

MIDDLE THAMES NORTHERN TRIBUTARIES PROJECT

GEOLOGY AND GEOARCHAEOLOGICAL ZONES IN THE LEA VALLEY

The Middle Thames Northern Tributaries (comprising the Ver, Colne, Brent, Lea, Roding and lesser tributaries) include nationally significant Mesolithic sites, besides regionally significant later prehistoric and Roman ones. Underlying their floodplains are waterlogged sediment sequences of known potential for palaeo-environmental reconstruction and preservation of wooden structures. These river valleys have been highlighted as having very high priority for investigation in the *Eastern Counties Archaeological Research Framework* (Brown and Glazebrook, 2000).

The Middle Thames Northern Tributaries Project is a study which aims to collate geological, geoarchaeological data in such a way as to provide information for curators and academics to inform management and research strategies. The pilot studies, focussed on the Lea and Ver valleys, have used a wide range of data to identify a series of geoarchaeological zones. They have been funded by English Heritage through the ALSF.

This summary contains information on the geology and the zones in the Lea Valley pilot area. It has been derived from the MTNT Project Assessment Report (Bates, Heppell and Gascoyne 2006). It is designed to provide a general background and is not exhaustive – if in doubt please consult an appropriate specialist

The summary includes information on:

- Bedrock Geology
- Pleistocene Sequences
- Superficial Geology, sediments and stratigraphy in the Lea Valley
- The development of the zone model
- The Stratigraphic framework
- The Zones



ENGLISH HERITAGE



BEDROCK GEOLOGY

The geological history of the region is influenced by the bedrock geology and the Middle Pleistocene history of drainage changes associated with major glaciation in the region during the Anglian cold stage (Gibbard, 1977, 1979, 1985).

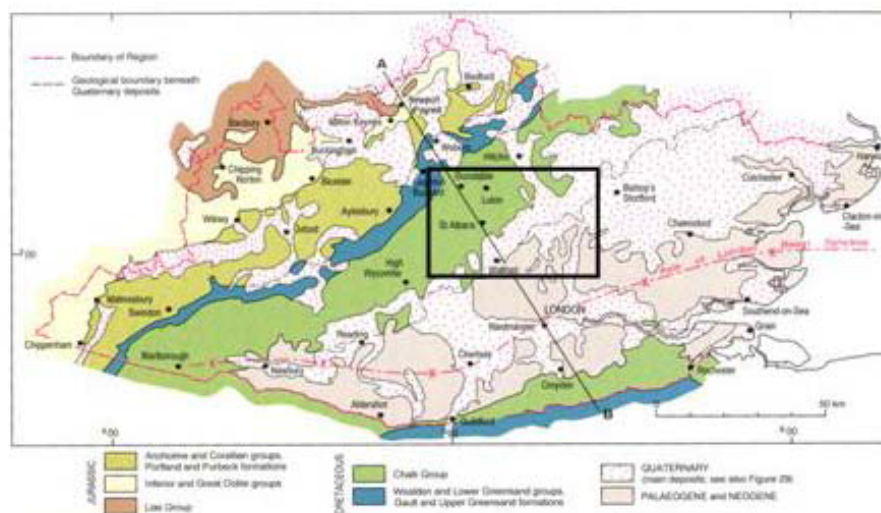
Bedrock geology consists of chalk of the Cretaceous period and Palaeogene sediments infilling the London Basin. The chalk trends SW to NE through the study area forming the northern margin of the London Basin (a synclinal structure with the axis of the syncline running through the London conurbation). This means that the chalk dips to the southeast through both study areas.

Younger sediments of the Palaeogene consist of a thin outcrop of the Thanet Sand Formation and Lambeth Group with more extensive spreads of Thames Group sediments (London Clay) to the south.

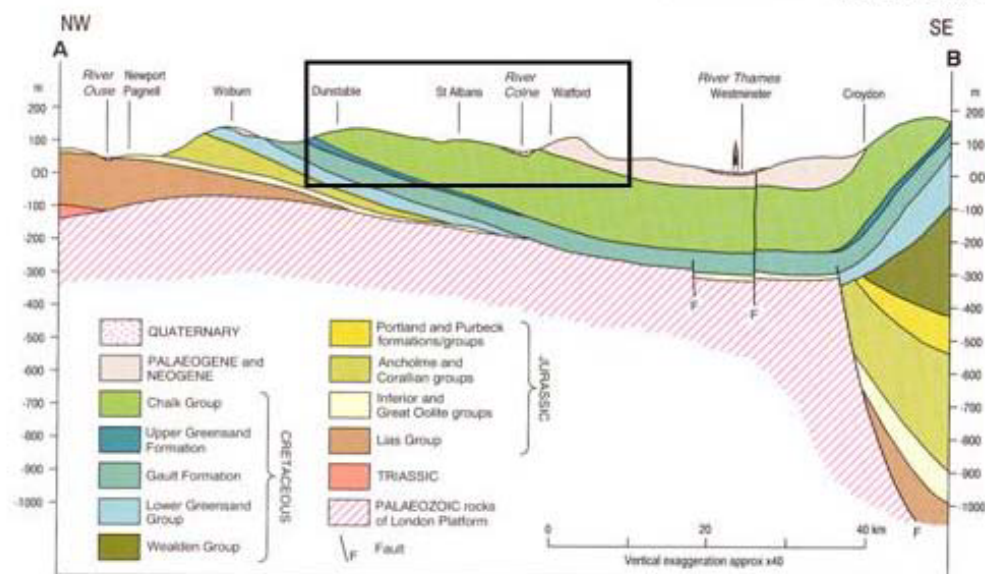
Key factors of importance relating to the bedrock geologies are:

