). Historic Environment Records are the most comprehensive records of archaeological sites within a local planning authority area. However, they vary in their inclusion of Palaeolithic archaeology and indicators of potential for the occurrence of Palaeolithic archaeology (see the Worcestershire HER case study). It is, therefore, important to consider other sources, such as those identified in Table 1, when considering the Palaeolithic archaeological potential of an area.

Panel A: Key organisations engaged with Palaeolithic & Pleistocene remains

- British Geological Survey (https://www.bgs.ac.uk/);
- British Society for Geomorphology (https://www.geomorphology.org.uk/);
- GeoConservationUK Groups (previously RIGS Groups; http://wiki.geoconservationuk.org.uk/index.php?title=Main_Page);
- Geological Society (https://www.geolsoc.org.uk/; including Regional Groups);
- Geologists’ Association (https://geologistsassociation.org.uk);
- Historic England (https://historicengland.org.uk/);
- Lithic Studies Society (http://www.lithics.org/);
- Natural England (https://www.gov.uk/government/organisations/natural-england);
- Prehistoric Society (http://www.prehistoricsociety.org/);
- Quaternary Research Association (https://qra.org.uk/);

There is also a wide range of other local and regional societies (e.g. the Ussher Society; http://www.ussher.org.uk/).

<table>
<thead>
<tr>
<th>Source</th>
<th>Caveats</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADS (Archaeology Data Service; <a href="https://archaeologydataservice.ac.uk/">https://archaeologydataservice.ac.uk/</a>)</td>
<td></td>
</tr>
<tr>
<td>Ancient Human Occupation of Britain Projects (AHOB; <a href="https://ahobproject.org/">https://ahobproject.org/</a>)</td>
<td></td>
</tr>
<tr>
<td>BGS (British Geological Survey) mapping (<a href="https://www.bgs.ac.uk/products/onshore/home.html">https://www.bgs.ac.uk/products/onshore/home.html</a> &amp; <a href="https://www.bgs.ac.uk/igeology/">https://www.bgs.ac.uk/igeology/</a>)</td>
<td>May not be precise at site-based scales. Shallow deposits may not be mapped at all (e.g. less than 1m not mapped). See also the Ebbsfleet Academy case study. Can be discrepancies in the mapping and/or naming of deposits between different map sheets, especially if produced at different times.</td>
</tr>
</tbody>
</table>
### HERs

- [HERs](https://www.heritagegateway.org.uk/gateway/chr)

Inclusion of Pleistocene archaeology may be variable. Some HERs include identification of areas of archaeological potential that may include Pleistocene archaeology but many do not. See also the Worcestershire HER case study.

### Historical mapping

- Historical mapping (accessible on-line through EDINA Digimap: [https://digimap.edina.ac.uk/](https://digimap.edina.ac.uk/); and National Library of Scotland: [https://maps.nls.uk/](https://maps.nls.uk/))

Can show old quarries but not necessarily indicative of extraction boundaries.

### Journals:

- *Boreas*
- *Journal of Quaternary Science*
- *Lithics*
- *Proceedings of the Geologists’ Association*
- *Proceedings of the Prehistoric Society*
- *Quaternary International*
- *Quaternary Newsletter*
- *Quaternary Science Reviews*

Plus other national, international and local journals.

### Monographs:

- *Digging Up the Ice Age* (Buteux et al. 2009)
- *Neanderthals Among Mammoths: Excavations at Lynford Quarry, Norfolk* (Boismier et al 2012; [https://archaeologydataservice.ac.uk/archives/view/lynford_he_2016/contents.cfm](https://archaeologydataservice.ac.uk/archives/view/lynford_he_2016/contents.cfm))
- *Quaternary of the Thames* (Bridgland 1994)
- *Quaternary of the Trent* (Bridgland et al. 2014)
- *The Pleistocene History of the Middle Thames Valley* (Gibbard 1985)
- *The Pleistocene History of the Lower Thames Valley* (Gibbard 1994)
- *Thames Through Time: The Archaeology of the Gravel Terraces of the Upper and Middle Thames: Early*

Accessibility in some cases.
<table>
<thead>
<tr>
<th>Source</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ordnance Survey Mapping</td>
<td>(<a href="https://www.ordnancesurvey.co.uk/">https://www.ordnancesurvey.co.uk/</a>)</td>
</tr>
<tr>
<td>Palaeolithic &amp; Mesolithic Lithic Artefact Database (PaMELA;</td>
<td>(<a href="https://archaeologydataservice.ac.uk/archives/view/pamel_2014/overview.cfm">https://archaeologydataservice.ac.uk/archives/view/pamel_2014/overview.cfm</a>)</td>
</tr>
<tr>
<td>QRA (Quaternary Research Association) Field Guides</td>
<td>(<a href="https://www.qra.org.uk/field-guides/">https://www.qra.org.uk/field-guides/</a>) Accessibility</td>
</tr>
<tr>
<td>Regional Research Frameworks</td>
<td>(<a href="https://www.algao.org.uk/england/research_frameworks/">https://www.algao.org.uk/england/research_frameworks/</a>)</td>
</tr>
<tr>
<td>Roe (1968, 1981;</td>
<td>(<a href="https://archaeologydataservice.ac.uk/library/browse/issue.xhtml?recordId=1075404&amp;recordType=MonographSeries">https://archaeologydataservice.ac.uk/library/browse/issue.xhtml?recordId=1075404&amp;recordType=MonographSeries</a>)</td>
</tr>
<tr>
<td>TERPS (The English Rivers Palaeolithic Survey;</td>
<td>(<a href="https://archaeologydataservice.ac.uk/archives/view/terps_eh_2009/">https://archaeologydataservice.ac.uk/archives/view/terps_eh_2009/</a>)</td>
</tr>
<tr>
<td>Upper Palaeolithic Site Database (based on Wymer &amp; Bonsall 1977;</td>
<td>(<a href="https://archaeologydataservice.ac.uk/archives/view/upalgaz_na_2011/index.cfm">https://archaeologydataservice.ac.uk/archives/view/upalgaz_na_2011/index.cfm</a>)</td>
</tr>
</tbody>
</table>

Table 1: Sources of selected guidance.
5. Pleistocene deposits – Origin, archaeological and palaeoenvironmental potential

5.1 Palaeolithic and palaeoenvironmental potential (including importance of deposits in the absence of archaeological remains)

Pleistocene deposits are geological deposits laid down during the Pleistocene epoch. Geologists tend to regard them as distinct from 'bedrock' and use the term 'superficial deposit' when describing them. The terms ‘drift deposit’ or simply ‘drift’ were also widely used in the past and are still found occasionally in the modern literature.

Geological nomenclature can be confusing. Deposits of the same age, in different parts of the country, sometimes even in the same river basin, may have different names. In addition, as the understanding of Quaternary stratigraphy has evolved, new interpretations have led to the renaming of deposits. However, old names do not go away and may be encountered in key reference sources. This is another reason why expert advice is key when curating the Palaeolithic resource.

Pleistocene deposits contain much of the evidence for the Palaeolithic occupation of Britain, mostly in the form of stone tools. Of equal importance is the preservation of palaeoenvironmental remains, including pollen, seeds and other parts of plants, bones and teeth of animals, insects, snails and various microscopic plant and animal taxa. This biological material and the deposits themselves provide the evidence used to reconstruct the habitats in which the Palaeolithic occupation of Britain occurred.

In dynamic environments such as river floodplains, glaciated terrain, caves and marine beaches, individual deposits may represent deposition in spatially limited settings, such as floodplain ponds; and/or during short periods of time, sometimes as short as a single flood event or a single tidal cycle. As a result Pleistocene deposits may be locally variable with different types of deposit intimately juxtaposed in their stratigraphic relationships and in their spatial distribution. A Pleistocene specialist should be involved in the interpretation of such deposits.

The main types of Pleistocene deposit are described briefly in the following paragraphs with comments on their Palaeolithic and palaeoenvironmental potential. Their approximate distribution in England can be seen in Table 2 & Figure 3. This section and Table 2 should be read bearing in mind the factors affecting the overall distribution of Palaeolithic and palaeoenvironmental remains in England. Of particular importance is the widespread destructive impact of glaciation on all remains, including pre-glacial Pleistocene deposits in Midland and northern England and the scarcity of evidence for Palaeolithic occupation north and west of a line approximately from the Humber to the Severn (Figure 4).
Figure 3: Distribution of main Pleistocene deposit types. Reproduced, with modifications (selected superficial Pleistocene deposits removed), with the permission of the British Geological Survey ©UKRI. All Rights Reserved.
5.2 River deposits
Relevant project case studies: Happisburgh; Ebbsfleet Academy; Ebbsfleet Elephant; Southall Gas Works; Nightingale Estate/Ponds Farm; The Trent; Dunbridge; Chard Junction

5.2.1 River terrace formation
In Britain as a result of tectonic uplift during the Pleistocene, rivers have cut down into the landscape to form the present river valleys. This down-cutting was episodic and remnants of
former valley floors are preserved in some places on the valley sides. These are River Terraces. They are often underlain by river terrace deposits in which gravel and sand are major components (Figures 5 & 20). It is important to understand that in some places drainage patterns have changed in the past and river deposits can be found in areas where rivers no longer flow (e.g. the River Thames used to flow through St. Albans and discharge through Norfolk).

Figure 5: River terrace schematic for the Middle and Lower Thames (Bridgland et al. 2006: fig. 2).

5.2.2 Sand and gravel
Gravel is transported and deposited by energetic rivers. High energy conditions are associated with steep channel gradients and/or large discharge volumes. Today in Britain such rivers are active in upland and piedmont areas but in the colder parts of the Pleistocene, climatic conditions in lowland Britain transformed lowland rivers so that the most common river terrace deposits associated with the cold parts of the Pleistocene in lowland as in upland areas are sand and gravel. Fine-grained deposits are much less common. In many gravel deposits, Palaeolithic and palaeoenvironmental remains are absent or rare, occurring only as isolated and worn or broken specimens. They are also more likely to represent moved or reworked material. Where they do occur there is a noticeable tendency for such remains to be found near the base of the deposit.

5.2.3 Fine-grained deposits
Clay and silt are evidence of deposition in slow-moving or standing water. In river terrace deposits they are often preserved as the infill of floodplain ponds or ancient river channels (palaeochannels), sometimes recognisable as such in cross-section occurring within, below or cut into the top of the more widely preserved gravel and sand. Favourable conditions for the preservation of fine-grained deposits are associated with locations remote from more active channels, or with the warmer parts of the Pleistocene. Fine-grained deposits have the
greatest potential for preserving Palaeolithic remains in primary context, former land-surfaces, and palaeoenvironmental remains in general.

5.2.4 Peat
Peat accumulates on terrestrial surfaces where particular hydrological conditions exist. Peat may occur as a river terrace deposit, often in association with fine-grained deposits. It may consist exclusively of plant remains or may include some mineral sediment, usually an indication that the site of peat accumulation was subject to inundation by sediment-laden floodwater. Peat is a very important potential source of palaeoenvironmental remains. Whilst referred to here within the context of floodplain deposits, it is important to note that peat may also form in other settings (e.g. lakes; section 5.7).

5.3 Windblown sands and silts

5.3.1 Coversands (described as Blown Sand in Figure 3)
Coversands are windblown sand deposited in cold (periglacial) climatic conditions. In Britain they are localised in SW Lancashire and in eastern England in an area between the Breckland in East Anglia and the Vale of York. Remnants of dune forms may sometimes be recognisable but the surface of the sand is usually featureless. Deposition has been dated to the last cold phase of the Devensian Lateglacial (Figure 8). There is potential for the preservation of Upper Palaeolithic remains within or beneath coversands.

