ASSESSMENT OF ARCHAEOLOGICAL RESOURCE IN AGGREGATE AREAS IN THE LONDON BOROUGH OF HAVERING
London

London Borough of Havering

ALSF project

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Contents

Tables

Graphs

Figures

Executive Summary

Museum of London Archaeology (MOLA) and the London Borough of Havering, with funding from the Aggregates Levy Sustainability Fund administered by English Heritage, carried out an assessment of the archaeological resource in aggregates producing areas within the Greater London Borough of Havering. The primary aim of the project was to improve knowledge of the archaeological resource of the aggregate producing areas of Havering in order to provide the appropriate tools to facilitate strategic planning decisions, and the management and preservation of archaeological sites and historic landscapes within those areas.

The project was primarily a GIS-based data analysis of available archaeological data; it identified, characterised and digitally mapped, available information on Havering's archaeological resource in areas of past, present and potential future aggregates extraction. This was intended to enhance existing baseline data, to improve archaeological mitigation of future extraction proposals in the borough, and to increase public, industry and other stakeholders' awareness of the archaeology and historic landscapes within the aggregates areas.

The assessment focussed on four selected Study Areas within Havering and tried to make a correlation between potentially commercially valuable aggregates and zones of past human activity. Areas of past, present and potential future extraction were identified from British Geological Survey (BGS) mapping, historic Ordnance Survey (OS) maps, the BritPits database and current minerals permissions. Urban areas were excluded from the assessment as these would not be subject to any extraction in the future.

The project entailed the enhancement of the Greater London Historic Environment Record (GLHER) for Havering with archaeological data from the National Monuments Record (NMR) database, as well as transcribed archaeological cropmarks/parchmarks visible on air photographs from the National Mapping Programme (NMP). The enhanced data was then further modified to show the distribution of past human activity on the aggregates resource by chronological period and by type of archaeological find or feature, i.e. 'asset' (e.g. domestic, industrial, agricultural etc). The report summarised and analysed the asset density and asset distribution for each chronological period, and attempted to identify any patterns in past occupation and activity and the history of archaeological investigation, in order to assess how the information could be used for future heritage asset resource management. Through a series of asset density maps, this has provided an invaluable overview of the nature of activity over time, which has not previously been possible.

The assessment revealed some clear patterns associated with asset density, geology, topography and asset distribution. Study Areas with a history of gravel extraction had the highest number of assets, followed by those areas that have been subject to past investigations such as fieldwalking projects or NMP mapping. The highest density Study Area (in the southern part of Havering) is also associated with the East London Gravels project, for which a number of investigations had been carried out in advance of extraction. These investigations have provided invaluable information and dating evidence across various periods, and they highlight the importance of archaeological investigation in extraction areas.

The asset density reflects current understanding of the archaeological resource, with lower density areas being less well understood than high density areas. The report also highlights some irregularities in the general trend of increased asset density which may

indicate anomalies within the data resulting, from investigation practices or genuine aspects of past occupation and activity. Visibility and attraction for investigators also plays an important role in the recording of assets. Whilst cropmarks and earthworks, for example, would be more obvious to investigators, other assets are likely to be underrepresented because they remain buried and are therefore harder to identify.

Several factors in recovering archaeological evidence were highlighted in the project: investigation in advance of extraction has played an important role in the recovery of assets, and where mitigation is carried out, detailed dating evidence can be collected an provide significant information of the historic landscape character of an area; in areas with a low density of investigations in advance of development/extraction, fieldwalking has played a major role in the recording of assets, although with less dating evidence as the recording largely relies on visibility of an assets.

The asset densities and accompanying archaeological resource assessment provided the basis for a research strategy and agenda. This identified a number of general research priorities comprising, e.g. extension of the NMP survey across the Borough, re-assessment of assets recovered by antiquarians (where possible); and targeted investigation of assets of uncertain date or nature. Further specific research priorities were identified to improve understanding of particular periods. This research framework would be appropriate to any investigation into the archaeology or heritage of the aggregates resource.

A stakeholder seminar was held at Museum in Docklands, following the completion of the draft report. Stakeholders, local experts, specialists and representatives of the industry were invited to hear about the project and to discuss and comment on its results. These comments were incorporated in the final version of the assessment report, which has been disseminated on CD Rom, as word and pdf documents.

1 Introduction

1.1 Background

1.1.1 This project is a survey of the archaeological assets of the London Borough of Havering (LBH) focussing on areas where aggregates have been extracted, are being extracted, or which have the potential to produce aggregates in the future. It has been undertaken by Museum of London Archaeology (MOLA) working closely with Havering Council and the Greater London Archaeological Advisory Service (GLAAS). The project was funded by the Aggregates Levy Sustainability Fund (ALSF) administered by the English Heritage (EH) Historic Environment Enabling Programme (HEEP). The project follows similar projects in Gloucestershire, Worcestershire, Warwickshire, Norfolk, Suffolk and the Isle of Wight.

1.1.2 The primary aims of the project were to improve the quality and quantity of available archaeological data in respect of potential aggregate producing areas within Havering, and to facilitate more informed advice concerning the impacts and mitigation of present and future aggregates extraction. It is intended that this will provide input to:

- Reviews of minerals frameworks;
- Reviews of existing minerals permissions;
- Assessment of new application sites for minerals permissions;
- Archaeological Research Frameworks;
- Mitigation strategies for archaeological remains in minerals extraction sites;
- Future Research.

1.1.3 The data may also be of use to:

- Produce baseline archaeological data to facilitate mineral planning decisions;
- Define all actual and potential areas of aggregate working, creating a Geographical Information System (GIS) database;
- Enhance the Greater London Historic Environment Record (GLHER) in the aggregate producing areas;
- Assess the state of archaeological knowledge of each aggregate producing area (Resource Assessment);
- Develop an archaeological Research Agenda and Research Strategy for aggregates areas to complete the Research Framework;
- Develop historic environment policies and mitigation strategies for aggregates areas;
- Increase understanding of archaeology and aggregates and facilitate further dialogue between archaeologists, minerals planners, the public and the aggregates industry.

1.1.4 The principal outputs of this project have been this report and GIS mapping, which can be used to enhance the GLHER. It is also available in the form of a CD-ROM and as downloadable pdf files on-line from the Archaeological Data Service (ADS).

1.1.5 This project is in accordance with ALSF Theme 1.1 Quarries:

> "Identification and characterisation of the historic environment in key existing or potential areas of terrestrial extraction"

1.1.6 It has been designed to meet published criteria for ALSF projects (english-heritage.org.uk/server/show/nav.1315):

- developing the capacity to manage aggregate extraction landscapes in the future;

- delivering to public and professional audiences the full benefits of knowledge gained through past work in advance of aggregates extraction;
- reducing the physical impacts of current extraction where these lie beyond current planning controls and the normal obligations placed on minerals operators;
- addressing the effects of old mineral planning permissions;
- promoting understanding of the conservation issues arising from the impacts of aggregates extraction on the historic environment.

1.1.7 The project accords with English Heritage research themes

> A 'Discovering, studying and defining historic assets and their significance'; and
>
> D 'Studying and assessing the risks to historic assets and devising responses' (English Heritage 2005b, 4).

1.1.8 The project was carried out in accordance with the English Heritage Corporate Strategy which is integral to the Strategic framework for Historic environment Activities and Programmes in English Heritage (SHAPE 2008). In accordance with the SHAPE framework, the primary driver of the project can be identified as Corporate Objective 1A:

> 'Ensure that our research addresses the most important and urgent needs of the historic environment'.

1.1.9 This objective would be achieved through Research programme G2 'Defining the questions: Devising research strategies, frameworks and agenda' within sub programme number 11172.110 'Supporting research Frameworks: national, regional, local, diachronic and thematic frameworks'.

1.1.10 The project can also be identified within Corporate Objective 4B:

> 'Develop and disseminate policies, principles, guidelines, standards and exemplars to promote better management of change in the historic environment'

1.1.11 This objective would be achieved through Empowerment programme D4 'Guidance for Local Government'. This would place the project within sub programme number 42244.110 'Promoting Characterisation in Strategic Planning'.

1.2 Report Scope

1.2.1 This report includes:

- A description of the origins, background, financing and personnel of the project (Section1);
- A description of the aims and objectives of the project and how they have been fulfilled (Section 2);
- A discussion of the methodology used to achieve those objectives, including its origins, problems encountered during the project and measure taken to resolve them (Section 3);
- A description of the aggregates resource within the Study Area, including its geological origins, geology types and history of past and proposed future extraction (Section 4);
- An overview of past archaeological investigation of aggregate areas in Havering (Section 5);
- Period based summaries of the current state of knowledge for each of the main archaeological periods. It includes a short discussion of the distribution of known finds and sites across the Project Area and in relation to aggregates and a discussion of their significance (Section 6);
- A summary of the density assessment (Section 7);
- A discussion of spatial trends (Section 8).