- the calcareous properties of the chalk enhance preservation of vertebrate, mollusc and ostracod remains in sediments derived from the chalk.
- the free draining properties of chalk dominated sediments and bedrock enhance the leaching of material from the sediments.
- the impervious nature of some elements of the Palaeogene sequence (i.e. London Clay) resulting in the developments of higher water-tables and the potential waterlogged deposits to preserve plant remains, insects

Distribution of the Bedrock Geology and cross-section through the London Basin (from Stumbler 1996)



Approximate position of study area MTNT



PLEISTOCENE SEQUENCES

The Pleistocene sequences in the region are dominated by fluvial deposits of the pre-diversion Thames and post-diversion tributaries on the north bank of the Thames as well as glacial deposits associated with ice sheets and ice dammed lakes.

Prior to 470,000 years ago drainage through the area was dominated by a major river system draining from the Reading direction through the Vale of St. Albans and eastwards towards the Suffolk/Essex coast (Gibbard, 1985, 1994). This river (an ancestral Thames) deposited a series of sand and gravel bodies known collectively as the Kesgrave Formation/Sands and Gravels. These deposits formed as part of former floodplains turned into river terraces by downcutting and uplift along the line of the former river. Glaciation during the Anglian period around 470,000 B.P. resulted in the advance of ice to the Vale of St. Albans and as far south as Hornchurch in Essex. This ice effectively dammed the former course of the river, created a series of ice dammed lakes in the vicinity of Watford and through a complex sequence of manoeuvres pushed the Thames into its current southerly location (Gibbard, 1985). Following ice retreat deposition of sands and gravels within the main Thames and newly formed tributary valleys such as the Lea commenced and terrace formation followed through time.

Thus in both the Lea valley and around St Albans extensive suites of sands and gravels (Kesgrave Sands and Gravels) are present that are overlain by till from the Anglian ice. Post Anglian activity has been more extensively recorded and preserved in the Lea system where a number of river terraces composed of sands and gravels are preserved.

The most recent phase of sand and gravel deposition and terracing occurred in the late Pleistocene between 10 and 30ka B.P. and has resulted in the creation of the modern floodplain in the Holocene and the underlying late Devensian river gravels. Minor changes in sedimentation patterns within the Holocene floodplain are well attested to in the valley and demonstrate the complexity of the sequences associated with the last 10,000 years of human history. Sediments present within the alluvium typically consist of clay-silts and sands with occasional beds of peat. These are particularly well represented in the sequences around Broxbourne (Warren *et al.*, 1934).

Quaternary epochs and the Marine Isotope Stage framework for the Lea Valley study area

<i>Epoch</i>	<i>Age kBP</i>	<i>MI Stage</i>		<i>Traditional stage (Britain)</i>	<i>Climate</i>	<i>Palaeogeographical events</i>
Holocene	Present–10,000	1	Alluvium	Flandrian	Warm — full interglacial	Thames flowing in present course. Study are part of north bank tributaries flowing southwards
Late Pleistocene	25,000	2	Buried channel	Devensian	Mainly cold; coldest in MI Stage 2 when Britain depopulated and maximum advance of Devensian ice sheets; occasional short-lived periods of relative warmth ("interstadials"), and more prolonged warmth in MI Stage 3.	
	50,000	3	Shepperton			
	70,000	4				
	110,000	5a–d	Kempton Park Gravel			
	125,000	5e				
Middle Pleistocene	190,000	6	Taplow Gravel	Wolstonian complex	Alternating periods of cold and warmth; recently recognised that this period includes more than one glacial–interglacial cycle; changes in faunal evolution and assemblage associations through the period help distinguish its different stages.	
	240,000	7				
	300,000	8				
	340,000	9				
	380,000	10				
	425,000	11	Hoxnian	Warm — full interglacial		
	480,000	12	Lowestoft Formation	Anglian	Cold — maximum extent southward of glacial ice in Britain; may incorporate interstadials that have been confused with Cromerian complex interglacials	Major glaciation: Thames blocked by ice in Vale of St.Albans: major drainage modification
	620,000	13–16	(Dollis Hill Gravel – MIS 14)	Cromerian complex and Beestonian glaciation	Cycles of cold and warmth; still poorly understood due to obliteration of sediments by subsequent events	Thames flowing to NE through St.Albans. Study areas part of south bank tributaries flowing northwards
	780,000	17–19	Kesgrave Formation			
Early Pleistocene	1,800,000	20–64			Cycles of cool and warn, but generally not sufficiently cold for glaciation in Britain	

SUPERFICIAL GEOLOGY OF THE LEA VALLEY

The superficial geology (or drift that includes both man-made and natural sediments lying close to the earth's surface that have accumulated in the recent past (last 2 million years) has been mapped as surface expressions of the underlying sequences by the BGS and this has been the base mapping data for the region.

In all cases our work uses the mapped lithostratigraphic units as provided by the BGS that reflect the presumed origin of the sediments combined with the characteristics of the sediments in the near surface zone. It is only rarely that consideration of the deeper parts of the drift or superficial geology have been integrated into the BGS system.