5.3.2 Loess
Loess is windblown dust (mainly silt). In Britain substantial deposits of loess (>1.0m thick) are recorded in only a few places in south-east and southern England (Essex, Kent, Sussex). There is however a windblown dust component in near-surface deposits and soils in many parts of England, notably but not exclusively on the Chalk and other limestone bedrocks. Most loess deposits are Devensian in age (Figure 8) but older deposits do exist. Loess deposits may incorporate or bury Palaeolithic and/or palaeoenvironmental remains.

5.3.3 ‘Brickearth’
Relevant project case studies: Southall Gasworks
The term ‘brickearth’ was originally applied in the 19th century to fine-grained, largely stoneless superficial geological deposits used for brickmaking. Deposits described as ‘brickearth’ usually incorporate a silt-rich component of possible wind-blown origin (loess; Section 5.3.2) but may also include lenses and seams of sand and occasionally gravel. Although the term ‘brickearth’ has often been used in the geological literature, deposits so named have probably not all been formed in the same way and there is no generally accepted explanation to account for their formation. ‘Brickearth’ has been recorded in various topographical and stratigraphic situations but probably most widely in the form of extensive outcrops on river terrace remnants overlying other river terrace deposits. Palaeolithic and palaeoenvironmental remains have been recorded in or beneath deposits described as ‘brickearth’.

5.4 Glacial deposits
Palaeolithic or palaeoenvironmental remains are rare in glacial deposits and invariably more or less distant from their place of origin. However, glacial deposits typically mantle pre-
existing landforms and deposits and may therefore bury landscapes and deposits that include such remains.

5.4.1 Till
Often called ‘boulder clay’ in the earlier literature, till is a geological deposit originating as material caught up in glacial ice and subsequently deposited when the ice melts. Tills are variable mixtures of fine-grained and stony material. Tills of more recent glacial episodes, especially the Devensian, may be locally shaped into topographically distinctive landforms, but tills of earlier glaciations generally survive as dissected and topographically featureless remnants.

5.4.2 Glacial sand and gravel
Sediment-laden meltwater from a glacier may deposit sand and gravel beneath or around the margins of the ice. When the ice melts these deposits form distinctive topographic features marking the ice’s former extent. Meltwater also feeds into river systems beyond the ice front and glacially-derived sediment may be a significant component in river terrace deposits downstream from the glaciated area.

5.5 Slope deposits (Head)
Relevant project case studies: Valdoe

Near-surface geological material on valley-side slopes is always prone to downslope displacement by processes of creep and wash but in cold (periglacial) climates a thicker layer may be displaced by the process of solifluction. The resulting slope deposits, often called 'head' are highly variable in character, depending on the nature of the upslope source area. Both palaeoenvironmental and Palaeolithic remains may be among the material displaced downslope and slope deposits may bury landscapes that include palaeoenvironmental or Palaeolithic remains.

5.6 Raised beach deposits
Relevant project case studies: Valdoe; West Sussex Coastal Plain

As a result of tectonic uplift during the Pleistocene, raised shoreline features are present in many places around the coast of England, sometimes including beach deposits (Figure 6). These deposits include shingle, sand and silt, any of which may incorporate palaeoenvironmental or Palaeolithic remains. Fine-grained deposits have the greatest potential for preserving Palaeolithic remains in primary context, former beach surfaces, and palaeoenvironmental remains in general.
5.7 Lacustrine (lake) deposits

Relevant project case studies: Ebbsfleet Elephant

Lakes vary greatly in size and in the length of time during which they exist, ranging from regional ice-dammed lakes to floodplain ponds. This affects significantly the extent and stratigraphic significance of lake deposits. These are typically fine-grained, reflecting deposition from suspension in still or slow-moving water. Lake deposits may display rhythmic bedding resulting from seasonal variations in sediment input. Annual layers produced in this way are termed varves. They may also incorporate Peat (Section 5.2.4). Coarser sediment may be present locally or periodically where or when faster-moving river water enters a lake. Lake deposits are an important potential source of palaeoenvironmental remains, and lake margins, due to their resource-rich nature have a significant potential for the preservation of Palaeolithic remains.

5.8 Clay-with-flints

Clay-with-flints sensu stricto consists of the insoluble residue of the chalk, mainly represented by broken but unworn flint, mixed with reddish or yellowish clay representing the remains of formerly overlying sediments. This deposit is widely present on the Chalk in the south of England and may locally be overlain by or pass laterally into deposits, termed Clay-with-flints sensu lato, which include sand, water-worn pebbles and, less commonly, blocks of sarsen sandstone. There are no records of palaeoenvironmental remains in the Clay-with-flints but its presence, particularly on level summit areas identifies terrains with long, relatively undisturbed histories. As such, there is potential for evidence of Palaeolithic occupation to be preserved on or in the upper part of this deposit.

5.9 Tufa and Travertine

Tufa and travertine are names given to sedimentary deposits formed by precipitation of calcium carbonate. A distinction is sometimes made between tufa as a less dense, more porous and friable material and travertine as denser and less porous. These deposits form where lime-rich water evaporates in subaerial locations such as spring heads, seeps, and river and lake margins. Where deposition continues for long periods it can form thick and extensive sheets, draping the local topography and enveloping organic material to become a rich source of palaeoenvironmental, and potentially Palaeolithic, evidence. Dates and palaeoclimatic data can also be obtained from tufa and travertine. Where tufa is subject to erosion, tufa sands may be present in associated sediment sequences.
5.10 Cave, solution pipe and fissure deposits
Relevant project case studies: Caves

These are all deposits that result from the fall, collapse or inflow of material into voids in bedrock. They are mostly but not exclusively encountered on limestones.

5.10.1 Cave deposits
Cave deposits include coarse rubbles resulting from the collapse of bedrock within the cave, water-laid deposits representing both flowing and standing water, deposits accumulating as the result of material falling into the cave through openings in the cave roof and calcite deposits precipitated chemically to create a wide variety of forms collectively termed speleothems, of which stalagmites and stalactites are examples. These deposits often occur in complex stratigraphic arrangements reflecting episodic histories of deposition and erosion, and the irregular spaces that they occupy. Dates and palaeoclimatic data can be obtained from speleothems. Palaeoenvironmental remains are often preserved in cave deposits and evidence of Palaeolithic occupation may be present, including soot deposits.

5.10.2 Solution pipe deposits
Most solution pipes are initiated in limestone bedrock beneath a cover of other sedimentary rocks. These overlying rocks generally form much of the infill of the pipe and in large pipes the bedding of these rocks can be traced vertically downward into the pipe. The loss of sediment into the pipe may cause localised faulting around the pipe in the overlying sediments and pipes may contain rubbly deposits resulting from collapse into voids in the pipe infill. Closed ground depressions created by subsidence over pipes can become sites of localised deposition with the resulting deposits themselves becoming susceptible to subsidence and forming part of the pipe infill. These deposits may incorporate palaeoenvironmental material and may preserve land surfaces with evidence of Palaeolithic occupation.

5.10.3 Fissure and graben deposits
Relevant project case-studies: Glaston

Fissures and grabens are depressions at the ground surface between masses of bedrock. Fissures are a common feature produced by solution on limestones. Less commonly such depressions are the result of lateral stresses displacing coherent rock types to create widened joints (fissures) or allow downfaulting of masses of bedrock (grabens). As voids open at the ground surface they can receive and accumulate material blown, falling or washed in from above. This material may include palaeoenvironmental remains, and there is the possibility that it may include Palaeolithic material.

5.11 Palaeosols
Palaeosols are old soils buried beneath later sediments. Their structure, fabric and fossil content (e.g. pollen, phytoliths) can provide evidence about the environments in which they formed. They mark the position of former land-surfaces which can potentially retain evidence of Palaeolithic occupation.
<table>
<thead>
<tr>
<th>Type of deposit</th>
<th>Project Regions&lt;sup&gt;1&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>West Midlands &amp; North</td>
</tr>
<tr>
<td>Raised Beach</td>
<td>y</td>
</tr>
<tr>
<td>Glacial Till</td>
<td>yy</td>
</tr>
<tr>
<td>Loess</td>
<td>y</td>
</tr>
<tr>
<td>Peat</td>
<td>y</td>
</tr>
<tr>
<td>Coversand</td>
<td>y</td>
</tr>
<tr>
<td>Slope deposits (Head)</td>
<td>y</td>
</tr>
<tr>
<td>Brickearth</td>
<td>y</td>
</tr>
<tr>
<td>River deposits</td>
<td>yy</td>
</tr>
<tr>
<td>Lacustrine deposits</td>
<td>y</td>
</tr>
<tr>
<td>Clay with flints</td>
<td>y</td>
</tr>
<tr>
<td>Cave/rockshelter deposits &amp; fissures/solution features</td>
<td>y</td>
</tr>
</tbody>
</table>

Table 2: Approximate distribution of Pleistocene deposits in England (indicative presence/absence by region, intended as a guide only; y: present; yy: common). <sup>1</sup>See Figure 7 for the borders of the four project regions.
Figure 7: Project regions (see also Table 2).
6. Key stages of the Pleistocene
To establish the significance of Palaeolithic and palaeoenvironmental remains that come to light during site investigations we need to understand the history of environmental change during the Pleistocene. There are two separate but related strands that can be explored: (1) the evidence for environmental conditions (Section 6.1) and (2) the opportunities for dating that evidence (Section 6.2).

To provide some context, the Palaeolithic occurs in the geological epoch known as the Pleistocene which is split into Early (2.588 to 0.780 mya), Middle (0.780 to 0.128 mya) and Late (0.128 to 0.011 mya) sub-divisions. It has been further divided into a number of stages known as Oxygen Isotope Stages (OIS) or Marine Oxygen Isotope Stages (MIS), that are linked to broad global fluctuations in climate. Some of these stages have traditional names, which are summarised in Figure 8.
Figure 8: Key Palaeolithic periods & Pleistocene stages, with Marine Oxygen Isotope Stage (MIS) numbers and commonly used Stage names. Intervals of absence, hominins & technologies are based on current knowledge of the British Palaeolithic and may change as new finds come to light. Spans of relevant dating techniques are based on latest Historic England guidance (Scientific Dating of Pleistocene Sites: Guidelines for Best Practice; Consultation Draft). Specific case-study timeframes are approximate, see individual case studies for chronological details.
6.1 The environmental evidence

The Pleistocene deposits described in Section 5 provide an important indication of the landscape setting in which they were deposited — such as meandering river, braided river, lake, pond, glacier and marine beach. Where the remains of plants or animals are present, their known habitat preferences provide an indication of environmental and climatic conditions when they were alive.

Recording and interpreting the palaeoenvironmental evidence is important even when there are no associated archaeological remains. This is well demonstrated in the Nightingale Estate/Ponds Farm case study. The more we know about past environmental conditions, the easier it becomes to recognise those that favoured the Palaeolithic occupation of Britain.

Plant remains are the key to past patterns of vegetation which in turn are to a significant extent a response to climate. Pollen can provide information about both local and regional vegetation. Plant macrofossils are a more reliable indication of local conditions.

The habitat preferences of terrestrial animals such as mammals, reptiles, insects and land snails can provide information about climatic conditions including temperature, precipitation and seasonality. Closely related to climatic conditions and also a significant aspect of habitat preference is the vegetation type normally occupied by animals — such as broad-leaf woodland, coniferous woodland, grassland and marshland.