- A discussion of the limitations placed upon the project by the nature of the data being used (Section 9);
- An outline of the research agenda organised by period and a summary of the key research objectives (Section 10);
- A discussion of approaches to mitigation including the likely impact of aggregate extraction on archaeological remains, the relevant Planning Policy, the types of invasive and non-invasive investigations undertaken to determine the likely potential and significance of any archaeological remains on sites, and appropriate mitigation strategies for different types of archaeological remains (Section 11);
- A conclusion summarising the project origins, methods and results (Section 12) and Acknowledgements (Section 13);
- Bibliography (Section 14) and Appendices detailing additional information associated with the methodology (Section15);
- The final part of this report (Section 16) with all the period based distribution maps.

1.3 Management and Personnel

1.3.1 This project was managed by MOLA and undertaken at Mortimer Wheeler House, 46 Eagle Wharf Road, London N1 7ED. The English Heritage (EH) Project Officers were Robert Whitehead (GLAAS) and David Divers (formerly GLAAS North-East, now MOLA); the advisor for the London Borough of Havering is Peter Hall of the LBH Development Planning Team.

1.3.2 The management team consisted of:

- David Bowsher, MOLA Senior Post-Excavation Manager (Project Executive)
- Jon Chandler, MOLA Assessments Manager (Project Manager)

1.3.3 Project members in addition to the management team included Expert Team Leaders and Experts.

Expert Team Leaders

- LBH Development Planning Team Leader (PH) – Peter Hall and his team provided information regarding the current state of Minerals Planning Policy;
- GLHER Manager (SC) – Stuart Cakebread and his team provided GLHER baseline datasets and advice on data enhancement;
- Project Officer (IR) – Iris Rodenbüsch MOLA Senior Archaeologist (Assessments) undertook most of the project, wrote the Project Report and co-ordinated the work of other team members;
- Geomatics Manager (SJ) – Sarah Jones, MOLA Geomatics Manager created a bespoke ArcGIS project, supervised GIS specialists and provided advice and feedback on GIS aspects of the project;
- Graphics Manager (TW) – Tracey Wellman, MOLA Graphics Manager was responsible for the supervision of the graphics team providing figures and illustrations for the report.

Experts

- GIS Specialists (GS) - The MOLA Geomatics team prepared and loaded datasets;
- Geoarchaeology Specialists, were consulted where appropriate;
- LBH former Conservation Officer (SS) – Sue Smith commented on the period summaries and general background;

- Period experts - Period experts including Jon Cotton (JC), Jenny Hall (JH) and Bob Cowie (BC) commented on the period summaries of the Resource Assessment.

1.4 The Project Area

1.4.1 The Project Area is located in the London Borough of Havering (LBH), hereafter referred to as Havering (Fig 1). To the north and east the borough is bordered by the Essex countryside, to the south by the River Thames, and to the west by the neighbouring boroughs of Redbridge and Barking & Dagenham.

1.4.2 The name 'Havering' devolves from the Royal Liberty of Havering, to which Edward IV granted a charter in 1465. Edward the Confessor was the first notable person to have a connection with the area. He occupied the royal house in the village of Havering atte Bower. The London Borough of Havering was created in 1965 as a result of the merger of the former Romford Borough and Hornchurch Urban District Councils (VCH *Essex* VII, 1-8).

1.4.3 The assessment area comprises those areas of Havering that contain aggregate geologies which are, have been or could potentially be extracted (i.e. are not within urban areas). Havering covers an area of 114.5km^2 and the aggregate geologies cover a large part. After buffering (see Section 3.1.5), the Project Area had a size of 37.6km^2, just under a third of the borough. The Project Area was then subdivided into four discreet 'study areas', largely based on topography and the nature of the archaeological resource (see Section 3.3). For the purposes of this assessment the identified potential aggregate geologies include both solid and superficial geologies (see Section 4.4), typically sand and gravel deposits.

1.5 Minerals Planning Context

1.5.1 The purpose of the project was to construct a strategic overview of the extent and character of the aggregates deposits in Havering, and the archaeological resources within those areas. This increased understanding was intended to inform the prioritisation of the preservation of significant sites (through formal designation and other resource management methods) and the management of all sites through the minerals planning process.

1.5.2 The report will provide an appraisal of the Borough's aggregate mineral resources from an archaeological perspective, and form a suitable tool to identify constraints on extraction and opportunities for further archaeological research.

1.5.3 Havering has produced aggregate for development in Greater London for much of the 20th century and continues to contain large reserves of aggregates resources. As a member of the London Aggregates Working Party, the Council has been involved in ongoing discussions with the Greater London Authority (GLA), other minerals planning authorities and the aggregates industry over the production figure in the draft replacement London Plan (published in October 2009). In September 2010 the GLA published a further alteration to the draft replacement London Plan policy on aggregates which reduced the London-wide production figure from 1 million tonnes to 700,000 tonnes per annum (tpa) and apportions this target between the four minerals planning authorities within London at a rate of 250,000tpa to Havering and Hillingdon, and 100,000tpa to Hounslow and Redbridge. This matter was discussed at the Examination in Public in December 2010. While the Inspector's Report has yet to be published, it is expected that the minor alteration to the policy on aggregates will be accepted.

1.5.4 The London Borough of Havering's Core Strategy (Adopted July 2008) of the emerging Local Development Framework (LDF) includes Core Policy CP13 (Minerals Extraction) which sets out the Council's strategic approach to minerals extraction in the borough. As part of the LDF, the Council will identify specific sites and preferred areas for aggregates extraction in a separate Minerals Sites

Development Plan Document (DPD). The Minerals Sites DPD will be a statutory document within the LDF with the purpose of implementing CP13 as set out in the Core Strategy. This will be achieved by allocating suitable (and available) sites to make provision for an output of 250,000tpa of aggregates to 2027, including appropriate phasing of and controls on the identified sites to ensure the prudent use of Havering's reserves of primary aggregates and protection of residents' amenity and the environment.

1.5.5 In October 2010 the Borough of Havering produced the Scoping Report document which forms Stage A in the Sustainability Appraisal (SA) process for the Minerals Sites DPD. It addresses the requirements of Strategic Environmental Assessment (SEA) as required under the European Union Directive 2001/42/EC, and Sustainability Appraisal (SA) as required by Section 39 of the Planning and Compulsory Purchase Act 2004. In line with Government Guidance 1, it acts as an addendum to the Havering Core Strategy Scoping Report produced in March 2005, and reflects a second stage of scoping that contains additional information relevant to the assessment of the Minerals Sites DPD (Minerals Sites Development Plan Document Sustainability Appraisal Scoping Report, October 2010). The Council expects to publish the Minerals Sites DPD Issues and Options Report for consultation in May 2011.

1.5.6 In addition, the London Borough of Havering also adopted its 'Heritage' Supplementary Planning Document (SPD) in March 2011. The SPD provides guidance on the implementation of those Core Strategy and Development Control policies of the LDF relating to heritage. The SPD includes a section on archaeology and ancient monuments and additional guidance on the implementation of Development Control Policy DC70 (Archaeology and Ancient Monuments). The SPD makes particular reference to Archaeological Priority Areas (APAs) and Archaeological Priority Zones (APZs) in Havering and outlines the key issues to be considered and addressed in applications that relate to development within either of these.

1.5.7 In view of the current review of minerals planning policy, this report produces a survey of the archaeology assets within Havering focussing on areas where aggregates (and other mineral resources) have been extracted, are in the process of being extracted, or will potentially be extracted in the future. It is intended that this assessment should provide a foundation for both the application of existing minerals planning policy and the development of future policies and to facilitate a greater interface between those with an archaeological interest in these areas and those involved with minerals planning and extraction.

2 Aim and Objectives

2.1 Aims

2.1.1 The primary aim of the project is to improve knowledge of the archaeological resource of the aggregate producing areas of Havering. This would provide the appropriate tools to facilitate strategic planning decisions and the management and preservation of archaeological sites and historic landscapes within those areas. The project also aims to identify, characterise and digitally map available information on Havering's archaeological resource in areas of past, present and potential future aggregates extraction; this is intended to enhance existing baseline data, to improve archaeological mitigation of future extraction proposals in the borough, and to increase public, industry and other stakeholders' awareness of the archaeology and historic landscapes within the aggregates areas.