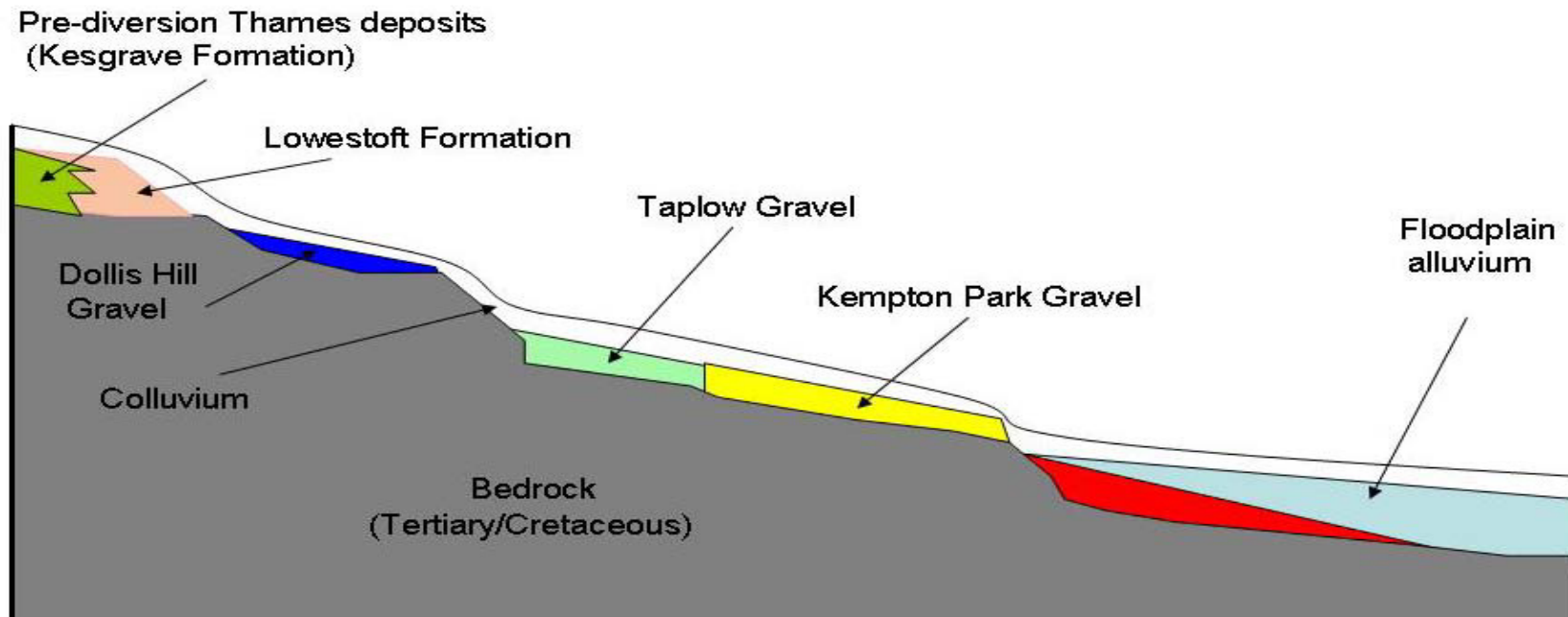
No primary interpretations of the sequences from sediment cores/test pits/exposures etc. have been undertaken here and our geoarchaeological perspective has been obtained using commonly applicable principles of geomorphology/sedimentology coupled with the interpreted stratigraphy to make inferences about the geoarchaeological framework and significance.

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SEDIMENTS AND STRATIGRAPHY IN THE LEA VALLEY

Sediments and stratigraphy within the region can be broadly divided into 3 categories:

- Sequences associated with the pre-diversion Thames and the Anglian glaciation.
- Sequences associated with the post-Anglian course of the river (remnants of former floodplains) now forming terraces along the valley margins.
- Sequences lying within the valley bottom consisting of floodplain alluvium (still accumulating) over older late Pleistocene sands and gravels.



Schematic Profile through the Lea Valley showing main stratigraphic units present within the study area