The habitat preferences of aquatic plants and animals such as fish, amphibians, snails, ostracods, diatoms and foraminifera (Table 3) provide similar information about climatic conditions but also information about the water body that they occupied — such as standing or running water, intertidal or subtidal, water depth, bottom conditions and vegetation.

The larger the number of different plants and animals represented in a deposit, the more reliable the interpretation of the environmental conditions can be. This potential has been exploited using the habitat preferences of insects in Mutual Climatic Range (MCR) calculations to determine mean summer temperature maxima and winter minima experienced by the insect assemblage.

Further information about the various techniques used for palaeoenvironmental reconstruction is detailed in Table 3, and in the Historic England Geoarchaeology and Environmental Archaeology guidance.
<table>
<thead>
<tr>
<th>Evidence</th>
<th>Information it gives us</th>
<th>Where can it be used?</th>
<th>Where can I find out more?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Geoarchaeology (analysis of the sediments)</strong></td>
<td></td>
<td></td>
<td>Historic England Geoarchaeology guidance</td>
</tr>
<tr>
<td>Sediment descriptions</td>
<td>Description of the sedimentary sequences provides important, primary information on the nature of the depositional environment through time. For example, sands and gravels indicate deposition with a high-energy fluvial environment, such as a braided river system, during cold climatic conditions. Fine-grained mineral sediments, such as silt or clay indicate deposition in a low-energy environment, such as a lake, pond or slowly moving river. Soil and peat formation indicate the formation of semi-terrestrial or fully terrestrial conditions resulting in the colonisation of vegetation adapted to the specific local conditions.</td>
<td>All environments</td>
<td>Historic England Geoarchaeology guidance</td>
</tr>
<tr>
<td>Deposit modelling</td>
<td>The combination of sedimentary sequences from multiple sites can enable deposit modelling to be carried out. This technique can depict the likely arrangement of subsurface deposits from the creation of transects, contoured maps and/or 3D-models. This can be used to: (1) help understand the former landscapes and environmental changes that took place across the site and its surroundings, and (2) identify the most likely locations for Palaeolithic archaeology and/or palaeoenvironmental evidence.</td>
<td>All environments</td>
<td>Historic England Deposit Modelling guidance, including Bytham case study (Howard et al.) Relevant case study: Southall Gasworks</td>
</tr>
<tr>
<td>Technique</td>
<td>Description</td>
<td>Environment</td>
<td>Guide</td>
</tr>
<tr>
<td>----------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>------------------------------</td>
<td>--------------------------------------------</td>
</tr>
<tr>
<td>Micromorphology</td>
<td>This is an established technique that can provide information about sediment formation on a microscopic level. The identification of sediment forming processes, not visible to the naked eye, can provide important cultural and environmental information at a high resolution, such as the identification of depositional events/processes (e.g. palaeosols) and presence of micro-artefacts.</td>
<td>All environments</td>
<td>Historic England Geoarchaeology guidance</td>
</tr>
<tr>
<td>Physical properties</td>
<td>Various tests can be undertaken to characterise the physical properties of individual sedimentary units. These can include organic matter and calcium carbonate content, particle size and shape analysis, clast lithology, magnetic susceptibility, peat humification and geochemical analysis. Such analyses can help to characterise the origin of the material (e.g. the bedrock material), the mode of deposition (e.g. fluvial, wind-blown) and any post-depositional processes (e.g. soil development, burning).</td>
<td>All environments</td>
<td></td>
</tr>
<tr>
<td>Archaeobotany/Palaeobotany (analysis of plant remains)</td>
<td>The analysis of pollen grains and spores (palynology) is a widely used technique that can provide valuable information on vegetation composition, structure and succession, plant migration, climate change, potential human modification of the natural vegetation cover and diet. Best preserved in fine-grained waterlogged deposits. Does not preserve well in calcareous and/or coarse-grained sediment.</td>
<td></td>
<td>Historic England Environmental Archaeology guidance</td>
</tr>
<tr>
<td><strong>Phytoliths</strong></td>
<td>Phytoliths are small (5-50µm) opaline silica bodies produced by plant cells from silica and water. Herbs, including grasses, and woody taxa phytoliths can be differentiated. Unlike other techniques, specific parts of the plants can be identified, such as stems, leaves or husks. They are often preserved where other microfossils are commonly absent, including dry, alkaline and aerobic conditions.</td>
<td>All sediments</td>
<td></td>
</tr>
<tr>
<td><strong>Diatoms</strong></td>
<td>Diatoms are unicellular algae, with different species occupying the bottom of, or floating within, water bodies (e.g. oceans, lakes, ponds, rivers, salt marshes, ditches), and living in soil and on trees. They are valuable because species are indicative of a wide variety of environmental conditions (e.g. marine, brackish or freshwater) and changes in temperature, salinity, pH, oxygen and mineral content.</td>
<td>Fine-grained deposits</td>
<td></td>
</tr>
<tr>
<td><strong>Plant remains</strong></td>
<td>Seeds and other plant components (e.g. stems, leaves, buds) preserved in either a waterlogged, charred or mineralised state may provide valuable information on vegetation history, climate change and diet. Plant remains can also be suitable for radiocarbon dating.</td>
<td>Wet to waterlogged sediment (uncharred); all sediments (charred)</td>
<td></td>
</tr>
<tr>
<td><strong>Waterlogged wood and charcoal</strong></td>
<td>Wood preserved by anaerobic, waterlogged conditions or burning (charcoal) can provide primary data on woodland composition, and hence vegetation history, fire, and material culture (wooden artefacts) and local environmental conditions.</td>
<td>Wet to waterlogged sediment (uncharred); all sediments (charcoal)</td>
<td></td>
</tr>
</tbody>
</table>

**Zooarchaeology (analysis of animal remains)**
<table>
<thead>
<tr>
<th><strong>Insects</strong></th>
<th>Insects can provide valuable information on regional and local environmental conditions, human and animal diet. Insects also have the potential to provide quantitative terrestrial palaeoclimatic records using the Mutual Climatic Range (MCR) method, based upon the modern climatic ranges of selected species in the fossil record.</th>
<th><strong>All sediments</strong></th>
<th><a href="https://www.historicengland.org.uk/environmental/archaeology/">Historic England Environmental Archaeology guidance</a></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mollusca</strong></td>
<td>Mollusca are preserved on land (e.g. soil, mires), and in freshwater (e.g. lakes, rivers), brackish water (e.g. high salt marsh) and marine (e.g. estuaries) sediments where there is an adequate amount of calcium carbonate. They have the potential to provide palaeoenvironmental reconstructions, which are dependent on recording species with particular climatic or habitat ranges.</td>
<td><strong>Calcereous sediments</strong></td>
<td>---</td>
</tr>
<tr>
<td><strong>Ostracoda</strong></td>
<td>Ostracods (Ostracoda) are aquatic invertebrates, with species occupying the bottom of, or floating within the water body. They are highly sensitive to changes in salinity, as well as rainfall, temperature and alkalinity.</td>
<td><strong>Waterlain deposits</strong></td>
<td>---</td>
</tr>
<tr>
<td><strong>Foraminifera</strong></td>
<td>Foraminifera are organisms found in saline habitats from salt marsh to deep oceans. They are good indicators of changes in water depth, salinity and climate.</td>
<td><strong>Brackish and marine sediments</strong></td>
<td>---</td>
</tr>
</tbody>
</table>
Vertebrates, animals with backbones, are divided into five classes: mammals, birds, reptiles, amphibians, and fish. Bones and teeth are the most commonly preserved body parts, and on the majority of sites these tend to be dominated by mammalian skeletal elements. Studies of vertebrate remains allow a range of insights into human-animal relationships including palaeoenvironmental reconstruction and diet, and Pleistocene stratigraphy and relative dating.

Best preserved in calcareous sediment but found in a wide range of other sediment types

**NB:** This table is not an exhaustive list of available techniques and the information they can provide, but documents those most frequently used within / associated with the Palaeolithic period.

<table>
<thead>
<tr>
<th>Method</th>
<th>Summary</th>
<th>Materials</th>
<th>Further information</th>
</tr>
</thead>
</table>
| Radiocarbon     | Radiocarbon (C14) dating technique can be carried out on a wide-range of organic materials including: wood, charcoal, seeds, insects, bone/teeth, pollen, Ostracoda, Foraminifera, Mollusca, pottery, peat and organic-sediment, and can be applied to materials up to 50,000 years. | Organic remains / sediments | Historic England Scientific Dating team  
<pre><code>                    |                                                                         |                          | Historic England Scientific Dating of Pleistocene Sites guidance |
</code></pre>
<p>| Luminescence    | Optically Stimulated                                                    | Mineral-rich             |                                                                                     |</p>
<table>
<thead>
<tr>
<th>dating</th>
<th>Luminescence (OSL) and Thermo Stimulated Luminescence (TL) date the last time sediments were exposed to sunlight or heat, which zeros the luminescence signal. It is a technique most often used on mineral-rich sediments and artefacts (e.g. struck flint) and can be applied over the last 500,000 years (depending on the source geology).</th>
<th>sediments (OSL) and Struck flints (TL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uranium series</td>
<td>Uranium (U) series can be used to provide ages for a range of different materials, and can be applied to materials over the last ca. 450,000 years.</td>
<td>Carbonates, Molluscs, bone and peat</td>
</tr>
<tr>
<td><strong>Amino Acid Racemisation</strong></td>
<td>This technique measures the extent of amino acid racemisation in biological materials as an estimate of age over the last ca. 400,000 years</td>
<td>Biological material (especially Molluscs)</td>
</tr>
<tr>
<td>Electron Spin Resonance</td>
<td>Electron Spin Resonance (ESR) detects the presence of electron charges trapped in biological and minerogenic material. The intensity of the ESR signal is a measure of the accumulated dose and can be used as an age estimate.</td>
<td>Carbonates and burnt flint</td>
</tr>
<tr>
<td>Biostratigraphy</td>
<td>A relative dating</td>
<td>Biological remains</td>
</tr>
</tbody>
</table>
Technique based around species' distributions and evolution, as expressed through the first and last appearance dates of specific taxa. A particularly good example of this technique being applied is the 'Vole Clock', which tracks key changes in the dentition of Pleistocene water voles.

| Tephrochronology | The use of these volcanic ash layers (tephras) to determine the age of associated sediments. Dating is either by comparison with previously recorded eruptions, or through direct dating of the tephra, or associated material. | Tephra in stratified organic or inorganic sediments |
| Palaeomagnetism | The method exploits past changes in the earth's magnetic field. Magnetic signals can be recorded in igneous rocks, heated artefacts or sediments forming in marine or lake environments. | Igneous rocks, heated artefacts and/or marine/lake sediments. |
| Age-depth modelling | Statistical calibration software can be used to combine multiple dates with stratigraphic information to create continuous chronologies for sequences, thus enabling age | On all dating methods |
estimates for changes recorded in parts of the sedimentary or palaeoecological record that cannot be dated directly.

Table 4: Geochronological techniques (dating methods).

Secondly there are stratigraphic methods which rely on an understanding of how the physical landscape evolved in the Pleistocene or on a knowledge of the stratigraphic range of individual species or combinations of species (Table 4). These methods can be used to construct relative chronologies.

Some of the most robust relative chronologies have been inferred from river terrace and raised beach sequences (Figures 5 & 6). Such chronologies are based on the understanding that the British landmass has been subject to tectonic uplift throughout the Pleistocene and therefore in river terrace and raised beach sequences higher elements are generally older. There are complications in the more northerly parts of Britain associated with glaciation and the effects of isostatic depression and rebound.