2.2 Objectives

- Produce baseline archaeological data to facilitate mineral planning decisions. For the methodology adopted to address this objective see 3.2 for the definition of aggregate geologies, 3.3 for the definition of the aggregates resource and 3.6 for the definition of the study areas;
- Define all actual and potential areas of aggregate working (the 'aggregates resource'), creating a GIS-based database. For the methodology adopted to address this objective see 3.2 for the definition of aggregate geologies and 3.3 for the definition of the aggregates resource;
- Collate all available archaeological data for aggregate producing areas. For the methodology adopted to address this objective see 3.5. The outputs for this objective formed the inputs into the Resource Assessment (Objective 7);
- Enhance the GLHER in the aggregate producing areas with data from the National Monuments Record (NMR) data, National Mapping Programme (NMP) survey and the results of the 'Backlogs Project' (Objective 5);
- Assess the state of archaeological knowledge of each aggregate producing area (Resource Assessment). For the methodology adopted to address this objective see 3.9. For the Resource Assessment see Sections 6 and 8;
- Develop an archaeological Research Agenda and Strategy for aggregates areas. For the methodology adopted to address this objective see 3.10. For the Research Agenda and Strategy see Section 10;
- Develop historic environment policies and mitigation strategies for aggregates areas. For the methodology adopted to address this objective see 3.11. For a discussion of appropriate assessment, evaluation and mitigation strategies see Section 11;
- Increase understanding of archaeology and aggregates and facilitate further dialogue between archaeologists, minerals planners, the public and the aggregates industry. For the methodology adopted to address this objective see Section 3.

3 Methodology

3.1 Introduction

3.1.1 The project is based upon the methodology designed for *Archaeological Resource Assessment of the Aggregates on the Isle of Wight* (MOLA 2010a), *The Aggregate Landscape of Gloucestershire; Predicting the Archaeological Resource* (Mullin 2004) and that of *Archaeology and Aggregates in Worcestershire* (Jackson and Dalwood 2007). It entailed the following stages:

- Definition of the aggregate resource (including definition of aggregate geologies, identification of past extraction sites and exclusion of urban areas) and creation of the Study Areas;
- Enhancing and cleaning of the extracted GLHER data, from the Backlogs Project, NMP survey and NMR data;
- Creating asset density maps for asset types within each chronological period;
- Creating an Archaeological Resource Assessment for the aggregates resource (in the form of period summaries);
- Developing a Research Agenda and Strategy for the aggregates resource;
- Outlining recommendations for future research and mitigation of aggregates extraction.

3.1.2 Project data was managed by means of a geographical information system, ArcGIS (ArcMAP 9.3.1). GIS shows spatial data (the map) with underlying information on that data held in a table, which can be exported in various formats compatible with excel and other spreadsheet and database programmes.

3.2 Defining the Study Areas

Defining the aggregate Resource

3.2.1 The Aggregates Geologies were those areas of Havering which are presently, have been or potentially could be exploited to produce aggregates. The definition of the aggregate resource consisted of the identification of the relevant geologies and their spatial extent, using British Geological Survey (BGS) Directory of Mines and Quarries (BGS 2008). GIS polygons of existing minerals sites, identified in the borough's Unitary Development Plan (UDP), and the BritPits Database (obtained under licence), were used to identify aggregate extraction sites and to determine their underlying geologies.

3.2.2 At this stage proposed future minerals sites being developed for the emerging Minerals Sites Development Plan Document of the LDF were not within the public domain and could not therefore be used as a project resource. However, Peter Hall and other Havering Planning Officers were consulted about which geologies were considered to have aggregate extraction potential.

3.2.3 With advice from the LBH Planning Team and the GLAAS, the river and plateau terrace gravels were identified as having the potential to provide aggregates.

Current and Potential Exploitation

3.2.4 The London Borough of Havering (LBH) Planning Team provided the location and extent of current extraction sites. The type of aggregates produced by each of these sites, either bedrock or superficial, were identified and the sites were compared to the appropriate underlying geology maps. This produced a list of all currently exploited geologies.

3.2.5 Data was obtained from the BGS that consisted of general geological tables at a

nominal scale of 1:50,000 in order to define the spatial extent of relevant geologies, both bedrock and superficial aggregates (Fig 2). General geological resource data at 1:50,000 was supplied in digital format by the LBH planning department. The aggregates resource for the purposes of this project included any aggregates geologies which have not been scoped out (i.e. any aggregates resource not located within an urban area (see section 3.2.16).

3.2.6 The spatial extent of the relevant geologies was cross-referenced with areas of past and current minerals extraction and potential future extraction areas, to confirm that BGS mapping of the aggregates resource accurately reflected the exploited geologies. Present minerals extraction were identified from BGS data, BGS BritPits database (under licence), the LBH Minerals Planning data which is available in the public domain, Ordnance Survey (OS) 6":mile maps from London Borough of Havering (digital copies of 1st, 2nd, 3rd and revised editions and of most OS 1:10,000 scale maps post 1945). The BritPits data for Havering is shown on Fig 3.

3.2.7 Potential future areas allocated for minerals extraction were identified from the LBH Core Strategy and Development Control Policies DPD and forthcoming Minerals Sites DPD where these are available in the public domain. These past, present and future areas of aggregates extraction were included as layers of polygons within the GIS.

3.2.8 The areas of aggregate geology identified from the BGS were buffered by 100m to allow for any areas where aggregates are present beneath non aggregate deposits. Urban areas were plotted from current ArcGIS mapping and excluded from the aggregates resource layer.

3.2.9 The nature of the exploited geology, topography and landscape character was used to subdivide the aggregates resource into four specific study areas, represented by GIS polygons. This was undertaken with advice and comment from David Divers (MOLA) and Peter Hall (LBH), in order to ensure the Study Areas are appropriate and useful in the context of the subsequent archaeological analysis and current Minerals Planning proposals.

3.2.10 With advice from the LBH, the geologies/river terrace gravels with a potential to provide aggregates were identified. There are no hard stone geologies in Havering, only drift/superficial aggregate geologies.

Past Extraction

3.2.11 Areas of historic aggregate exploitation were identified in order confirm that the known extent of aggregate geologies as mapped by the BGS etc were accurate. In order to do this, digital Landmark Epoch Ordnance Survey (OS) 6 inch to the mile (1:10,000) scale maps were obtained under licence from the LBH, covering the period from the OS 1st edition in the late 19th-century to the present day. Quarries and pits shown on these maps were digitised as polygons in GIS to provide a distribution map of past aggregate and hard stone extraction. Any quarry or pit labelled as such was included, except where these were specifically labelled 'Brick Pit' or 'Clay Pit' on the map (brick and clay not being derived from aggregate). Features marked as 'ponds' on historic maps, where they reached a certain size and where not specifically within a domestic context, were also included in the past exploitation data and assumed to be water-filled former gravel pits. A total of 172 historic extraction sites were identified. The distribution of these extraction sites broadly agreed with the Black Park, Boyn Hill, Hackney, Lynch Hill, Stanmore and Taplow Gravel mapping of aggregate geologies as plotted by the BGS. The past and present extraction sites in Havering are shown on Fig 3.

Buffering

3.2.12 The digitised polygons of aggregate areas were buffered by 100m to allow for areas of low resolution in the geological survey, and to provide a wider context for the assessment of archaeological resources along the periphery of the aggregate

geologies.

3.2.13 In order to simplify the process of extracting data from the GLHER, the buffered polygons were merged to create a single polygon identified as the 'Aggregates Resource'. Figure 3 shows the buffered areas of relevant aggregates geology for Havering.

Excluded Areas

3.2.14 Urban Areas were excluded from the Aggregates Resource layer because, as stated in the Project Design, the nature of tenure (i.e. perpetual ownership of bricks and mortar) in urban areas makes future minerals extraction unlikely to take place. The extent of urban areas was based on current mapping. The Urban Areas polygons were buffered by 100m to allow for growth and development and because aggregate extraction is unlikely to be permitted in close proximity to such areas.

3.3 The Study Areas

Introduction

3.3.1 The aggregate resource within Havering identified above (the 'Project Area') was subdivided into four discreet 'study areas' based on the geology being exploited, the topography of Havering, and the landscape character. This element of the project meets Objective 1.2.3: the definition of the Study Areas (including their geology, topography and boundaries) are described below and they are shown in Figure 4.

Study Area 1

3.3.2 This Study Area is located in the north-west of the borough, in the open area between Romford and Ilford. The dominant aggregates resources in this area are the Hackney gravel formation in the south of the Study Area, and patches of Boyn Hill (second terrace) gravel in the north. In the north-west of Study Area 1, the BGS shows outcrops of London Clay. The Boyn Hill gravel was first defined near Maidenhead and occurs in the main Thames valley and in the tributary valleys of the Lea, Roding and Wey. The Hackney Gravel, formerly known as the Taplow terrace, was later identified as a separate deposit (Ellison 2004, 62). The BritPits database shows three former extraction sites located in the southern part of this Study Area and further potential aggregates geologies are located in the north.