THE ZONE MODEL

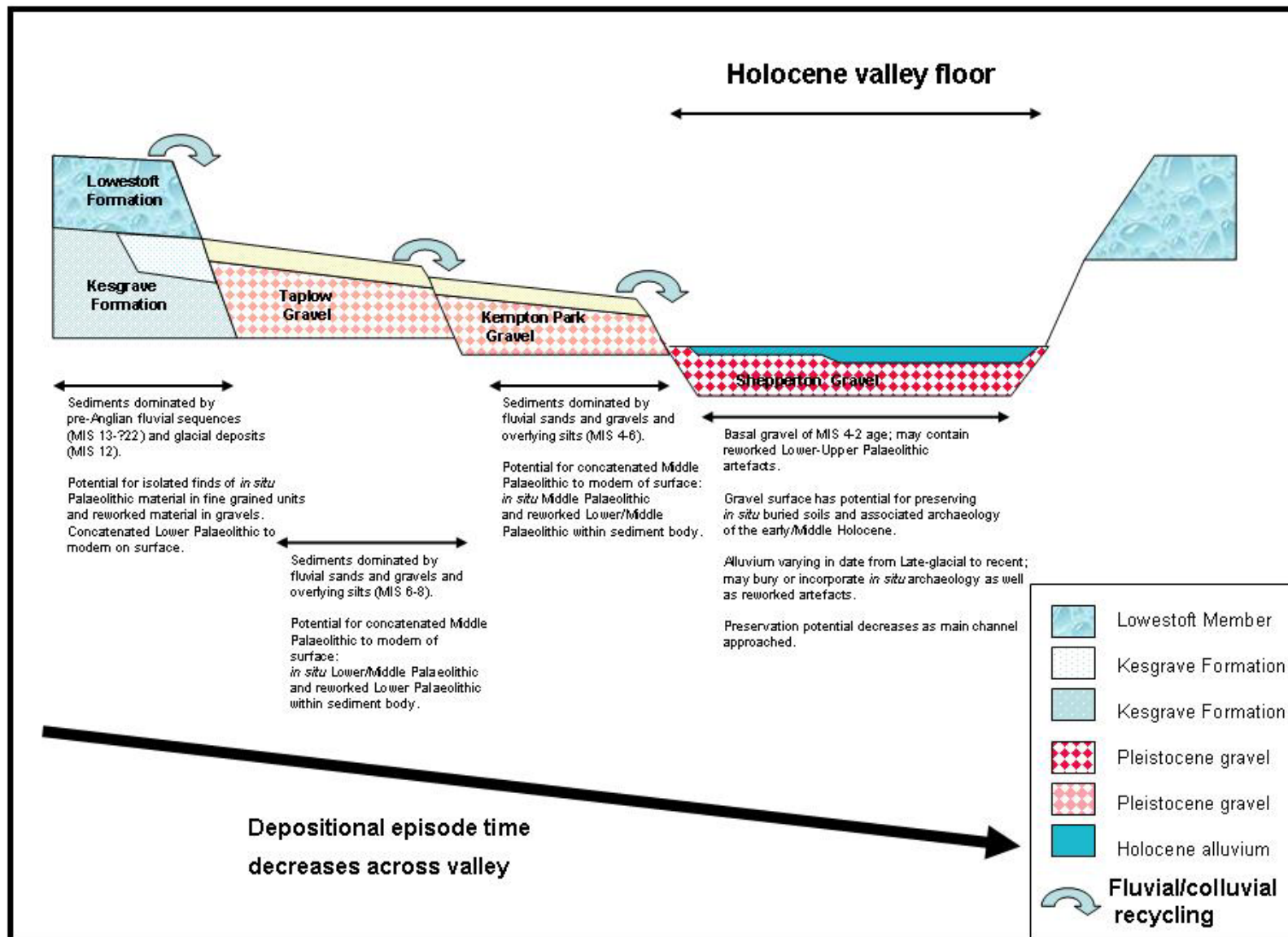
Introduction

The principal approach to integrating the geological and archaeological information in a meaningful way that can allow the contained archaeological resource to be interpreted has been through the development of a geoarchaeological model linking surface and sub-surface sequences, processes of both depositional and post-depositional character and site use/artefact discard/post-depositional behaviour. In order to achieve this interlinked approach a number of factors need to be considered:

- Site/sequence production factors. How was the site/sequence produced in the first place, what geological framework was responsible for site/sequence production.
- Temporal factors. How was the geological framework controlling site/sequence production modified through time, i.e. is it correct to assume that all temporal episodes are equally likely to produce sites/sequences for preservation?
- Site/sequence preservation factors. What are the post-depositional factors operating on the site/sequence that lead to preservation or destruction of the site/sequence and how do these vary through time

THE STRATIGRAPHIC FRAMEWORK

The broad stratigraphic framework was produced from the BGS mapping and academic study of the patterns of change during the Pleistocene and Holocene (e.g. Gibbard, 1985). Such models represent the baseline data for the region. This framework model enables a series of associated depositional environment types to be inferred that reflect geomorphological evolution and post-depositional factors that dictate the way in which archaeological material preserves. Consequently prediction may be made regarding the geoarchaeological operation of the region at a variety of scales as shown in the following diagrams.