The relative age and age range of deposits can also be inferred from the presence, or less reliably the absence, of animal and plant species with known age ranges (e.g. the presence of hippopotamus in MIS 5e / the Ipswichian Interglacial), or with a known stratigraphic level for their first appearance in the Pleistocene record or for their last appearance in the record.

Palaeolithic technology, i.e. the characteristics of stone tools and the techniques used to prepare them can also be used to identify major time periods in the Pleistocene (Section 7 & Figure 8).
7. The Palaeolithic occupation of Britain

7.1 The British Palaeolithic Record
The majority of British Palaeolithic sites and artefact findspots are concentrated in the south-east and East Anglia (Figure 9). Many of these sites and findspots are found in the deposits of extant river valleys (e.g. the Thames) or in the deposits of now-extinct rivers (e.g. the Bytham and the Solent). However sites and findspots are also found in other landscape settings (e.g. uplands and plateaux), and are found in smaller numbers in the south-west, the midlands and the north. An important question concerns the extent to which the smaller site and artefact records in the midlands and the north are a genuine reflection of the distribution of Palaeolithic hominins rather than a by-product of the destructive effects of glaciers (Figure 4) and/or geographical bias in archaeological research. It is also important to note that because of the paucity of evidence from these areas even relatively small occurrences of Palaeolithic remains may be of considerable importance.
Figure 9: Distribution of Lower and Middle Palaeolithic sites and findspots, highlighting their concentration in the south-east and their spatial association with Pleistocene gravel and sand deposits. Site data derived from the English Rivers Palaeolithic Survey (TERPS: Wymer 1999; Mepham 2009; with later additions by RH). Pleistocene sands and gravels data derived from the British Geological Survey (1:625,000 superficial geology mapping).

The majority of Palaeolithic sites and findspots are relatively small in terms of numbers of artefacts (Figure 10) and/or have been re-worked from their primary context (Figure 11 & Panel B). Long-lasting interventions in a development context (e.g. as at Lynford Quarry or the Ebbsfleet Elephant site) are therefore rare occurrences. However, it is important to recognise the value of both primary and secondary context Palaeolithic archaeology (Panel B).
Figure 10: Distribution of 'large' Lower and Middle Palaeolithic sites and findspots. Site data derived from the English Rivers Palaeolithic Survey (TERPS: Wymer 1999; Mepham 2009; with later additions by Hosfield). Pleistocene sands and gravels data derived from the British Geological Survey (1:625,000 superficial geology mapping). 'Large' defined by 100+ cores, or 100+ Levallois artefacts, or 250+ handaxes, or 250+ retouched flakes, or 500+ flakes, or some combination thereof.
Figure 11: Distribution of primary context Lower and Middle Palaeolithic sites. Site data derived from the English Rivers Palaeolithic Survey (TERPS: Wymer 1999; Mepham 2009; with later additions by Hosfield). Pleistocene sands and gravels data derived from the British Geological Survey (1:625,000 superficial geology mapping).
Panel B: Palaeolithic archaeology — the contributions of primary and secondary context sites

Primary context Palaeolithic sites are those where sediments and artefacts have been minimally disturbed by geological agents (e.g. water or ice) and remain associated with the original landscape setting of the hominin activity (e.g. Boxgrove). Their value to Palaeolithic archaeology can be easily understood, as they can preserve artefact scatters, other activity residues (e.g. butchered animal bones), features (e.g. hearths), and direct associations between artefacts and their palaeoenvironmental context. However, such primary context sites tend to represent small localities and short periods of Pleistocene time. By contrast, secondary context sites and findspots can represent much larger areas and longer time-spans. This is because secondary context artefacts have been transported by geological agents, after being discarded by hominins (e.g. washed downstream by floodwaters, and then re-deposited in river gravel and sand deposits). While these sites and findspots typically lack the fine resolution of primary context sites (e.g. undisturbed artefact scatters), their frequency and distribution means that collectively they provide the overarching picture of the English Palaeolithic.

The vast majority of artefactual evidence from the Palaeolithic is in the form of lithic (stone) tools and manufacturing debris. In the Chalk-rich landscapes of south-eastern England flint was predominantly used as a raw material, but away from this area other materials were utilised, such as chert in the south-west and quartzite in the Midlands (see also the Trent case study). However, artefacts produced from organic raw materials can also be found, including wood (e.g. spears or digging sticks), antler (e.g. soft hammers, used in flintknapping) and bone, although these are dependent on favourable preservation conditions.

7.2 The Lower Palaeolithic

The very earliest occupations of Britain (Lower Palaeolithic) are represented by the sites of Happisburgh 3 (MIS 25 or 21; c. 959–936 kya or 866–814 kya [all MIS ages are based on Lisiecki & Raymo 2005]) and Pakefield (MIS 19 or 17; c. 790–761 kya or 712–676 kya). Both sites are represented by small numbers of core and flake technology artefacts (Figure 12) and appear to represent brief hominin visits to Britain. The hominin species associated with these sites is uncertain, but may be *H. antecessor*, whose fossils are known only from the Atapuerca (Gran Dolina) site in northern Spain.
The Lower Palaeolithic record starts to increase in scale after c. 600 kya, with a number of significant open-air sites appearing in East Anglia (e.g. Happisburgh 1, High Lodge, Warren Hill), where they are mainly associated with the deposits of the now-disappeared Bytham River (Figure 13) and with the warm stage climates of MIS 13 (c. 533–478 kya). Boxgrove (West Sussex) also dates to late MIS 13, and is a key source of evidence for dietary strategies (probable hunting of medium-sized mammals such as horse), hominins (the tibia and teeth are thought to represent *H. heidelbergensis*), and handaxe technologies (Figure 14). Hominins appear to have been absent during the subsequent cold stage (MIS 12, c. 478–424 kya), which saw much of Britain covered by glaciers (Figures 4 & 8). As a general rule, cold stage occupations of Britain only appear to occur during the later Middle Palaeolithic (*Neanderthals*; Section 7.3) and Upper Palaeolithic (*H. sapiens*; Section 7.4).
Figure 13: Pre-MIS 12 palaeogeography of Britain (modified after Hosfield 2011: fig. 1). The Bytham River was destroyed by the Anglian (MIS 12) glaciation and replaced by extant rivers (e.g. the Trent and the Ouse). The Anglian glaciation also shifted the Thames into its current position.

The Lower Palaeolithic archaeological record significantly expands after the Anglian glaciation (MIS 12), with increasing numbers of sites and artefacts. This is especially true in the East Anglian and Lower and Middle Thames landscapes, with several iconic Palaeolithic sites associated with MIS 11 deposits (c. 424–374 kya), such as Hoxne, Barnham, Clacton and Swanscombe. Handaxes (Figure 14) are abundant in many of these sites, but core and flake technologies (often referred to as Clactonian; Figure 12) are also present on some sites (e.g. Clacton). The significance of these different technologies remains an ongoing debate in Palaeolithic studies, with different explanations highlighting raw materials, site/task function and group traditions as possible explanatory factors. The specific chronological relationships between these technologies is therefore of particular interest. Hominin fossil evidence is limited in this period, but the cranial fragments from Swanscombe have been described both as *H. heidelbergensis* and as early Neanderthals - it is increasingly clear from evidence across Europe that the gradual emergence of Neanderthals began by at least 400 kya. Direct dietary evidence is limited, but there are key examples, most noticeably at the Ebbsfleet Elephant site in the Lower Thames. Britain’s earliest evidence for controlled fire use may also date to this period (at Beeches Pit, dating to MIS 11).
Panel C: Britain is not an island…

Britain’s connection with the continent fluctuated throughout the Pleistocene. Prior to the Anglian glaciation (MIS 12) there was a permanent connection, irrespective of global sea-levels. However glacial meltwaters at the end of MIS 12 then breached the Dover-Calais landmass, and since then Britain has repeatedly cycled between island and peninsula status (Figure 15). These phases have broadly tracked climatic cycles, with island phases linked to warm interglacials and high sea-levels, and peninsula phases linked to cold glacials and low sea-levels, up to 100m below the present sea level. As a consequence of both climatic and sea-level fluctuations, Britain has been repeatedly occupied, abandoned, and re-occupied throughout the Palaeolithic, by *H. heidelbergensis* (e.g. abandoned during MIS 12), Neanderthals (e.g. during MIS 6) and *H. sapiens* (e.g. during the Younger Dryas in MIS 2). Increasingly, these settlement patterns are being related to artefact patterns, e.g. the changes in the dominant handaxe shapes between MIS 13, 11 and 9 during the Lower Palaeolithic period.
The transition from the Lower to the Middle Palaeolithic starts to occur during MIS 9 (c. 337–300 kya). This is reflected by the first appearance of Levallois technology (Figure 16), and the transition is best illustrated by the succession from core and flake and handaxe to Levallois technologies at Purfleet in the Lower Thames (Figure 5).

Figure 16: Early Middle Palaeolithic artefacts. From left: Levallois core and flake; flake scraper; Levallois point. Photograph ©: Department of Archaeology (Teaching Reference Collection), University of Reading. Artefacts produced by John Lord.

7.3 The Middle Palaeolithic
The British Middle Palaeolithic is commonly divided into early (MIS 8–7; c. 300–191 kya) and later (MIS 3; c. 57–29 kya) stages, separated by MIS 6–4. During both periods Britain was populated by Neanderthals, and the artefact record in the earlier Middle Palaeolithic is typified by Levallois technology. Key early Middle Palaeolithic sites are particularly concentrated in MIS 7 (c. 243–191 kya) and are especially well known from the Lower Thames (e.g. Creffield Road, Crayford, Baker’s Hole). Many of the largest sites (e.g. Baker’s Hole) are focused around raw material sources. In some cases, primary context archaeology associated with buried landsurfaces (palaeosols) has been identified (e.g. at Crayford and Creffield Road). However early Middle Palaeolithic sites are also found elsewhere and in other contexts, most noticeably the cave mouth occupations at Pontnewydd (North Wales) and the open-air occupation at Harnham associated with the interstadial conditions towards the end of the MIS 8 cold stage (c. 300–243 kya). Direct dietary evidence is again limited, but large mammal exploitation is suggested at Stanton Harcourt (Upper Thames) and other sites.
Panel D: Palaeolithic climates — a world apart?

Palaeoclimatic research has increasingly revealed the dynamism and complexity of our Pleistocene past. While the earliest 19th debates explored whether humans were strictly post-glacial, the 20th century saw an increasing acceptance of multiple ‘ice ages’. Yet it has been the marine and ice core research of the last 50 years which has enabled us to appreciate more fully the scale and rapidity of past climate change. The isotope signals of oxygen suggest past temperature shifts of several degrees over just a few decades: older notions of long-lasting and relatively unchanging Pleistocene climates have melted away. The study of Pleistocene climates and environments, and human responses to them, is therefore of considerable value as we face our own, self-inflicted, climate crisis.

Current evidence then suggests a long period of abandonment of Britain, spanning two cold intervals (MIS 6 and MIS 4; c. 191–130 kya and c. 71–57 kya) but also the warmer conditions associated with parts of MIS 5 (c. 130–71 kya). The reasons for this absence, particularly in MIS 5, are the subject of ongoing debates — any artefact discoveries from deposits of these ages will transform these debates.