Study Area 2

3.3.3 This Study Area is located in the north-east of the borough, east of Romford, and north of Upminster. The relevant aggregates geologies of this Study Area are located mainly in its southern part and comprise the Black Park (first and oldest terrace) and Boyn Hill (second terrace) gravel formation. This is in places capped by Brickearth (Enfield Silt formation) and head deposits. The northern part of the Study Area is dominated by outcrops of London Clay. The Black Park gravel is generally recognised as the oldest deposit was laid down by the Thames in its current position (Ellison 2004, 62). There is no BritPits data in this area, but the historic OS maps show some former extraction activity in the southern part and the underlying geology has potential for future extraction.

Study Area 3

3.3.4 Study Area 3 is located in the south-west of the borough, south-west of Hornchurch. The southern part of this Study Area is dominated by the Taplow gravel whilst the BGS shows Hackney gravel in the northern part. The Taplow gravel terrace formation is correlated from the Tye area near Maidenhead eastwards to London. Extensive deposits of Taplow gravel occur in the Thames valley and in the lower parts of the Brent, Wandle, Lea, Cray and Darnet valleys. Deposits of alluvium are

also located within this Study Area, along the river valleys of the Beam in the south and Ravensbourne and Rom in the north. The BritPits database shows quarried areas in the south as well as the north and a large registered landfill site is located in the southern part.

Study Area 4

3.3.5 Study Area 4 is located in the south-east of the borough and forms the largest of the four Study Areas, with the highest number of past aggregates extraction sites. There are four types of aggregates present: patches of Taplow gravel are located in the south-west, the Lynch Hill gravels in the centre, a small area of Boyn Hill gravels is located in the north-east and a very small area is also located on the Black Park gravel formation. In the north-east, the gravel terraces are capped by deposits of head. Alluvium has formed along the Ingrebourne Rivers and the Southall Sewer. The BritPits database shows a large number of extraction sites concentrated in the centre and the south of this Study Area, and the historic OS maps have shown a number of smaller former quarry pits in the north-east.

3.4 Data collation and GLHER enhancement

Data sources

3.4.1 In order to meet objectives 1.2.5 and 1.2.6, additional data was obtained from:

- The GLHER, maintained by EH/GLAAS. The database has recently been enhanced by information from the Greater London Backlogs project, carried out by MOLA (MOLA 2010b);
- The National Monuments Record (NMR), maintained by EH. This is generally not as comprehensive as information within the county HERs, but can occasionally contain additional information;
- LAARC – London Archaeological Archive and Research Centre data on past archaeological investigations maintained by the Museum of London;
- NMP archaeological cropmark/parchmark transcriptions of the southern part of Havering;
- Archaeological cropmark/parchmark transcriptions in the part of Havering not covered by the NMP, undertaken as part of the ALSF funded East London Gravels Project (Swift *et al* forthcoming).

The GLHER

3.4.2 The GLHER comprises a computerised database of designated and non-designated historic assets (sites of archaeological and historic importance) within Greater London, and includes diverse information about the archaeological landscape and related data about finds, sources and recording events. The database, one of the largest in the country, contains records from the earliest human occupation of the area that is now Greater London through to the Cold War. However, use of GLHER data, especially for academic research, has limitations of which researchers and others should be aware.

3.4.3 HERs have responded to the increased use of their resources and advances in computing (networks, hardware and applications) have facilitated this process. However, HERs have not had the resources to reconfigure records compiled according to older, more simplistic management systems. The result of this is variable level of detail and validity across the GLHER.

3.4.4 Within the context of this resource assessment the GLHER provides the most comprehensive body of data by which to compile archaeological summaries and mitigation strategies, bearing in mid the limitations outlined above.

3.4.5 The GLHER data used has recently been enhanced by the Greater London

Backlogs project (MOLA 2010b) which included the identification and quantification of past archaeological investigations arising from hard and soft aggregates extraction in Greater London. The study was conducted through the review of archaeological journals, newsletters and other publications, along with a trawl of archaeological datasets, including the Museum of London Archaeology database of past investigations and the GLHER. The results of this project were recorded in a database, as well as project report, which also contains the methodology for the project. Two additional sites were identified in the current Project Area as a result.

3.4.6 The conventional dates used for the main archaeological periods used for the project are as follows:

- Palaeolithic (*c* 700,000–10,000 BC),
- Mesolithic (*c* 10,000– 4000 BC),
- Neolithic (*c* 4000–2000 BC),
- Bronze Age (*c* 2000–650 BC),
- Iron Age (*c* 650 BC – AD 42),
- Roman (*c* AD 43–410),
- Early Medieval (*c* AD 410–1066),
- Later Medieval (*c* AD 1066– 540),
- Post-Medieval (*c* AD 1540–1901)
- Modern (*c* AD 1901 – present)

3.4.7 The GLHER enhancement (as described in more detail below) took place under the guidance of Stuart Cakebread, GLHER Manager, in accordance with national guidelines and GLHER recording practice.

Incorporating the NMR

3.4.1 A priority search of all monuments and events was requested from the NMR. This data was cross-referenced with the GLHER to identify any additional data. Monuments and events which did not relate to any existing GLHER assets on the project database were checked by the Project Coordinator under the supervision of the GLHER Officer. New assets were given a GLHER number and incorporated into the relevant layer of the project GIS. Discrepancies between the GLHER and NMR data were assessed by the GLHER Officer and the Project Officer. In general, the GLHER was found to be the more accurate source, where a positive determination could be made on the basis of the evidence. Where it was unclear which source was more accurate without a return to original archives and sources, the GLHER was therefore assumed to be correct.

3.4.2 The GLHER was generally found to be consistent. A very small number of NMR data corrections were necessary prior to the creation of the asset density figures. At the data collation stage problems with individual GLHER entries were identified, and where these were not major, they were corrected on the spot under the supervision of the GLHER manager.

Grouping entries

3.4.3 Some entries for individual finds or features of the same period were grouped together as one GLHER entry in the database. These entries were not further separated. For example, where a group of archaeological features or finds are an assemblage that should be considered together, these are grouped together as one entry. There will be an effect of this system for the asset density map. A single asset point could comprise more than one number of an asset, which the map will not show. These will however be assessed and considered in the report.

Separating entries

3.4.4 A number of records needed to be separated. Where objects which were not associated by archaeological context (such as individual chance finds) and discrete periods of activity or occupation were recorded as one GLHER number, this would result in an incorrectly low number of assets appearing in the asset densities for the periods concerned. In cases where an existing GLHER needed to be split, new records were created in the GIS layer of the project database for the additional assets.

Refining dating

3.4.5 There were a number of assets in the GLHER which were undated. This was particularly true of cropmarks and other aerial photograph evidence for which entries were often limited. Typically earlier assets were more likely to be undated. The date range was corrected if it could be determined from the GLHER data. In such cases the date range given reflected the scientific or typological dating of the asset as accurately as was possible from the information given in the GLHER.

3.4.6 In many cases (particularly relating to cropmark evidence) the GLHER entries were very limited and provided no indication of date other than the 'Monument Type'. Where a Monument Type was sufficiently clear (e.g. Second World War Anti Tank Block) it could be researched using the NMR Monument Class Descriptions and thesaurus in order to determine the likely date range. Other Monument Types were insufficiently clear (e.g. Linear Feature) and could potentially date to a wide range of periods. It was not within the scope of the project to re-assess the dating of any assets from primary material, even where this would have been possible. In these cases, such assets were given a date range which was considered to represent the entire range within which the true date of that feature could fall. For example 'Linear Feature' could represent anything from a Neolithic cursus to a post-medieval road, such Monument Types were therefore allotted the date range from the Neolithic (4,000 BC) to Post Medieval period (AD 1900), and each asset was considered when calculating the asset number of each of these periods.

National Mapping Program (NMP) sample areas

3.4.7 A large proportion of NMP mapping has previously been undertaken in Havering in the southern and south-western parts of the Borough as part of the mapping of Essex. This has left *c* 10km^2 of aggregates resources within the Borough which have not been mapped.

3.4.8 The NMP was initiated by the Royal Commission on the Historical Monuments of England (RCHME) in 1992. Since the merger of RCHME and English Heritage in 1999, the NMP has been run and funded by EH.

3.4.9 The aim of the NMP is 'to enhance our understanding about past human settlement, by providing information and syntheses for all archaeological sites and landscapes (visible on aerial photographs as cropmarks, parchmarks or earthworks) from the Neolithic period to the twentieth century' (Bewley, 2001, 78). To achieve this aim a methodology was developed from previous selective approaches to mapping from aerial photographs (e.g. Benson and Miles, 1974). The guiding principle of the methodology is 'to map, describe and classify all archaeological sites recorded by aerial photography in England to a consistent standard' (RCHME, 1995).