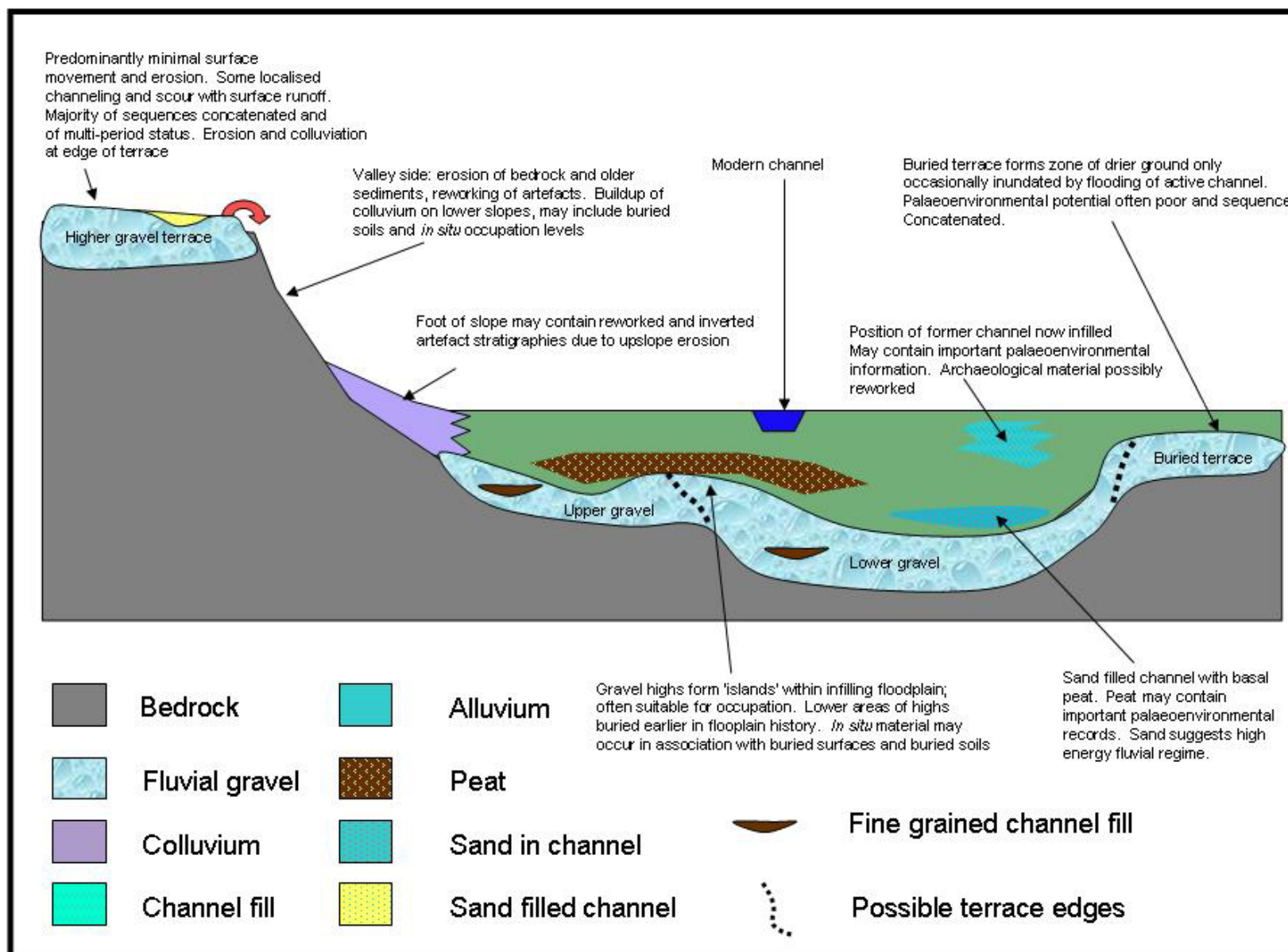


Regional stratigraphic framework and geoarchaeological issues for the Lea Valley

Geomorphic elements and evolution, depositional environments, post-depositional factors and archaeological preservation issues for the main lithostratigraphic elements in the Lea Valley study area.

Geomorphic element	Depositional environment type	Geomorphic evolution	Post depositional environmental factors	Archaeological preservation issues
Kesgrave Formation (MIS 13-722)	High energy river systems with non-cohesive channel banks with potential for lower energy river systems with cohesive channel banks and overbank flooding.	Episodic incision and aggradation of coarse grained sequences (sands/gravels). Sedimentation within braided systems resulting in stacked sequences of cut/fill form. Dominant lateral migration of sequences within overall sediment body.	Major erosion caused by fluvial incision and downcutting creating terraces in pre-diversion Thames system followed by glacial over-riding and modification. Post glacial (Anglian) weathering and colluviation.	<i>In situ</i> and reworked (through terrace systems) Lower Palaeolithic artefacts within main sediment body. Incision may lead to dewatering of sediments and through time decalcification of deposits lowering palaeoenvironmental potential. Surface of deposits may have concatenated sequences of Lower Palaeolithic to modern date.
Lowestoft Formation (MIS 12)	Glacial conditions with major ice bodies in sub-glacial or ice-sheet margin situations. High energy water flow and chaotic moraine dumps.	Till forming in ice marginal conditions during ice advance and sub-glacially during ice retreat phases. Localised lake formation in ice dammed locations.	Incised by south flowing tributaries of the diverted Thames. Weathering and colluviation of remnants.	Reworked Lower Palaeolithic artefacts within main sediment body. Surface of deposits may have concatenated sequences of Lower Palaeolithic to modern date.
Taplow Gravel (MIS 6-8)	High energy river systems with non-cohesive channel banks with potential for lower energy river systems with cohesive channel banks and overbank flooding.	Episodic incision and aggradation of coarse grained sequences (sands/gravels). Sedimentation within braided systems resulting in stacked sequences of cut/fill form. Dominant lateral migration of sequences within overall sediment body. Fine grained accretion within overbank situations during temperate episodes associated with meandering/anastomosing river system.	Sequences eroded through downcutting and left as terraced forms in post-diversion Thames system. Weathering and erosion (colluvial activity) on terrace edges.	<i>In situ</i> and reworked (through terrace systems) Lower Palaeolithic and Middle Palaeolithic artefacts. Incision may lead to dewatering of sediments and through time decalcification of deposits lowering palaeoenvironmental potential. Surface of deposits may have concatenated sequences of Lower Palaeolithic to modern date.

Kempton Park Gravel (MIS 4-6)	High energy river systems with non-cohesive channel banks with potential for lower energy river systems with cohesive channel banks and overbank flooding.	Episodic incision and aggradation of coarse grained sequences (sands/gravels). Sedimentation within braided systems resulting in stacked sequences of cut/fill form. Dominant lateral migration of sequences within overall sediment body. Fine grained accretion within overbank situations during temperate episodes associated with meandering/anastomosing river system.	Sequences eroded through downcutting and left as terraced forms in post-diversion Thames system. Weathering and erosion (colluvial activity) on terrace edges.	<i>In situ</i> and reworked (through terrace systems) Middle Palaeolithic artefacts (also occasional reworked Lower Palaeolithic artefacts). Incision may lead to dewatering of sediments and through time decalcification of deposits lowering palaeoenvironmental potential. Surface of deposits may have concatenated sequences of Lower Palaeolithic to modern date. Possible presence of rafts of sediments (including peats) resulting from incorporation in floating ice (Lea Valley Arctic Beds).
Geomorphic element	Depositional environment type	Geomorphic evolution	Post depositional environmental factors	Archaeological preservation issues
Shepperton Gravel (MIS 2)	High energy river systems with non-cohesive channel banks.	Episodic incision and aggradation of coarse grained sequences (sands/gravels). Sedimentation within braided systems resulting in stacked sequences of cut/fill form. Dominant lateral migration of sequences within overall sediment body.	Sequences buried by accumulation of Holocene alluvium.	Predominantly reworked Lower and Middle Palaeolithic artefacts. Surface of deposits may have late Palaeolithic material resting on surface. Possible presence of rafts of sediments (including peats) resulting from incorporation in floating ice (Lea Valley Arctic Beds).
Holocene alluvium (MIS 1)	Low to moderate energy river systems with cohesive banks and marsh development or floodplain conditions away from river.	Evolution of late glacial braided to Holocene anastomosing river with vertical accretion of sediment through time. Channel position becoming stable. Fine grained sediments predominate including biogenics (tufa/peat)	Some lateral erosion. Local water table fluctuations modify local conditions.	Range of later Prehistoric and Historical archaeological materials in situ on basal gravels or within landscape features associated with human activity. Much material may be <i>in situ</i> but reworking also apparent.