The later Middle Palaeolithic (associated with MIS 3, c. 57–29 kya, although the later Middle Palaeolithic period ends at around c. 40kya) sees the return of Neanderthals to Britain. There are relatively few sites, in both open-air and cave settings (e.g. Pin Hole and Robin Hood Cave at Creswell Crags), and numbers of artefacts are often small. This archaeological record probably reflects seasonal hunting parties, rather than permanent occupations. Unlike the early Middle Palaeolithic, the characteristic technology of the later Middle Palaeolithic is small, flat-bottomed handaxes, known as bout coupés (Figure 17). The key open-air site at Lynford suggests exploitation of mammoths by Neanderthals, although the exact nature of this (e.g. hunting and/or scavenging) is uncertain. The final stages of the later Middle Palaeolithic, around c. 40kya, sees the appearance of leaf-point technologies (Figure 18), at sites such as Beedings (West Sussex). A key ongoing question is whether these are the tools of the last Neanderthals or the first modern humans (H. sapiens).
Figure 17: Middle Palaeolithic bout coupé handaxe. Photograph ©: Department of Archaeology (Teaching Reference Collection), University of Reading. Artefacts produced by John Lord.

Figure 18: Middle Palaeolithic leaf (foliate) point. Photograph ©: Department of Archaeology (Teaching Reference Collection), University of Reading. Artefacts produced by John Lord.
7.4 The Upper Palaeolithic

The British Upper Palaeolithic (MIS 3–2; c. 40–11.5kya) is divided by the Last Glacial Maximum (LGM; c. 25–19 kya), during which time humans are again absent from Britain. During the Late Glacial (c. 14.7–11.6 kya), short cold intervals such as the Younger Dryas (c. 12.9–11.6kya) led to further periods of human abandonment. Lithic artefacts throughout the Upper Palaeolithic are dominated by blade-based technologies (e.g. backed blades, endscrapers, burins and points; Figure 19), with specific types varying between sub-periods. There is also a wide range of organic artefacts, including bone harpoons and points. Evidence from elsewhere in Europe indicates complex clothing and shelter technologies during this period. Key British sites include Gough’s Cave (evidence for cannibalism), Three Ways Wharf (evidence of reindeer and horse butchery), Paviland (evidence for burial and personal decorative items), and Creswell Crags (Britain’s only, to date, Upper Palaeolithic cave art).

Panel E: Diagnostic artefacts — a blend of technology and typology

Handaxes and scrapers: typological categories or functional (technological) descriptions? In truth, probably a bit of both. Many of our tool names date back to the earliest days of the archaeological discipline, and their adoption reflected assumptions about the tools’ uses, often derived from ethnography. Over time, many of these names became formal typological labels, often crystallising perceptions of their functions. Certain tool types were also burdened with further archaeological baggage, often in the quest to establish robust chronologies. For example, the division of handaxes into sub-categories, based on perceived notions of their quality and the assumption that increasingly well-made artefacts were progressively made over time, underpinned much of Lower Palaeolithic archaeology in the first half of the 20\textsuperscript{th} century. However absolute dating has challenged those simplistic notions of progression through time, although the key sub-divisions (Lower Palaeolithic: handaxes; Middle Palaeolithic: Levallois; Upper Palaeolithic: blade technology) have broadly survived. Moreover, use-wear studies are increasingly challenging single-use interpretations (Middle Palaeolithic scrapers, for example, appear to have been used to work all sorts of organic and inorganic materials).
Figure 19: Typical blade-based Upper Palaeolithic artefacts. Clockwise from top-left: blade core; backed blade; end scraper; burin; awl/piercer; shouldered point; Font Robert point. Photograph ©: Department of Archaeology (Teaching Reference Collection), University of Reading. Artefacts produced by John Lord.
Panel F: Palaeolithic mapping projects

The Palaeolithic occupation of Britain has been, and continues to be, documented in a range of projects. The Lower and Middle Palaeolithic record was synthesised in the English Rivers Palaeolithic Survey (TERPS) project during the 1990s — the site records can be accessed at: [https://archaeologydataservice.ac.uk/archives/view/terps_eh_2009/](https://archaeologydataservice.ac.uk/archives/view/terps_eh_2009/). The Upper Palaeolithic record was synthesised in Wymer & Bonsall (1977) — the site database can be accessed at [https://archaeologydataservice.ac.uk/archives/view/upalgaz_na_2011/](https://archaeologydataservice.ac.uk/archives/view/upalgaz_na_2011/). This should be used in combination with the Palaeolithic and Mesolithic Lithic Artefact (PaMELA) database, which can be found at: [https://archaeologydataservice.ac.uk/archives/view/pamela_2014/](https://archaeologydataservice.ac.uk/archives/view/pamela_2014/).

The Aggregates Levy Sustainability Fund (ALSF) supported a wide range of projects exploring Palaeolithic artefacts, sites and landscapes — a full list of ALSF-funded Palaeolithic project resources can be found at: [https://library.thehumanjourney.net/2795/55/Lost%20Landscapes-Appendix1-2.pdf](https://library.thehumanjourney.net/2795/55/Lost%20Landscapes-Appendix1-2.pdf).

More recent projects of note are the:

- Mapping Palaeolithic Britain project ([https://www.qmul.ac.uk/geog/research/research-projects/mappingpalaeolithicbritain](https://www.qmul.ac.uk/geog/research/research-projects/mappingpalaeolithicbritain));
- Trent Valley Palaeolithic Project ([https://archaeologydataservice.ac.uk/archives/view/tvpp_eh_2008/](https://archaeologydataservice.ac.uk/archives/view/tvpp_eh_2008/));

The BGS’ Pleistocene deposit mapping can be accessed through the iGeology app ([https://www.bgs.ac.uk/igeology/](https://www.bgs.ac.uk/igeology/)).

Finally, there has been a series of important HER-enhancement projects for Palaeolithic archaeology, based in Worcestershire (see also the Worcestershire case study), East and South Yorkshire, Norfolk and Essex ([https://historicengland.org.uk/research/current/discover-and-understand/early-prehistory/raising-awareness-of-early-prehistory/](https://historicengland.org.uk/research/current/discover-and-understand/early-prehistory/raising-awareness-of-early-prehistory/)).
8. Assessing the importance of Pleistocene and Palaeolithic remains

There are various factors that affect the importance of Pleistocene and Palaeolithic remains:

- How much is already known about the region in which they are found and about the time period that they represent.
- The depth and lateral extent of deposits.
- How they are preserved — whether in primary context (Panel B), or re-deposited by geological processes (secondary context; Panel B).
- Their condition — whether fresh or affected by processes of weathering and transport.
- Their diversity — including the number of fossil groups (e.g. plants, animals, insects) represented; the range of artefact types; and the presence of dateable material.
- The volume of material — the number of artefacts (see also Figure 10), bones and other material.

Thus at one end of the spectrum the greatest importance attaches to sites where diverse remains are preserved un- or minimally-disturbed, e.g. lake sediments and their contained flora and fauna; buried land surfaces and the flora and fauna that once occupied them; and surfaces on which the remains of hominin/human occupation are preserved where they were discarded (i.e. primary context sites). These sites are rare (Figure 11) but are of exceptional significance because they provide the ‘snapshots’ from which the prehistoric panorama has been built up and by which it can be revised and refined.

At the other end of the spectrum are more or less damaged or degraded individual specimens that are found in isolation, no longer associated with the place and time in which they originated. Such specimens are less important in regions rich in well-preserved and well-documented evidence, but they can be very important in regions where little or no evidence has previously been recorded.

Between these two extremes are disturbed, secondary context sites with multiple artefacts, occasionally in large numbers (Figure 10). Such sites have provided much of the national Palaeolithic context, indicating large-scale geographical and chronological trends in artefact types (e.g. fluctuations in the dominant shapes of handaxes between MIS 13, 11 and 9) and occupation histories (e.g. the apparent absence of hominins from Britain during MIS 6–4; Section 7.3).

All such remains, in both primary and secondary context, are of particular importance where they occur in regions, or relating to time periods, about which little has previously been recorded. To offer a chronological example with reference to Figure 8, the recovery of a handful of artefacts in primary context from MIS 5e / Ipswichian-age deposits would be very important, given the current absence of any evidence for hominin occupation in Britain during this period (see also Section 7.3). By contrast, a handful of re-worked artefacts from the already well understood MIS 11, which has a rich occupation record and is relatively well understood (see also Section 7.2), would be of less importance. From a geographical perspective, a handful of re-worked artefacts (i.e. in secondary context) from northern England would be far more important than similar artefacts from southern England, given the respective archaeological records in the two regions (Figure 9).

The above comments highlight the importance of existing knowledge when assessing the potential importance of new finds. The likely extent and importance of the Palaeolithic record for any given area can be identified from the National Regional Framework and relevant Regional Research Framework. Criteria for defining nationally important Palaeolithic sites are set out in the Historic England guidance document Identifying and Protecting Palaeolithic Remains (see also Sites of Early Human Activity: Scheduling Selection Guide). Within this, a
Palaeolithic site may be considered nationally important if it contains any of the following types of evidence (see also the Ebbsfleet Elephant case study):

1. Human remains
2. Remains that belong to a period or geographic area where evidence of a human presence is particularly rare
3. Organic (for instance, wooden) artefacts
4. Well-preserved indicators of the contemporary environment that can be directly related to the remains
5. Evidence of human lifestyles, for example interference with animal remains
6. One deposit containing Palaeolithic remains that has a clear stratigraphic relationship with another
7. Any artistic representation, no matter how simple
8. Features such as hearths, shelters, and floors
9. Exploitation of a resource, such as a raw material
10. Abundant artefacts

A site may also be designated as (for example) a Site of Special Scientific Interest (SSSI) or Scheduled Monument (SM, also sometimes referred to as SAM) as a result of its Palaeolithic importance (though such sites tend to be rare; e.g. Happisburgh Cliffs; see also the Happisburgh case study).
9. Pre-development investigation of Pleistocene and Palaeolithic remains — Requirements and Procedures

9.1 Overview

Archaeology is a material consideration in development management decision-making. The National Planning Policy Framework (NPPF) sets out the responsibilities for local planning authorities to require applicants to ‘describe the significance of any heritage assets affected’. It also states that ‘The level of detail should be proportionate to the assets’ [i.e. the archaeological deposits’] importance and no more than is sufficient to understand the potential impact of the proposal on their significance. As a minimum the relevant historic environment record should have been consulted and the heritage assets assessed using appropriate expertise where necessary.’ It is important to recognise that many Historic Environment Records (HERs) do not include comprehensive representation of Palaeolithic archaeological interest or potential (see also the Worcestershire HER case study). Therefore, additional sources (such as those in Table 1) will need to be consulted to assess Palaeolithic potential. Moreover, ‘appropriate expertise’ is required to advise on the Palaeolithic potential of a site. The sooner that expertise is engaged in the process the better as Palaeolithic archaeological investigation may require several phases of desk-based and field-based work (e.g. the Ebbsfleet Elephant case study).

Approaches will vary between local planning authorities but the stages identified below will be broadly applicable.

9.2 Desk-Based Assessment

All desk-based assessments should address the potential for Palaeolithic archaeological remains as they would any other archaeological period and should be written by/in collaboration with a Palaeolithic/Pleistocene specialist. Guidance already exists for the preparation of desk-based assessments (https://www.archaeologists.net/sites/default/files/CIfAS&GDBA_2.pdf): this section is intended to supplement those with prompts that are specific to the Palaeolithic. In some instances where there is particularly high potential for significant Palaeolithic remains a separate desk-based review of Palaeolithic remains may be advisable. It is particularly important that a specialist be engaged as soon as possible if the presence of either Pleistocene deposits or Palaeolithic archaeology is suspected.