3.4.10 In terms of this project, NMP data provides a more consistent framework than GLHER data, as it is taken from a prescribed resource typically in one or two projects, rather than being comprised from a variety of sources collected over a number of years to variable levels of detail. Each NMP mapping project digitally maps, interprets and records all archaeological sites visible on aerial photography and Environment Agency LiDAR data, within a given area. This allows additional information to be incorporated into the GLHER and improves the archaeological

baseline (meeting objective 1.2.5) through the location of previously unknown assets.

3.4.11 No further NMP mapping was undertaken in Havering during the lifetime of the project. The Research Framework, Agenda and Strategy has therefore identified the need for NMP to be extended across the aggregates resource within London Borough of Havering.

3.4.12 Archaeological cropmarks have been rectified and digitally plotted within the area of south Havering as part of the East London Gravels Project (Swift *et al* forthcoming), undertaken recently by MOLA with ALSF funding. This entailed examination of air photographs held by the National Air Photograph Library in Swindon, the Cambridge University Committee for Aerial Photography, and the GLHER. The evidence from these cropmarks provided an additional project resource and was incorporated into the database.

Adding an 'Asset Type' field

3.4.13 In order to facilitate the querying of the GIS project and development of the period based summaries, an Asset Type field was created in the extracted GLHER to record the nature of the remains, wherever possible.

3.4.14 The Asset Types conform to the glossary of the NMR Monument Class descriptors, plus two extra (Hoard and Palaeoenvironmental):

- Agriculture and subsistence
- Civil
- Commemorative
- Defence
- Domestic
- Gardens and parks
- Hoard
- Industrial
- Object
- Palaeoenvironmental
- Recreation
- Religious, ritual or funerary
- Transport
- Unassigned
- Water and drainage
- Multiple

3.4.15 Sites which have multiple assets were separated out into the various assets (i.e. by period) in order to ensure that the asset density maps provided a more accurate reflection of the number and type of assets, which might be obscured under a 'multiple' and 'multi-period' category (e.g. East London Gravels Project).

3.4.16 The assets include 'monuments' (comprising archaeological sites as well as other features of interest), findspots of individual objects, natural features and extant buildings and structures. Of these types, buildings typically date from the Medieval period onwards and are a more commonly occurring type in the post-medieval and modern periods. As the GLHER records the current state of archaeological work and knowledge, even monuments need not represent sites on a one to one basis. A single entry may comprise several 'sites' if there is currently insufficient information to distinguish between the different sites. Similarly, what is in reality a single site can

be represented by multiple GLHER entries, if there is insufficient evidence to indicate the separate elements of the site form a coherent whole, and they have therefore been entered individually. Where there is generally less information available (as in earlier periods), there is therefore likely to be an overall underestimation of the number of assets; and where there is more information available (as in later periods), there is likely to be an overall overestimation of the number of assets.

3.5 Asset Density Figures

3.5.1 The enhanced GLHER was used to create period specific asset density figures for the four Study Areas. The project database was queried to determine the number and distribution of assets of each period within each study area. These asset density figures and associated asset information formed the backdrop to, and basic information for, the resource assessment.

3.5.2 The asset density tables (see Tables 1, 2 and 3) provide the numbers of all assets of each period within each of the four study areas. The data was extracted by direct queries of the database which identified any asset which fell entirely or partly within a given period. Thus an asset dated from the Neolithic to Post-Medieval period would appear in the data for the Neolithic as well as the Post-Medieval period. As a result of this process a degree of overlap was expected between the different periods. This was anticipated to result partly from the expected genuine continuity of asset use and partly from the need to provide broad date ranges for assets of uncertain dating. The raw numbers were converted to asset densities per km^2 to allow comparisons to be made between the four Study Areas and the different periods.

3.6 Archaeological Resource Assessment

3.6.1 The archaeological resource assessment was carried out for each chronological period and was derived entirely from an analysis of the asset maps produced in GIS from the enhanced GLHER data (Objectives 1.2.2 and 1.2.8). It includes a discussion of asset densities and levels of past archaeological investigation across the Project Area (see section 5).

3.6.2 This resource assessment provided a baseline for the Research Framework (the Research Agenda and Strategy) and Mitigation Strategies. This was achieved through highlighting important areas where further research is necessary and those which would be particularly at risk from aggregate extraction and other activity. It also identified the areas which may have potential to provide further information on particular periods and themes, particularly those identified in the existing and developing documents of the regional research framework (MoLAS 2000; MOL 2002; RICHE draft 5 2009).

3.7 Research Agenda and Strategy

3.7.1 In order to meet objective 1.2.8, the resource assessment provides information and baseline for the development of the Research Agenda and Strategy. This includes the archaeological agenda for different detailed study areas and periods; periods and themes requiring additional research, including possible research questions for future investigations; and areas (spatial and thematic) where additional research is necessary to improve the archaeological baseline. It was not possible to undertake further NMP mapping within Havering during the life of the project, and this report has identified the need to further extent the NMP survey within the Research Agenda and Strategy.

3.7.2 The Research Agenda and Strategy makes reference to research questions and periods, as well as themes highlighted in regional research frameworks, both spatial (regional) and thematic. These include:

- The Greater London Regional Research Framework (MoLAS 2000; MOL 2002; RICHE draft 5 2009);
- National Ice Age Network and the Shotton Project (Buteux, *et al* 2005), which seeks to provide support for research into Pleistocene studies of England's sands and gravels.

3.7.3 The Research Agenda and Strategy will be used together with the Resource Assessment to develop management proposals and mitigation strategies for archaeological resources in aggregate areas.

3.8 Mitigation Strategies

3.8.1 In order to achieve objective 1.2.9, the project team provided an overview of the mitigation strategies which are involved in the mitigation of the impacts of aggregate extraction on archaeological resources. The sections also included:

- A discussion of the specific mitigation strategies necessary for particular geological conditions;
- those areas where more work would be required to make confident predictions as to the likely impact of extraction; and
- where geological or archaeological factors made it likely that a particular mitigation strategy would be requested.

3.9 Review and Dissemination

3.9.1 The draft report was reviewed by Robert Whytehead (GLAAS), David Divers (MOLA), Sue Smith (former LBH), Peter Hall (LBH) and Barney Sloane (EH). The period summaries were reviewed by Jon Cotton (MOL), Bob Cowie (MOLA) and Jenny Hall (MOL). All comments were incorporated in the report as far as applicable.

3.10 Seminar

3.10.1 A stakeholder seminar was held following the completion of the draft report at Museum in Docklands. Stakeholders and interested parties were invited to hear about the project and discuss and comment on its results: Bob Cowie (Project Officer MOLA); Brendan Kelly (Tarmac); Brian Evans (London Archaeological Forum LAF); David Bowsher (MOLA); David Divers (MOLA); Graham Ward (Essex Rock and Mineral Society); Jane Sidell (Inspector of Ancient Monuments EH); Jon Chandler (MOLA); Jon Cotton (Senior Curator Prehistory MOL); Katie Dickinson (Heritage Officer LBH); Keith Langridge (LAF); Linda Hawthorn (LAF); Peter Hall (Development Planning Team Leader LBH); Richard Ford (Brett Group); Robert Whytehead (Regional Archaeologist GLAAS); Rupert Featherby (MOLA); Simon Donoghue (Local Studies Library LBH); Simon Parkinson (Head of Culture and Leisure Services LBH) and Sue Smith (former Conservation Officer LBH);

3.10.2 The seminar included a presentation on the methodology and a summary of the results of the assessment (IR), current planning background in Havering (Peter Hall), the chronological summaries and their context made by local experts (Bob Cowie, David Divers, Sue Smith), and a discussion session chaired by Robert Whytehead. Comments and suggestions derived from the discussion held at the end of the seminar were also included in the report. The final version of the assessment has been disseminated on CD as word and pdf documents to the seminar attendees and Stakeholders.

4 Description of the Aggregates Resource

4.1 Introduction

4.1.1 Gravel and stone has been used for thousands of years, from the first handaxes and other tools made from local flint taken from the Thames terraces, to gravel dug to provide material for Roman roads and buildings. The earliest recorded gravel pits were found in Dagenham, with extraction tending to move eastwards over time. Extensive quarrying took place around Oldchurch in Romford in the 19th century, but the Greater London Council and local authority did not centralise records of quarrying until the 20th century. Larger-scale gravel extraction began with the rise of road building in the 18th century, but for a long time quarries were dug by hand. Extraction increased after the Second World War and again during the 1970s to supply the increase in house building and road schemes. New technologies and machines allowed for much larger areas to be extracted in much shorter time (Greenwood 2006).