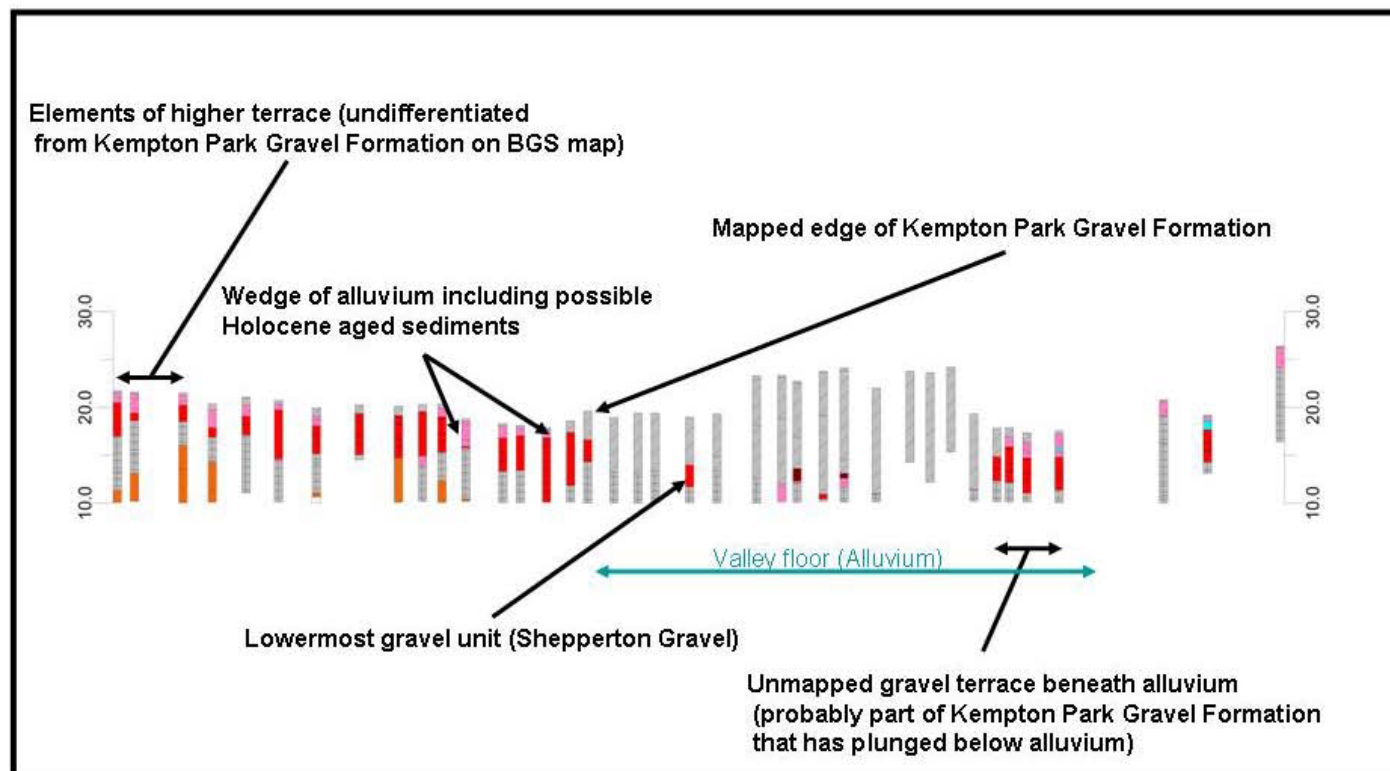


Regional stratigraphic framework and geoarchaeological issues for the Lea Valley with particular reference to the valley bottom 'Holocene' dequences

THE STRATEGIC FRAMEWORK... Cont.

The broad framework produced with reference to the BGS mapping and academic studies, coupled with the insight provided by the borehole information made it possible to consider subdivision of the area on the basis of geoarchaeological criteria. Here we have used the borehole data held in a Rockworks database to supplement the information derived from the geological mapping and more fully understand the nature of the subsurface stratigraphy

It should be remembered that much of the BGS mapping relies on near surface observations and consequently deeper buried elements (e.g. elements of buried Pleistocene terraces) will not appear through the BGS maps and without the reader having a detailed understanding of the map, approaches and regional geology the presence of important areas of sub-surface archaeology might be missed.