The close relationship between the potential for Palaeolithic archaeology and the presence of Pleistocene deposits does mean that other sources (e.g. British Geological Survey mapping; see also Table 1) will need to be considered beyond the archaeological references traditionally included in desk-based assessments. A checklist of questions is presented in Table 5. This list is not exhaustive but gives an idea of the information that should be included in a desk-based assessment to ensure that it can support an informed judgment as to the archaeological interest of a development site. The DBA may make recommendations for further work that might be needed to clarify the understanding of Palaeolithic potential and/or mitigate the impact of the proposed development upon any remains that might be present.
<table>
<thead>
<tr>
<th><strong>Key questions</strong></th>
<th><strong>Associated approaches &amp; issues</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Does the site contain Pleistocene geological deposits?</td>
<td>If yes or maybe then seek specialist advice. Be aware that BGS mapping of superficial Pleistocene geology is not always reliable with regards to the precise extent of superficial deposits (e.g. see the Ebbsfleet Academy case study). Sources in Table 1 will be helpful, especially geotechnical site investigation reports [boreholes &amp; test pits].</td>
</tr>
<tr>
<td>Are there any known Palaeolithic finds in the vicinity or within the geological deposit?</td>
<td>If yes or maybe then seek specialist advice. Be aware that the presence of Palaeolithic archaeology that is relevant to the potential of a particular development site may occur quite some distance (often several kms) away. Sources in Table 1 will be helpful here, especially TERPS.</td>
</tr>
<tr>
<td>What is known about the Pleistocene deposits? Their character? Their age? Depth? Thickness? Extent? Faunal/environmental remains?</td>
<td>Refer to sources such as those identified in Table 1 including geotechnical site investigations [boreholes &amp; test pits] and the BGS website. Consider the potential of different types of deposits such as those listed in Section 5.</td>
</tr>
<tr>
<td>Is there a history of investigation of these deposits? What was the nature of that investigation?</td>
<td>Refer to sources such as those identified in Table 1. Be aware that relevant investigations may have occurred some distance away, including in neighbouring planning authorities. Sometimes relevant investigations may have occurred decades or even centuries ago and the terminology used may be less familiar. Also consider the purpose of those investigations — for instance was the focus artefact collection? Or understanding the sedimentary sequence? Or dating? If no investigation, what is known about the date of these deposits and their relationship to others that might be better understood? What might comparable/contemporary deposits elsewhere tell us about the potential for archaeological remains?</td>
</tr>
<tr>
<td>Refer to national and regional research frameworks</td>
<td>Be aware that for some regions’ research questions may be as simple as ‘is there any Palaeolithic archaeology in this area?’</td>
</tr>
<tr>
<td>What is the potential for Palaeolithic remains and what is the likely significance of any Palaeolithic remains that might be present?</td>
<td>Refer to the Historic England Sites of Early Human Activity Scheduling Selection Guide.</td>
</tr>
<tr>
<td>What is the nature of the impact of the proposed development?</td>
<td>Palaeolithic remains can occur at surface or near surface (Glaston case study), or within...</td>
</tr>
</tbody>
</table>
deeply stratified deposits (West Sussex Coastal Plain case study; Southall Gasworks case study; Nightingale Estate/Ponds Farm case study).

Table 5: Checklist of key questions and associated approaches and issues relevant to a DBA evaluation of Palaeolithic potential.

9.3 Field investigation

In some instances field investigation may be necessary to inform planning decisions, in others fieldwork may occur after a decision has been made as part of a condition to mitigate the impact of a development upon the archaeological interest. In either instance an iterative approach is likely, with multiple phases of field investigation, both invasive and non-invasive, required to assess the archaeological interest and to mitigate the impact of the development. Given the close relationship between Palaeolithic remains and Pleistocene deposits a deposit-led approach is advised (e.g. see the Ebbsfleet Elephant, West Sussex Coastal Plain and Southall Gasworks case studies), and Historic England’s Deposit Modelling and Archaeology guidance should be consulted. Where the site is designated as an SSSI or Scheduled Monument additional permissions will be needed for invasive field investigations. Field investigation strategies should always be developed and overseen by a Palaeolithic/Pleistocene specialist. The sub-sections below cover ‘field assessment’ (9.3.1) and ‘field mitigation’ (9.3.2) separately, although the same techniques and approaches may apply to both.

Table 6 shows the range of techniques that can be applied to field investigation, while Figure 20 highlights potential deposit variations (using a schematic river landscape) and the importance of appropriate sampling strategies.

Figure 20: Schematic river floodplain and terrace landscape. Note the spatial variations in coarse-grained (i.e. gravel) and fine-grained (e.g. sands, silts) deposits, and the potential for lower-resolution sampling to capture only some of that variability.
As the case studies illustrate there is considerable variability between sites in the nature of the Pleistocene deposits and the Palaeolithic archaeology. As such, outlining precise sampling strategies is neither possible nor desirable here. Historic England guidance for environmental sampling and geoarchaeology should be applied, and sampling strategies should also be designed with appropriate expertise. In many instances that will mean specialists in addition to the Pleistocene/Palaeolithic expertise already engaged (i.e. with expertise in topics such as lithics, Pleistocene mammalian fauna, dating, sediments, botanical remains, invertebrates etc; e.g. Nightingale Estate/Ponds Farm case study). Sampling should be sufficient to contextualise any archaeological remains and characterise the deposits, including their extent, presence/absence of dateable deposits (see also Table 4), presence/absence of archaeological remains, presence/absence of biological remains, and the nature of those remains.

9.3.1 Field assessment: As with all archaeological investigations there will be an assessment phase of work intended to characterise the deposits and their potential — to evaluate the nature, extent, preservation and significance of any archaeological remains that may be present. This is commonly undertaken prior to the determination of the planning application and the results will inform subsequent stages of site investigation, either further assessment or mitigation. The percentage of an area that is assessed and the strategy used will depend upon the nature of the site, the sorts of deposits being assessed, prior knowledge of the deposits and the research questions associated with them. Typically the assessment will be seeking to answer questions similar to those in Table 5 in order to inform appropriate mitigation: i.e. are Pleistocene deposits present? Where? What is the nature of these deposits? Are Palaeolithic archaeological remains present? Where? What is the nature of those remains? The sampling should be sufficient to address these questions.

Field assessment for Palaeolithic archaeology will typically draw upon a range of techniques to investigate the nature of the sub-surface geology — both invasive (e.g. boreholes, test pitting, trenching) and non-invasive (e.g. geophysical survey [e.g. see the Happisburgh case study], walkover survey) as well as techniques targeted at identifying archaeological remains (e.g. test pitting [see the Valdoe case study], sieving [see the Ebbsfleet Academy case study], trenching, fieldwalking). Which techniques are appropriate will depend upon the nature of the deposits, and the research questions being posed. It is possible that targeted work undertaken in accordance with specialist advice might rule out the need for further investigation (e.g. the West Sussex Coastal Plain case study). Alternatively there may be more than one phase of assessment fieldwork (e.g. the Southall Gasworks and Ebbsfleet Elephant case studies). Usually multiple strands of information are needed in order to understand the character of a deposit and its archaeological interest. Commonly used techniques and case study examples of their applications are listed in Table 6. Suggested sample sizes for sediment/clast characterisation (derived from Jones et al. 1999) are summarised in Panel G.

9.3.2 Field mitigation: In all instances it is likely that an iterative, staged approach to field investigations will be taken (e.g. the Ebbsfleet Elephant case study), with each investigation informing and refining future stages. In most instances some form of trenching or test pitting will be used but where deposits are located at depth this is usually informed by coring (e.g. Ponds Farm and West Sussex Coastal Plain case studies). It is not always the case that the most appropriate archaeological mitigation will be open area excavation, as is typical for
other archaeological periods. In some cases dating deposits or undertaking palaeoenvironmental analysis may be the most appropriate mitigation (e.g. Nightingale Estate/Ponds Farm case study). Ongoing monitoring of the site may also be an appropriate response (e.g. the Dunbridge and Chard Junction case studies).

<table>
<thead>
<tr>
<th>Techniques</th>
<th>Case Study Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coring</td>
<td>Happisburgh; Nightingale Estate, Hackney &amp; Ponds Farm 2, Aveley; West Sussex Coastal Plain</td>
</tr>
<tr>
<td>Geophysics</td>
<td>Happisburgh</td>
</tr>
<tr>
<td>Palaeoenvironmental sampling: borehole samples (particle size analysis, organic matter determinations, pollen, ostracods, chironomids, diatoms &amp; worm granules)</td>
<td>Nightingale Estate, Hackney &amp; Ponds Farm 2, Aveley</td>
</tr>
<tr>
<td>Palaeoenvironmental sampling: bulk samples (plant macrofossils, vertebrates, insects, Mollusca; gravel samples)</td>
<td>Nightingale Estate, Hackney &amp; Ponds Farm 2, Aveley</td>
</tr>
<tr>
<td>Test pits</td>
<td>Ebbsfleet Academy; Ebbsfleet Elephant; Glaston; Valdoe</td>
</tr>
<tr>
<td>Trenching</td>
<td>Ebbsfleet Elephant</td>
</tr>
<tr>
<td>Watching Brief</td>
<td>Chard Junction Quarry; Ebbsfleet Academy; Kimbridge Farm Quarry</td>
</tr>
</tbody>
</table>

Table 6: Commonly used field investigation techniques. See also Historic England’s Geoarchaeology and Environmental Archaeology guidance documents.

Panel G: Suggested sample sizes for sediments

Jones et al. (1999) suggested the following sample sizes for sediment analyses:

- Grain size: >50 clasts per sample for assessing the mean grain size of gravel. Bulk samples should be taken for grain size analysis (see also below).
- Roundness and shape: >35 clasts per sample.
- Fabric and sorting: >30 clasts per sample.
- Clast lithology: >100 clasts per sample.

Samples of 300–500 clasts for clast lithological analysis was suggested (after Bridgland (1986), requiring the following bulk sample weights for a typical sandy gravel:

- 10–15kg (where the grain size range is 8.0–16.0mm);
- 20–25kg (where the grain size range is 11.2–16.0mm);
• 30–50kg (where the grain size range is 16.0–32.0mm).

Finally, the following minimum sample weights were recommend to obtain c. 100 clasts from sediments with different maximum particle diameters (after Gale & Hoare 1992):

- Till (maximum particle diameter: 2mm): c. 1.0kg;
- Glaciofluvial gravel (maximum particle diameter: 6mm): c. 1.0kg;
- Modern river gravel (maximum particle diameter: 9mm): c. 1.0kg;
- Till (maximum particle diameter: 50mm): c. 18.0kg;
- Glaciofluvial gravel (maximum particle diameter: 50mm): c. 23.0kg;
- Modern river gravel (maximum particle diameter: 50mm): c. 31.0kg.

9.4 Off-site/post-excavation analysis

It is important to note that as with other archaeological investigations much of the analysis and investigation occurs off site. Given the iterative nature of many Palaeolithic investigations it is particularly important that analysis of samples and finds is undertaken promptly and the results used to inform subsequent phases of work, including field work. A list of commonly analysed remains can be found in Table 3 (and see also, e.g., the Nightingale Estate/Ponds Farm case study).