4.1.2 The Project Area lies within the Lower Thames Valley in the Thames basin which is formed by a broad syncline of chalk that outcrops in the north as the Chiltern Hills and the North Downs to the south. This syncline is filled with Tertiary deposits (Palaeocene and Eocene sands and clays). The lower deposits comprise the Thanet sands and the Lambeth Group (Upnor, Reading and Woolwich Formations). The upper sediments are London Clay (Ruddy forthcoming).

4.1.3 Above the bedrock lie the Pleistocene (Quaternary) fluvial deposits of the River Thames arranged as a series of steps or terraces, which have developed over the past 2 million years. These terraces represent the remains of former floodplains of the river, the highest being the oldest with each terrace becoming progressively younger down the valley side. The fluvial deposits that make up the terrace landforms are predominately sand and gravels, sometimes interdigitated with silts and clays. A similar sequence of gravel overlain by sands and silts inter-bedded with organic deposits underlies the present floodplain. Brickearth caps the gravel in places and a swathe of alluvial silt and clay deposited very recently (within the last 10,000 years) covers the floodplain (Corcoran 2003).

4.2 Geological Description

4.2.1 Havering lies on the north side of the Thames valley and the landscape slopes down in a series of three gravel terraces towards the river from the highest ground in the north-east at *c* 30m Ordnance Datum (OD) to south-east (at *c* 5m OD). These terraces represent former river beds of the Thames formed by the action of the river over the past half million years. Their deposition was influenced by the climate, sea level and tectonic activity (Bridgland 1994; Blum 2007).

4.2.2 The last 2.6 million years of earth history (the Quaternary) is the period in which the climate has alternated between cold and warm phases on a cycle of *c* 100,000 years. During the long cold phases and particularly at the warmer end of these 'stages' the river was wider and braided comprising multiple channels. Gravel was carried by the stream power and gradually aggraded into a thick body of sediment. During such episodes of initial warming, the combination of the volume of meltwater and low sea levels caused the river to cut down into the floodplain widening the valley-floor and creating the river terraces (Ruddy forthcoming; Maddy 1997; Westaway *et al* 2002).

4.2.3 The Thames gravels preserve a record of environmental and climate change and are an important repository of Palaeolithic flint artefacts, and each terrace can be attributed to a separate glacial–interglacial phase. The quarrying of terrace gravels and major construction projects have provided opportunities for the study of these terraces. The sequence of gravel deposits is often complex and fragmentary and the stratigraphy of deposited material can be complicated (Bridgland 1994; 2006;

Bridgland *et al* 2003). Despite the complexity, the middle and lower Thames terraces are of unique importance within north-west Europe for the extent of preservation of both cold-climate fluvial sands and gravels, finer-grained interglacial sediments and the record of past human activity that is preserved within them (Ruddy forthcoming).

4.2.4 The interglacial deposits are of particular interest as they contain faunal and cultural material from which the environment and animal and hominin (human) colonisation of Britain can be reconstructed (Bridgland 1994; White and Schreve 2000). Britain became cut off from Europe during warm stages (when global sea levels rose) and reconnected during glacials (when water was locked up in the ice caps). This lead to a distinct mix of species in fossil assemblages from each interglacial over the last half million years and has enabled the differentiation of the various temperate episodes of the late Middle Pleistocene in Britain through the recognition of particular fossil mammal assemblages. Palaeolithic artefacts within the deposits have proved rich and varied, providing a record of hominin species and behaviour (White and Schreve 2000; Bridgland 2006).

4.2.5 The cyclical nature of global climate became apparent from the study of cores drilled through the sea bed where the stratigraphy was less confusing as the accumulation of gravel has not been subject to erosion (Shakleton 1967; cf Lowe and Walker 1997). The climate cycles seen in these marine cores have been numbered into 12 stages that cover the last half million years. The last five glacial–interglacial cycles recognised in marine cores have been correlated with the Thames terrace sequence (Ruddy forthcoming).

4.2.6 Advances in the last 20 years have lead to a framework that has enabled archaeologists to date the artefacts and fossils from the more remote periods of British prehistory. Within the Project Area, three post-Anglian terraces are represented. From high to low (older to younger) these terraces are known as the Boyn Hill/Orsett Heath Gravel, Lynch Hill/Corbets Tey Gravel and Taplow/Mucking Gravel (Ruddy forthcoming).

Lower Palaeolithic (Boyn Hill/Orsett Heath Gravel)

4.2.7 The Boyn Hill/Orsett Heath Gravel terrace (dated to 450,000–350,000 BP) occurs in patches over the London Clay bedrock at Hornchurch, North Ockendon and to the north-west of Aveley. Hornchurch is the most southerly point known to have been reached by the ice sheets of the Anglian glaciation, and the Boyn Hill Gravel overlies the till here. This underlines the fact that the lower Thames came to occupy its present position after the Anglian ice sheets blocked the old route of the river (Bridgland 1994; Ruddy forthcoming).

4.2.8 The hominin species present in Britain at this time is thought to be Homo heidelbergensis (Stringer 2006). Sites in Britain have provided a record of changing lithic material culture and demonstrate phases of occupation of Britain through the Lower and Middle Palaeolithic (*c* 700,000–38,000 BP). All the Palaeolithic lithics recovered from the gravel terraces are ex situ, so their original upstream context is unknown (Ruddy forthcoming).

Lower and Middle Palaeolithic (Lynch Hill/Corbets Tey Gravel)

4.2.9 Part of the Project Area lies on the second of three terraces preserved on the Essex side of the valley: the Corbets Tey Gravel dated to between 350,000–250,000 BP.

4.2.10 A handful of diagnostic flint tools were recovered from sites on this gravel terrace (Moor Hall Farm, at Great Arnold's Field and Hunt's Hill Farm). A number of other Lower Palaeolithic handaxes have been discovered within the Project Area during gravel quarrying (see 6.2). In the south-west of the Project Area, around Hornchurch, a third, lower-lying terrace, is mapped. The Taplow/Mucking Gravel is younger, dated to *c* 230–180,000 BP.

The present landscape

4.2.11 During the last glaciation (the Devensian), modern humans (Homo sapiens sapiens) arrived in Britain and the Shepperton/Floodplain Gravel, the bed of the present day River Thames on the south side of Havering, was laid down. This terrace, lies outside the Project Area, buried beneath the alluvium of the Thames.

4.2.12 Deposits in the Project Area that relate to the last glacial complex comprise 'head' and 'brickearth' which cap the gravel terrace in places. These deposits were formed by a range of processes. Head is a term usually used to denote mixed sediments with a variety of sizes of rock fragments that have been eroded and transported down-slope by gravity or surface wash ('colluviated'). Colluvium often accumulates at the break of slope on valley sides, and within the Project Area head is mapped at the boundary between the Corbets Tey and Mucking Gravels. These slope processes are exacerbated when iced hillsides thaw. In the warmer seasons, when the upper layers of the soil and sediment melt, the material can slide over the still frozen substrate. This is called solifluction and is characteristic of periglacial environments, areas bordering glaciated zones (Ruddy forthcoming).

4.2.13 Brickearth is a generic term that subsumes an array of sediment types that may have accumulated by being blown in by wind (aeolian), derived from slope processes as described above or associated with rivers (fluvial or alluvial). In the lower Thames these deposits are mapped as Langley Silt complex which typically formed during the most recent phases of climate change from the height to the close of the last glaciation between 20,000–12,000 BP to the present day (Gibbard 1994, 136). Brickearth is found capping the gravel in some areas of Havering.

The River Thames (Holocene)

4.2.14 The Thames is a major landscape feature and the slopes overlooking the river were likely to have been an attractive focal point for colonisation, so even though the river now lies outside the Project Area it is considered central to understanding the archaeology of the river terraces. At the end of the last Ice Age, *c* 12,000 years ago, the climate began to warm into our current interglacial. Over the succeeding millennia the river evolved from a braided to meandering form, as sea and river levels rose from –35m OD to the present height (*c* 6m OD).

4.2.15 During the Holocene, relative sea level (RSL) in the Thames estuary has risen on a fairly continuous basis. However, this process has been interrupted by periods of stabilisation or regression, particularly during the Neolithic. This sequence of RSL changes in the lower Thames was first compiled by Devoy (1979; 1980; 1982). Devoy's pioneering work has now been supplemented by a wealth of new archaeological data from the Greater London area (Sidell 2003). Alternating layers of peats, organic clays and silts overlie gravels on the floodplain, representing RSL fluctuations. These alluvial sequences can provide information on environmental and landscape change and resources available for exploitation by prehistoric people (Long *et al* 2000). When waterlogged, these deposits can also preserve organic evidence of human activity such as timber structures. During periods of falling RSL marsh or wood fen peat would have developed over silty clay alluvium and these areas could have provided valuable summer pasture. While the Project Area was too high to be affected by these fluctuations in river level, it is important to realise that these changes would have affected the range of resources available to its inhabitants (Ruddy forthcoming).