Geological transect along the M25 corridor showing how the borehole data in the Rockworks database can enhance our knowledge of the sub-surface stratigraphy. Here un-differentiated graves exist at both ends of the transect

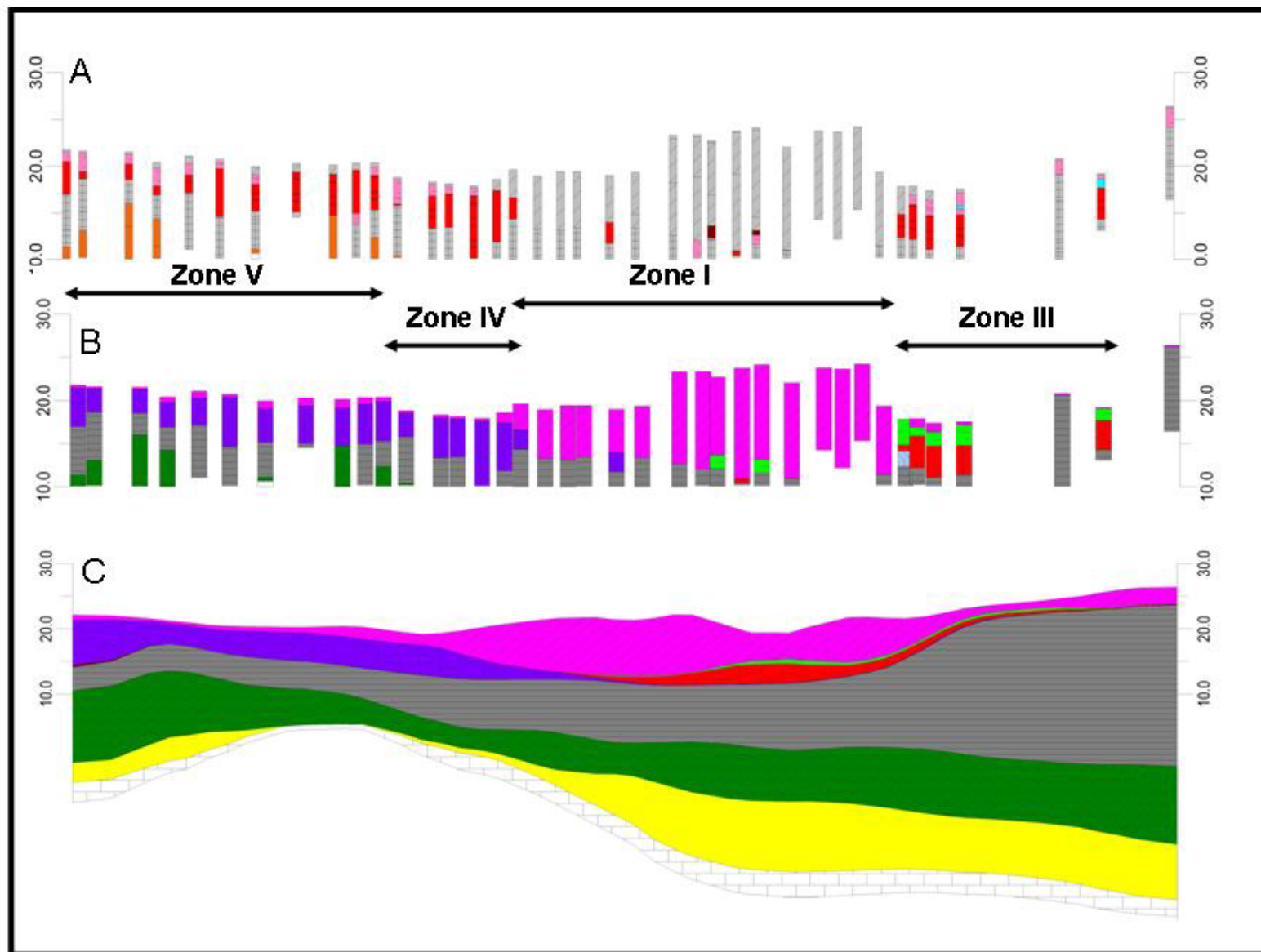


Figure Lithology; B: Stratigraphy; C: Modelled stratigraphy for section through Lea Valley study area along the line of the M25 showing the relationship between lithology, stratigraphy and geoaerchaeological zones.

THE ZONES

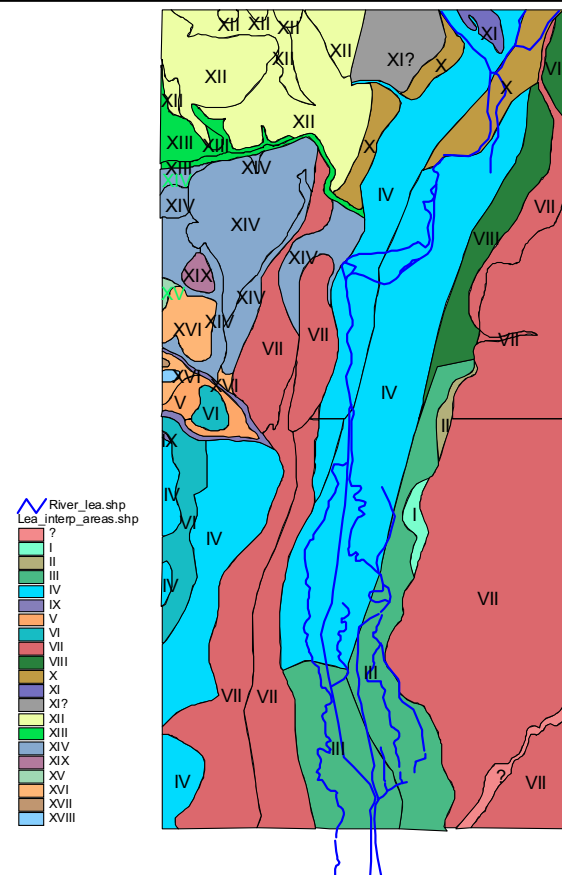
On the basis of this approach nineteen discrete zones have been identified throughout the region. These have been identified on the basis of:

- The mapped BGS superficial geology
- The position of the zones within the geomorphological framework
- The potential nature of sequences in transition zones between units mapped by the BGS (i.e. those areas in which sediments from 2 adjacent mapped zones may be intermittently distributed).