9.5 Reporting

As with all archaeological reporting current guidelines on good practice should be followed. However, given the variability, and often paucity, of Palaeolithic archaeology within Historic Environment Records reporting of findings to HERs is incredibly important. Such reporting should not only cover the results of investigations undertaken as part of the planning process, but all findings and investigations. HERs are the first point of reference for those wanting to understand the archaeological potential of an area but can only represent the archaeology they know about. While it is usual that HERs receive final investigation reports and publications it is not necessary to wait for final published reports before alerting an HER to a site of Palaeolithic interest. In fact the sooner an HER is made aware of archaeological deposits and discoveries the sooner it can include that knowledge in the daily decisions that the HERs underpin. It is also important that HERs recognise that local investigations can be relevant to understanding other deposits situated quite some distance away (often many kms). The Worcestershire case study is a good illustration of the benefits of enhancing an HERs Palaeolithic record, while the Dunbridge case study was reported through the ADS (as well as various academic papers).
10. References


11. Case Studies

The case studies (Figure 4 & Table 7) have been selected to highlight differing approaches, both methodological and curatorial, to Palaeolithic and Pleistocene resources. They illustrate both high- and low-profile sites, deposits and regions. The focus of the individual case studies is briefly outlined below. Some of these cases involved public engagement to raise the profile and public understanding of Palaeolithic archaeology and this is highlighted in a number of case studies including Ebbsfleet Academy, Nightingale Estate, Chard Junction, and Happisburgh.

Several case studies (West Sussex Coastal Plain [Wilkinson], Southall Gasworks [Green & Batchelor], Nightingale Estate & Ponds Farm [Batchelor et al.], and Ebbsfleet Academy [Wenban-Smith et al.]) highlight ‘work-a-day’ examples, emphasising both methodological approaches and the accumulated understanding which is built up from such sites, where Palaeolithic artefactual remains both are, and are not, present. The challenge of working with deep deposits (in non-quarry contexts) is also addressed (Nightingale Estate & Ponds Farm). The Glaston case study highlights the potential for Palaeolithic discoveries where development impact is relatively shallow.

Other case studies (Ebbsfleet Elephant [Wenban-Smith] and Happisburgh [Ashton]) are associated with internationally important discoveries, but the emphasis is nonetheless on methodological and curatorial approaches taken.

While some of the case studies (Happisburgh [Ashton], Chard Junction Quarry [Basell et al.], Dunbridge [Bridgland & Harding] and Valdoe Quarry [Pope]) were not directly developer-funded as per current practices (e.g. the Valdoe Quarry work was ALSF-funded), they are included because of their valuable methodological contributions. They also highlight the importance of long-term watching briefs and successful working relationships with the aggregates industry (e.g. Chard Junction Quarry and Dunbridge).

The importance of good baseline data-sets, particularly in areas or regions with scarcer and/or lower profile Palaeolithic and Pleistocene resources is also highlighted (Worcester HER [Shaw]). The Trent Valley case study (Howard et al.) provides an example of investigating the Palaeolithic potential of poorly understood regional Pleistocene landscapes.

While the majority of the case studies deal with open-air sites and fluvial deposits, Dinnis emphasises the potential of cave deposits, while the Glaston case study emphasises the importance of sediment traps (i.e. fissures and grabens) as potential sources of Pleistocene and Palaeolithic remains.

All of the case studies include keywords to indicate location, Palaeolithic period(s), investigative method(s), type(s) of deposit, and any features of interest. The case studies and their keywords are summarised in Table 7. All of the case studies also have a pro-forma graphic (Figure 21) to illustrate the various stages represented by the case study with reference to the planning process. Inevitably, the pro-forma is more suitable for some case studies (e.g. Ebbsfleet Academy) than others (e.g. Happisburgh), and is absent where not appropriate (e.g. Caves).
Figure 21: Project stages pro-forma, as used in the majority of the case studies.
<table>
<thead>
<tr>
<th>Author(s)</th>
<th>Where</th>
<th>Region</th>
<th>Palaeolithic period(s)</th>
<th>Type of investigation</th>
<th>Methods</th>
<th>Type(s) of deposit</th>
<th>Features of interest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ashton</td>
<td>Happisburgh, Norfolk</td>
<td>East Midlands &amp; East Anglia</td>
<td>Lower Palaeolithic (MIS 21–13)</td>
<td>Fieldwork</td>
<td>Boreholes; Geophysics; Offshore investigation</td>
<td>River channel deposits</td>
<td>Public involvement; Shoreline management; Earliest record of human activity in Britain</td>
</tr>
<tr>
<td>Basili et al. (TBC)</td>
<td>Chard Junction Quarry, Somerset</td>
<td>South-west</td>
<td>Later Middle and Late Pleistocene (MIS 12–2)</td>
<td>Fieldwork; Post-exavation analysis &amp; publication</td>
<td>Terrestrial Laser Scanning; Gamma GPS; Cosmogenics; OSL; Geoarchaeology; Sedimentology; Deposit modelling</td>
<td>River terrace deposits (gravel)</td>
<td>Recording by Terrestrial Laser Scanning</td>
</tr>
<tr>
<td>Batchelor et al.</td>
<td>Nightingale Estate, Hackney &amp; Ponds Farm 2, Aveley, East London</td>
<td>South-east</td>
<td>Early Middle Palaeolithic (MIS 9–7)</td>
<td>Literature review; Fieldwork; Post-exavation analysis &amp; publication</td>
<td>Boreholes (Ponds Farm 2); Deep trenching (Nightingale Estate); Dating (OSL, AAR, U-Series); Palaeoenvironmental assessment &amp; analysis</td>
<td>Made ground; River terrace deposits (gravel, organic-rich sediment)</td>
<td>Media attention (Nightingale Estate)</td>
</tr>
<tr>
<td>Bridgland &amp; Harding</td>
<td>Dunbridge, Hampshire</td>
<td>South-east</td>
<td>Lower Palaeolithic–early Middle Palaeolithic transition (MIS 9–8)</td>
<td>Watching brief (working quarry); OSL dating</td>
<td>Monitoring of quarry faces &amp; ‘reject heaps’; Digital Terrain Modelling; OSL dating</td>
<td>River terrace deposits</td>
<td>Geoarchaeological watching brief across lifetime of working quarry</td>
</tr>
<tr>
<td>Cooper</td>
<td>Glaston, Rutland</td>
<td>East Midlands &amp; East Anglia</td>
<td>Early Upper Palaeolithic (MIS 3)</td>
<td>Chance finds; Excavation; Post-exavation analysis &amp; publication</td>
<td>Sondage excavation; Grid-square excavation</td>
<td>Sands within geological fault (graben feature)</td>
<td>Co-association of lithic artefacts and hyena den remains</td>
</tr>
<tr>
<td>Dinnis</td>
<td>n/a</td>
<td>South-west; West Midlands &amp; North</td>
<td>Later Middle Palaeolithic &amp; Upper Palaeolithic</td>
<td>n/a</td>
<td>n/a</td>
<td>Cave deposits</td>
<td>Potential for surface fissures and outermost portions of larger caves to retain Pleistocene deposits and be threatened by development</td>
</tr>
<tr>
<td>Green &amp; Batchelor</td>
<td>Southall Gasworks, West London</td>
<td>South-east</td>
<td>Early Middle Palaeolithic (MIS 9–7)</td>
<td>Desk-based assessment; Evaluation</td>
<td>Deposit modelling; Test-pitting</td>
<td>Made ground, Brick earth; River terrace gravels</td>
<td>n/a</td>
</tr>
<tr>
<td>Howard</td>
<td>Trent Valley</td>
<td>East Midlands &amp; East Anglia</td>
<td>All Palaeolithic (pre-Anglian to Holocene)</td>
<td>Regional evaluation</td>
<td>Boreholes; Desk-based; Field visits to quarries &amp; other exposures</td>
<td>River terrace deposits; Glacial deposits</td>
<td>Regional study; Impact of glaciation on river drainage pattern</td>
</tr>
<tr>
<td>Pope (TBC)</td>
<td>Valdoe, West Sussex</td>
<td>South-east</td>
<td>Lower Palaeolithic (MIS 13)</td>
<td>Fieldwork; Excavation</td>
<td>Topographic survey; Boreholes; Trenches</td>
<td>Raised beach, Head</td>
<td>Public involvement; High potential locality</td>
</tr>
<tr>
<td>-----------</td>
<td>---------------------</td>
<td>------------</td>
<td>----------------------------</td>
<td>----------------------</td>
<td>-----------------------------------------</td>
<td>------------------</td>
<td>------------------------------------------</td>
</tr>
<tr>
<td>Shaw</td>
<td>Worcestershire</td>
<td>West Midlands &amp; North</td>
<td>All Palaeolithic</td>
<td>HER enhancement</td>
<td>Literature review; re-assessment of lithic and faunal collections; HER updating; GIS mapping and modelling</td>
<td>River terrace deposits; Colluvial and solifluction deposits</td>
<td>Enhancement of HER, enabling utilisation as tool to inform curators on areas of possible Palaeolithic potential</td>
</tr>
<tr>
<td>Wenban-Smith</td>
<td>Southfleet Road, Kent</td>
<td>South-east</td>
<td>Lower Palaeolithic (MIS 11)</td>
<td>Excavation</td>
<td>Section-cleaning; Palaeoenvironmental sampling; Ground-reflecting laser survey; Machine-trenching; Hand-dug test pits; Watching brief; 3D artefact recording; Sediment block lifting of faunal remains</td>
<td>Lacustrine; Fluvial gravel; Colluvial</td>
<td>Deep &amp; complex sequence; Elephant remains; Undisturbed lithic scatter; Multiple horizons with lithic evidence</td>
</tr>
<tr>
<td>Wenban-Smith et al.</td>
<td>Ebbsfleet Academy, Kent</td>
<td>South-east</td>
<td>Lower Palaeolithic (MIS 11–8)</td>
<td>Fieldwork</td>
<td>Trenches &amp; test-pits; Sampling &amp; sieving; Watching brief; Lithological analyses</td>
<td>River terrace deposits (fluvial sand &amp; gravel)</td>
<td>Systematic &amp; volume-controlled gravel sieving</td>
</tr>
<tr>
<td>Wilkinson</td>
<td>West Sussex Coastal Plain</td>
<td>South-east</td>
<td>Lower Palaeolithic (MIS 13–7)</td>
<td>Fieldwork</td>
<td>Boreholes; Trenches; Deposit modelling</td>
<td>Raised beach; Solifluction deposits</td>
<td>n/a</td>
</tr>
</tbody>
</table>

Table 7: Keyword summaries of project case studies
12. Glossary

Acheulean: A stone tool industry typified by handaxe technology. It mainly occurs in Britain between MIS 15 and MIS 9.

Anglian: A glacial stage (MIS 12; c. 450,000 years ago) associated with a major Middle Pleistocene glaciation, during which ice sheets extended as far south as Oxfordshire and north London.

Aveley Interglacial: The interglacial period associated with MIS 7 (c. 243–191kya).

Aurignacian: A blade technology-based industry of the Upper Palaeolithic, dating to c. 40,000-30,000 years ago.

Blade technology: Characteristic of the Upper Palaeolithic in Britain, this stone technology is defined by the careful preparation of cores (blade cores) that enables the production of large numbers of similar blades.

Blade: Elongated, parallel-sided flake.

Boucoupé: A distinctive type of handaxe, sub-rectangular in shape with a flat base. They are associated with Neanderthals and the later Middle Palaeolithic.

Braided River: Typified by a network of river channels, usually relatively shallow, separated by small, often temporary, islands. Sediments tend to be coarse-grained (e.g. gravels).

Breckland: A landscape of sandy heathland in south Norfolk and north Suffolk. It contains significant Pleistocene deposits, relating to both glaciations and river activity (including the Bytham River).