Modern topography

4.2.16 The Ingrebourne and the River Beam are tributaries of the Thames flowing roughly south, their valleys dissecting the river terraces. These rivers have influenced landscape and are a distinguishing feature of the area. The Ingrebourne is the largest river in the area, its valley to the north of Hornchurch is lined by a narrow lobe of Anglian till. The river would have carried reworked Pleistocene Thames

sediments and flint pebbles from the Tertiary (Palaeogene) outcrop to the north (Bridgland 1994; Ruddy forthcoming).

4.3 Minerals Resource Classification

4.3.1 Deposits of Pleistocene river gravels and sands are present above the solid geology, and have been partially mapped by the British Geological Survey. These deposits were laid down by precursors of the river Thames and its tributaries.

4.3.2 Aggregate resources may be divided into those which are commercially viable for extraction and those where extraction would not be economic. The commercial viability of any given aggregate resource is likely to vary with time due to changes in demand, changes in use, development of new extraction methods, and the varying cost and availability of alternative aggregate resources.

4.3.3 This project maps aggregates across the borough, generally at the 'inferred' level where they can be identified from existing geological information but have not been evaluated or characterised. Consequently, little is known about their economic viability or suitability for any given application.

4.3.4 Mineral resources cannot be classified as 'measured' until they have been fully evaluated. This typically happens as part of a planning application by a commercial extractor and is not usually in the public domain before submission of an application due to commercial sensitivity. This means that some areas that are extremely unlikely to ever produce viable aggregates, have also been included. The larger sample size however, will increase confidence in the archaeological characterisation.

4.4 Aggregate Areas

Superficial aggregates

4.4.1 Terrace Gravels are located along the Thames valley, at progressively lower elevations above the modern floodplain. They are currently divided into eight terraces, the oldest one being the Black Park gravel at *c* 35 to 55m OD. In many places, particularly on the north side of the Thames, the river terrace deposits form a bench or terrace feature that is bounded by a concave break of slope on the margin farthest from the contemporary river channel, and a convex slope on the margin nearest the river. Where the base of the deposit rests on London Clay, it can be clearly defined, whilst it is masked by downwash on the higher terraces which are located on hilltops. It is difficult to distinguish between the different terrace deposits as they have a very similar composition although there is evidence that the proportion of quartz and quarzite clasts decreases whilst the angular flints increase in the more recent terraces (Ellison 2004, 61–62).

4.4.2 Alluvium occurs in the River Thames valley, its main tributaries and also minor valleys where there is a distinctive floodplain developed. Alluvium forms a nearly flat surface in valley floors. Such alluvial deposits occur throughout the Borough of Havering, the major ones being the Ingrebourne, Rom and Beam.

4.4.3 The following superficial aggregate geologies are considered to have aggregate extraction potential in Havering.

4.4.4 Thames River Terrace Gravels (see Fig 2):

- Black Park Gravel
- Boyn Hill Gravel
- Hackney Gravel
- Lynch Hill Gravel
- Taplow Gravel

- Enfield Silt (Brickearth)

Solid aggregates

4.4.5 The following solid aggregate geologies have been identified in Havering:

- Sandstone (Thanet Sand Formation)
- Sandstone (Bagshot formation)
- Upper Chalk (extreme south of Borough)

4.4.6 The lowest (oldest) sediment in the London Basin is the Thanet Sand Formation which overlies the Chalk. The Bagshot Beds are a series of sands and clays of the upper Eocene formation of the London basin in England and derive their name from Bagshot Heath in Surrey. There are no BritPits extraction sites in any of the above solid geologies.

4.5 Overview of Past and Present Extraction

Introduction

4.5.1 The earliest recorded gravel pits in the area are in the Dagenham Corridor (part of the Metropolitan green belt), running from Hainault to the River Thames and including the Eastbrookend Country Park, the Chase Local Nature Reserve and the Beam Valley Country Park, with extraction tending to move eastwards over time and much of the area around Oldchurch, Romford, was dug away in the 19th century.

4.5.2 With the rise of road building in the 18th century larger-scale gravel extraction began, and for a long time quarries were hand-dug. After World War II gravel extraction increased up until the 1990s, when less land remained available to quarry. By the late 1970s mineral companies were extracting deposits that were ignored in the 1950s and 1960s, needing to supply the increase in house-building and big road-construction schemes such as the M25. Machines such as draglines, box scrapers and larger trucks, allowed huge areas to be quarried in just a few years. Archaeologists then had to record hundreds of acres/hectares.

4.5.3 By the 1970s, much of the gravel terraces in south Havering and around Thurrock were characterised by quarries left open or badly filled in, ugly tips and landfill sites for London's rubbish. Badly restored land, usually unsuitable for agriculture, became derelict or rough grazing for ponies and sometimes cattle.

4.5.4 From the 1960s onwards a few companies started restoring the land back to agriculture, for example at Bush Farm. Other sites have since been reinstated as small reservoirs or lakes for leisure and wildlife use. With the setting up of Thames Chase Community Forest more land has been restored, hedgerows replanted and the first trees planted on restored land creating new woodland (Greenwood *et al* 2006).

Past aggregates extraction

4.5.5 Aggregate minerals occur, and have been extracted, in many areas within Havering. Minerals extraction comprises mainly sand and gravel (aggregates) but also Brickearth and London Clay for cement manufacture. The main areas of extraction are the deposits of sand and gravel between Rainham and Upminster and in the Rom Valley, on the terraces above the rivers in the south of the borough.

4.5.6 Fig 3 shows that Study Area 4, in the south-eastern part of the borough, contains the majority of past aggregates extraction sites. It contains the highest variety of aggregates out of all study areas, including Taplow gravel, Lynch Hill gravels, Boyn Hill and Black Park gravel formation. An average of *c* 3 km^2 of the landscape has been quarried out in this Study Area in the past. For comparison, in Study Area 1

the quarried areas cover *c* 0.19 km^2 of land, in Study Area 3 the area covers *c* 0.62 km^2, and only 0.003 km^2 in Study Area 2.

4.5.7 The OS 1st and 2nd edition maps up to 1899 show only a few small-scale quarries across the borough. These are located in Jutsums Park in Study Area 1; in the area of The Chase/Harrow Lodge Park nature reserve in Study Area 3; in contrast there are five locations within Study Area 4: in the eastern part of the study area, south-east of North Ockendon; in the area of Great Sunnings Farm, south of Upminster Cemetery; on the east side of Aveley Road; in the area of Ayletts Cottages, south of Warwick Lane; and to the north-west of the junction of the A13 road with New Road. There are no extraction sites in Study Area 2.

4.5.8 A first significant increase in quarries across Havering can be recognised in the 1950s and 1960s, when existing quarries are being expanded and additional areas exploited. As the distribution map (Fig 3) shows, the focus lay on the southern part of the borough, and thus mainly on Study Area 4 as well as, on a smaller scale, in Study Area 3. The largest extraction site in Study Area 3 lay in the south of this area, in south Hornchurch, in the area of Mardyke Farm to the south of Dagenham Road. The area is now a registered landfill site. A number of large extraction sites were located in Study Area 4, more precisely in the centre and south-west of this area. One of the larger sites was the Hornchurch RAF airfield which was extensively quarried in the 1970s and later infilled and landscaped. It now forms the Hornchurch country park. Aggregates extraction sites can also be found further to the east of the Hornchurch airfield, between Rainham and Upminster.

4.5.9 There are no registered areas of past extraction in Study Area 2. When past extraction sites were identified from OS maps, a number of ponds were located across the borough which, when reaching a certain size, were assumed to be former quarry pits. A number of these sites have been identified in the south of Study Area 3 within relevant aggregates geologies areas.

4.5.10 Potential future areas allocated for minerals extraction were identified from the London Borough of Havering Core Strategy and Development Control Policies DPD and forthcoming Minerals Sites DPD where these are available in the public domain. These past, present and future areas of aggregates and hard rock extraction were included as layers of polygons within the GIS.

Active sites

4.5.11 There are currently only three active quarry sites in the borough. Rainham quarry (Aylett Gravel Ltd), South Hall Farm and Spring Farm Quarry (Brett Group), located in the south-west of Study Area 4, east of Rainham.