The zones are available as a shapefile with detailed attribute data appended (see below).

Attributes in the zone shapefile

- Zone
- Total area of the zone
- Area lost to extraction
- Percent of area lost
- Number of boreholes
- Geomorphological characteristics
- Sediment characteristics
- Superficial geology
- Superficial geology description
- Bedrock geology
- Bedrock description
- Sequence of deposits likely to be present
- Age range of sediments
- No of known Palaeolithic sites/finds
- As above Mesolithic
- As above Neolithic
- As above Bronze Age
- As above Prehistoric (un-defined)
- As above Iron Age
- As above Roman
- As above Saxon
- As above Medieval
- As above Post Medieval
- As above Modern
- As above Unknown period (e.g. cropmarks)
- Key research questions
- Investigative strategies



Geomorphological and sediment characteristics for zones I – XIX.

Zone	Geomorphological characteristics	Sediment characteristics	Mapped sediments	Likely sequences present
I	Valley floor, dominated by meandering channels, canalized channels and low slope angles (<1°)	Floodplain fines (clays/silts/sands and organics) over gravels and sands. Area of deep basin like feature in gravel surface topography.	Alluvium	Alluvium of Holocene date overlying gravels of Late Devensian date (Lea Valley Gravel)
II	Valley floor, dominated by meandering channels, canalized channels and low slope angles (<1°)	Floodplain fines (clays/silts/sands and organics) over gravels and sands	Alluvium	Alluvium of Holocene date overlying gravels of Late Devensian date (Lea Valley Gravel)
III	Valley floor, dominated by meandering channels, canalized channels and low slope angles (<1°)	Floodplain fines (clays/silts/sands and organics) over gravels and sands	Alluvium	Alluvium of Holocene date overlying gravels of Late Devensian date (Lea Valley Gravel). Towards edge gravels of the Kempton Park Gravel (earlier part of Devensian) may exist beneath the alluvium
IV	Valley edge, low lying topography (<3°)	Thin veneer of fine clays-silts overlying sands and gravels	Kempton Park Gravel Formation	Much of area will consist of early to mid Devensian sand and silts over gravels but thin spreads of Holocene alluvium may also be present
V	Valley edge, low lying topography (<3°)	Thin veneer of fine clays-silts overlying sands and gravels	Kempton Park Gravel Formation	Much of area will consist of early to mid Devensian sand and silts over gravels
VI	Valley side, low lying topography (<3°)	Fine grained clays-silts.	Enfield Silt Formation	Mid to Late Devensian silt probably overlying older gravels of the Kempton Park Gravel Formation
VII	Valley side	Bedrock at surface	Bedrock (various)	Eroding bedrock
VIII	Valley side, low lying topography (<3°)	Fine grained clays-silts.	Enfield Silt Formation	Silt possibly of multi-period formation overlying gravels of the Kempton Park Gravel Formation (downslope) and Taplow Gravel Formation (upslope)
IX	Valley side	Sands and gravels	Taplow Gravel Formation	MIS 6-4 cold stage gravels and possible warm interglacial silts
X	Valley side	Fine grained clays-silts.	Enfield Silt Formation	Silt possibly of multi-period formation overlying gravels of the Taplow Gravel Formation (upslope)
XI	Valley floors in tributary valleys	Coarse gravel and sand overlain by fine grained clay-silts	Alluvium	Probably late Devensian gravels beneath Holocene silts. Elements of colluvium probably also present

XII	Valley tops/plateau margins	Clays with poorly sorted gravels	Lowestoft Foramtion	Mixed packages of clay dominated till, coarse gravels intermittently present. Of Anglian date
XIII	Valley floors in tributary valleys	Coarse gravel and sand overlain by fine grained clay-silts	Alluvium	Probably late Devensian gravels beneath Holocene silts. Elements of colluvium probably also present
XIV	Valley tops/plateaus	Sands and gravels	Kesgrave Formation	Stratified sands and gravels with Pre-Anglian Thames deposits
XV	Valley tops/plateaus	Sands and gravels	Dollis Hill Gravel Formation	
XVI	Valley side	Sands and gravels	Taplow Gravel Formation	MIS 6-4 cold stage gravels and possible warm interglacial silts
XVII	Valley side	Fine grained clays-silts.	Enfield Silt Formation	Silt possibly of multi-period formation overlying gravels of the Kempton Park Gravel Formation (upslope), through the Taplow Gravel Formation to the Kesgrave Gravel Formation.
XVIII	Upper Valley side	Sand and gravel	Unknown	Possible fluvial sands and gravels
XIX	Valley floor, dominated by meandering channels, canalized channels and low slope angles (<1°). River confluence zone	Floodplain fines (clays/silts/sands and organics) over gravels and sands	Alluvium	Alluvium of Holocene date overlying gravels of Late Devensian date (Lea Valley Gravel). Towards edge gravels of the Kempton Park Gravel (earlier part of Devensian) may exist beneath the alluvium

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