Brickearth: A 19th century term used to describe fine-grained, largely stoneless geological deposits (which were used for brickmaking), that were often found capping river terrace deposits. The term has been used widely, but it is likely that not all ‘brickearths’ formed in the same way (e.g. not all may have a wind-blown content).

Bytham River: One of Britain’s lost rivers, the Bytham drained the Midlands and East Anglia, and flowed into the southern North Sea. It was destroyed by the Anglian glaciation.

Cheddar point: Blade-based artefact, with two oblique truncations, resulting in a distinctive trapezoidal shape.

Clactonian: A stone tool industry typified by core and flake technology. Its main sites (e.g. Clacton) date to early MIS 11 and early MIS 9.

Clay with flints: A mixed deposit of clay and whole/broken flints, that overlies the Chalk deposits in southern England (e.g. on the South Downs and the Chilterns).

Core & flake technology: Characteristic of the Lower Palaeolithic (although it occurs in all periods of prehistory), this stone technology is defined by an absence of core preparation and the production of irregular flakes.

Coversand: Wind-blown sands deposited during the last period of cold conditions in the Devensian Lateglacial.
Creffield Road: An important Middle Palaeolithic site in West London, that contained a buried landsurface with refitting Levallois artefacts, at the contact between the base of the Langley Silt and the top of the Lynch Hill Gravel.

Creswellian: A lithic industry dating to the late Upper Palaeolithic and associated with *H. sapiens*. It is dominated by blade-based artefacts (including Cheddar points), and is the equivalent of Late Magdalenian assemblages on the continent.

Devensian: The last glacial period, spanning MIS (marine isotope stages) 5d–2 (i.e. c. 115,000–11,600 years ago). Climate was generally cold, with conditions at their harshest during the Last Glacial Maximum (c. 26,000–19,000 years ago).

Devensian Lateglacial: The period at the end of the Devensian from the peak of the Last Glacial Maximum (MIS 2) to the end of the Pleistocene. A period of fluctuating climatic conditions, both extremely cold (e.g. Younger Dryas) and relatively warm (e.g. the Windermere Interstadial).

Down-cutting: The process by which rivers have cut down into the landscape to form the present river valleys, in response to tectonic uplift during the Pleistocene and cyclical sea-level changes.

Early Middle Palaeolithic (eMP): Spanned late MIS 8–7 (i.e. c. 250–180,000 years ago) and was associated with Neanderthals and Levallois technology.

Flakes: Stone piece removed from a block of stone (core) by percussion (with a hard or soft hammer) or pressure flaking.

Glacial till: A highly variable geological deposit of fine-grained and stony material, accumulated by glacial ice and then deposited when the ice melts.

Hackney Gravel: River terrace deposit in the Lower Thames.

Head (see slope deposits)

Handaxe: A bifacially-shaped stone tool, characteristic of the Lower Palaeolithic. They occur in a variety of shapes, including oval, pear or tear-drop, and pointed. They are commonly interpreted as large cutting tools, used in butchery. They first appeared in the British record between c. 600,000–500,000 years ago.

Hominins: All the fossil ‘human’ taxa that are more closely related to modern humans than they are to any other living taxon (e.g. chimpanzees).

*Homo antecessor*: An early European hominin species, whose fossils have only been identified at Atapuerca in Spain, where they date to c. 800,000–900,000 years ago (i.e. the earlier Lower Palaeolithic).

*Homo heidelbergensis*: An early European hominin species associated with the Middle Palaeolithic, whose fossils have been identified from sites across Europe (including Boxgrove). They date from c. 600,000–200,000, and later fossils (e.g. the skull fragments from Swanscombe) have also been described as early or proto-Neanderthals. Occasional sites, e.g. Boxgrove, suggest an ability to hunt.

*Homo neanderthalensis*: Associated with the Middle Palaeolithic, Neanderthal fossils are rare in Britain. Their hunter-gatherer lifestyle is marked by complex hunting, cave/rockshelter...
sites, frequent fire use, and burials, and there is increasing evidence for their use of personal decorative items (e.g. bird feathers).

**Homo sapiens**: Our own species. Present in Britain from the start of the Upper Palaeolithic onwards. Their hunter-gatherer lifestyle is marked by sophisticated hunting and fishing, complex sites (e.g. artificial shelters, controlled fires and storage pits), burials with grave goods, tailored clothing, and personal decoration.

**Hoxnian**: British name applied to the MIS 11 interglacial (c. 424–374kya).

**Ice age**: Commonly used to refer to the Pleistocene, but is an unhelpful term, as the Pleistocene involved a sequence of cold and warm climatic phases.

**Interglacial**: Warm climate stage within the Pleistocene, although it is clear from the MIS record that such stages were not uniformly warm.

**Interstадial**: Short period of less cold climate during a glacial period.

**Ipswichian Interglacial**: The interglacial period associated with MIS 5e (c. 124–119kya).

**Isostatic depression / rebound**: Changes in the elevation of the earth’s surface, largely in response to the advance and retreat of glacial ice.

**Lacustrine deposits**: Lake deposits, typically fine-grained as a result of forming in still water, with potential to document seasonal variations.

**Langley Silt**: Brickearth deposit that is found in West London, overlying River Terrace deposits and, less commonly, bedrock. It is associated with some important Middle Palaeolithic sites (e.g. Creffield Road).

**Last Glacial Maximum (LGM)**: A period of extreme cold in MIS 2, with Devensian ice sheets at their maximum extent and very low global sea-levels.

**Late Glacial**: See Devensian Late Glacial.

**Later Middle Palaeolithic (IMP)**: Spanned the early parts of MIS 3 (i.e. c. 60,000–40,000 years ago) and was associated with Neanderthals and bout coupé handaxes.

**Leaf point**: Bifacially shaped points, associated with the late Middle Palaeolithic and early Upper Palaeolithic in Britain, and typically interpreted as spear tips.

**Levallois technology**: Characteristic of the early Middle Palaeolithic in Britain, this stone technology is defined by the careful preparation of cores that enables the production of flakes with particular sizes and shapes.

**Loess**: Wind-blown dust deposit, with the main deposits in south-eastern and southern England, and mostly dating to the Devensian.

**Lower Loam**: Key river terrace deposit of the Lower Thames, identified in the Swanscombe area and dating to early MIS 11. It is associated with Clactonian technology at Swanscombe.

**Lower Middle Gravel**: Key river terrace deposit of the Lower Thames, identified in the Swanscombe area and dating to MIS 11. It is associated with Acheulian technology at Swanscombe.
Lower Palaeolithic: Associated with *H. heidelbergensis*, and possibly *H. antecessor* (although no fossils of the later species have been found to date in Britain), the Lower Palaeolithic in Britain spans MIS 25/21 (c. 850,000–950,000 years ago) to the end of MIS 9 (c. 300,000 years ago).

Lynch Hill Gravel: A River Terrace deposit in the Middle and Lower Thames, underlying the Lynch Hill terrace and dated to MIS 10–8.

Magdalenian: The last major industry of the Upper Palaeolithic, dating to c. 17,000–12,000 years ago, is characterised by distinctive stone and organic artefacts (e.g. bone and antler projectile points and harpoons).

Meandering river: Single-channel rivers characterised by regular, sinuous curves.

Middle Palaeolithic: Associated with Neanderthals, the Middle Palaeolithic in Britain spans MIS 8-3 (i.e. c. 250,000–40,000 years ago). It is typically divided into an early Middle Palaeolithic (early MIS 8–7) and a later Middle Palaeolithic (MIS 3), separated by a long period of hominin (Neanderthal) absence.

Marine Isotope Stage (MIS): Alternating warm and cool periods in the Earth’s paleoclimate, indicated by changing oxygen isotope values in deep sea core samples that reflect variations in global temperatures.

Mucking Formation: River terrace deposits in the Lower Thames, mapped there by BGS as Taplow Gravel underlying the Taplow Terrace. It can be split into the Mucking Upper Gravel (MIS 6), Aveley interglacial deposits (MIS 7), and the Mucking Lower Gravel (MIS 8).

Mutual Climatic Range: A method of determining the past climate at an archaeological site by examining the climatic tolerances of a range of species found at the site. The method utilises animal groups with specific requirements and tolerances (e.g. beetles).

Palaeochannel: A remnant of a river or stream channel that has been filled or buried by younger sediment.

Palaeolithic: The Old Stone Age, spanning c. 950,000–11,600 years ago in Britain.

Palaeolithic record: The archaeological record associated with the Palaeolithic occupation of Britain. It is dominated by lithic artefacts, but also includes modified animal remains, organic artefacts (e.g. in wood, bone and antler), *hominin* remains, fire traces, and cave art.

Palaeolithic technology: Palaeolithic technology is dominated by lithic (stone) artefacts, reflecting preservation bias. Specific technologies vary broadly between the sub-divisions of the Palaeolithic: Lower (unprepared core and *flake*; *handaxes*); Middle (prepared core and *flake* [*Levallois*]; *flake tools*); Upper (prepared blade core; *blade* tools).

Periglacial: Landscapes on the margins of fully-glaciated areas.

Piedmont: An area at the base of a mountain or mountain range.

Pleistocene: A geological epoch that lasted from about 2,580,000 to 11,600 years ago, and was characterised by repeated glaciations.
**Primary context**: Sites where sediments and artefacts have been minimally disturbed by geological agents (e.g. water or ice) and remain associated with their original landscape setting.

**Raised beach deposits**: Associated with raised shoreline features, raised beach deposits include shingle, sand and silt.

**Reworked**: An artefact or other material which has been eroded out of its original location (e.g. where an artefact was discarded by a hominin), transported and then re-deposited in a new location by natural agents (e.g. water or ice).

**River terraces**: The remnants of former valley floors, which are preserved in some places on the valley sides as a by-product of **downcutting**. They are often underlain by river terrace deposits in which gravel and sand are major components.

**Scrapers**: A characteristic Palaeolithic stone tool, made on flakes and blades, with a steeply blunted (retouched) working edge. Use-wear increasingly shows a wide range of functional uses, not just as, e.g., hide scraping tools.

**Secondary context**: Sites where artefacts and sediments have been transported by geological agents (e.g. washed downstream by floodwaters, and then re-deposited in river gravel and sand deposits).

**Slope deposits (Head)**: Variable geological deposits, originating from valley sides and transported downslope through the processes of soil creep, slope wash and freeze-thaw activity.

**Syncline**: A trough or fold of stratified sediments in which the strata slope upwards from the axis.

**Taplow Gravel**: A *river terrace* deposit in the Middle and Lower Thames, underlying the Taplow Terrace and dated to MIS 8–6.

**Taxa / Taxon**: A unit of organisms (e.g. a geographic population or a genus) which are related and whose characteristics can be differentiated from other units (e.g. other geographic populations or genus).

**Tectonic uplift**: Vertical elevation of the earth’s surface, in response to natural geological causes.

**Tufa / Travertine**: Sedimentary deposits formed by precipitation of calcium carbonate, where lime-rich water evaporates (e.g. spring heads, seeps, and river and lake margins).

**Upper Palaeolithic**: Associated with *H. sapiens*, the Upper Palaeolithic in Britain spans later MIS 3–2 (i.e. c. 40,000–11,600 years ago). There is a significant period of human absence around the time of the **Last Glacial Maximum**.

**Younger Dryas**: A brief period of extremely cold conditions during the **Devensian** Late Glacial, lasting from c. 12,900–11,600 years ago, which both started and stopped very rapidly.