4.5.12 Permission was given for extraction at Ingrebourne Links, Moor Hall Farm, New Road Rainham in November 2010.

5 Overview of archaeological fieldwork within the Project Area

5.1 Introduction

5.1.1 The introduction of PPG16 in 1990 (replaced by PPS5 in March 2010) has led to a change in the nature of the vast majority archaeological work. Many more projects have been undertaken, but these have generally been small with fewer opportunities for large-scale excavations. Most have not usually taken place within an academic framework and opportunities for site/settlement/area syntheses have been few. With a wider range of contractors, the onus has been on Planning Archaeologists to encourage consistent approaches and national and professional bodies, such as EH or IFA, to set standards, support the development of research frameworks, regional artefact type series and so on, and allow for reasonably regular synthetic studies.

5.1.2 Since 1990 most fieldwork has been associated with development, mainly urban or residential, but also including road schemes, pipelines and aggregate extraction. This has meant that fieldwork has been geographically biased towards these areas, principally along the main river valleys where settlement is concentrated. This geographical bias has lead to a similar bias in archaeological data and any discussion of archaeological distributions needs to be conducted with this in mind.

5.1.3 There have been a number of past investigations across the four Study Areas overall, but the level of investigation various considerably for each of those areas. Only one investigation has been undertaken to date in Study Area 3; the NMP survey covers Study Area 4, as well as the southern parts of Study Area 3 and 4, respectively, but not Study Area 1. A number of fieldwalking projects have been carried out in Study Area 2 (Harold Court HCD01, Warley Hill WRH01, Hole Farm HFA00 and Pages Farm PGF01). In the Warley Hill and Hole Farm area, concentrations of burnt flint were recovered, and although undated it is thought to probably indicative of prehistoric activity and both sites are thought to possible prehistoric sites (London Archaeologist Round-up 2000 and 2001). Part of the borough has also been subject to NMP surveys which has provided additional evidence in from of cropmarks of earthworks, ring ditches etc. The majority of investigations have been carried out in Study Area 4, a considerable number of these in connection with the East London Gravels Project which has significantly increased our understanding of the history in this area. The results of these projects area explained in more detail, below.

5.2 The East London Gravels Project

5.2.1 In 2006, the Museum of London Archaeology Service (now MOLA) produced the publication *From Ice Age to Essex. A history of the human habitation in East London*, based on archaeological findings at excavations on gravel extraction sites. The project was funded by the ALSF, administered by English Heritage and introduced to provide funds to tackle a wide range of problems affected by the extraction of aggregates. 'Understanding the east London gravels project', as it became known, was one of a relatively small number of ALSF round 1-funded projects approved that was primarily concerned with the assessment of 'backlog' archives (i.e. where fieldwork has been completed but the analysis and dissemination has not been carried out).

5.2.2 The project included a group of sites investigated between 1963 and 1999 which were being analysed. The archaeological sites were located in the London Boroughs north of the Thames and east of the river Lea that were historically part of the county of Essex. A series of important archaeological excavations were undertaken in the course of gravel extraction. The quarries exploited the river gravels, deposited by the Thames, which rise in a series of steps towards the A12 road.

5.2.3 Of those sites analysed as part of the East London Gravels project, five are located within the Borough of Havering, and all of them in Study Area 4 (see Fig 5). The fieldwork on these sites was carried out in advance of gravel extraction. They revealed important information and findings about the landscape and history of human occupation of east London. A brief overview of the sites is included below.

Hunt's Hill Farm

5.2.4 The site lies between Upminster and Aveley, within the Thames Chase Community Forest. In the 1970s it was still farmland and cropmarks seen in 1976 lead to the discovery of the archaeological site. A series of ditches marked out the sites of farms and fields of prehistoric and Roman date.

5.2.5 One of the earliest finds recovered from the excavations at Hunts Hill Farm was a flint arrowhead of the Early Bronze Age, and the first evidence of settlement dates to the Middle Bronze Age. During the Late Bronze Age and Early Iron Age occupation continued with the construction of a series of round houses, which were built within larger enclosures. At the end of the Iron Age a large rectangular enclosure dominated the hill.

5.2.6 After the Roman conquest much of Hunts Hill Farm was used as farmland. The Late Iron Age enclosure was remodelled and perhaps adapted as a stock enclosure. More fields or paddocks and animal enclosures were laid out, and new wells or waterholes were dug. Some of the Roman period inhabitants of the area were cremated and their ashes buried in pots, sometimes accompanied by flagons or cups. These cremations were usually set into or alongside the field ditches.

5.2.7 A small Early Saxon cemetery with grave goods, perhaps of a family group, was also lined up alongside a late Roman field ditch. A settlement of this period was found at the southern end of Hunts Hill Farm, where there was a well and traces of a timber house. In the early medieval period, a hall-house with fields and a stave-lined well was built at Hunts Hill Farm. This was possibly part of the Domesday manor known to have been in the south part of Upminster parish.

5.2.8 Later the site became part of a medieval ridge-and-furrow field system and farming continued through the 20th century. World War I uniforms were buried in the soil to act as fertilizer and hundreds of buttons were dug up.

Great Sunnings Farm and Manor Farm

5.2.9 These two sites lie east of Upminster in an area of higher gravel terrace that is now mostly used for arable farming and market gardening, though it has also been subject to intensive gravel extraction.

5.2.10 A few stray flint implements of the Mesolithic period from Manor Farm are the only evidence of early prehistoric activity in area. Although there was a small amount of Late Bronze Age pottery at Manor Farm, most of the evidence for prehistoric settlement - including curvilinear gullies that may have marked the site of a round house - date to the Early to Middle Iron Age.

5.2.11 During the Later Iron Age a pair of large, roughly rectangular defensive enclosures dominated the Great Sunnings Farm site. These were linked and had steep-sided ditches about 4m wide and 2m deep. Occupation continued during the early Roman period, and a system of long narrow fields was laid out across the site. At Manor Farm a small Early Roman cemetery of five cremation burials with grave goods was discovered.

5.2.12 A few fragments of Early Saxon pottery show that the Manor Farm site was still occupied after the Roman period, although little is known of this period.

Moor Hall Farm and Great Arnold's Field

5.2.13 These two sites are separated by Launders Lane as it winds down towards the old London Road, the A13. They lie close to the edge of the Thames marshes on a

gravel spur about 6–8m above sea level, higher than much of Rainham parish.

5.2.14 This area was once used for stock raising, arable and market gardening. In the early 1970s, parts of Moor Hall Farm were affected by deep ploughing for the first time, increasing the rate of damage to the archaeological remains. Ploughing and the growing of cereals meant that in drier summers these sites produced cropmarks alerting archaeologists to their existence. Sand and gravel extraction finally reached the area in 1963 (Great Arnold's Field) and in 1977 to supply the construction of the M25 (Moor Hall Farm), prompting archaeological excavations.

5.2.15 The earliest finds from Moor Hall Farm were fragments of Early Palaeolithic handaxes that had come from the Thames gravels. Mesolithic microlithic flint implements and a flint adze were also found during the excavations, although there was no evidence for occupation at this period.

5.2.16 Great Arnold's Field was the site of a Neolithic ritual monument. The remains of this consisted of a large ring ditch about 15m in diameter. A settlement with similar finds was excavated about 1.6 km to the south-west (at Brookway).

5.2.17 During the Late Neolithic and early Bronze Age, the Beaker people settled at Moor Hall Farm and reused the site at Great Arnold's Field. Occupation continued throughout the Late Bronze Age.

5.2.18 After a gap of about 500 years the site was reoccupied in the Middle Iron Age. A settlement of roundhouses developed on the crest of the hill. During the Later Iron Age a ditched enclosure was constructed, with an east-facing entrance and dominating the higher ground at Moor Hall Farm. Although there were traces of 'ramparts' between ditches, none were found on the inside. Similar enclosures have been found at Orsett Cock and Gun Hill near Tilbury. This site was not evidently designed with defensive considerations paramount.

5.2.19 During the Roman period the site became divided up into fields, some of which extended into Great Arnold's Field. A late Roman farm or settlement was built alongside Launders Lane in the 3rd–4th centuries.

5.2.20 The area was mentioned in the Domesday survey as Launders Manor. An early medieval farmstead, dating to the 12th century, was excavated in 1963 in Great Arnold's Field.

Whitehall Wood

5.2.21 Excavations in 1982 and 1983 in the open field between Whitehall Wood and Little Brick Kiln Wood, uncovered traces of a prehistoric field system and settlement. Three shallow discontinuous linear ditches are interpreted as elements of a rectilinear field system. The evidence for occupation at Whitehall Wood consisted of various shallow scattered postholes, post pits, gullies and pits of uncertain function as well as associated flintwork (rough chunks and flake cores). Some of the postholes appeared to form lines and so might represent fences or stock pens constructed within the fields. The impression is that there was probably a single farmstead set within the eastern portion of the field system at Whitehall Wood, but the evidence is too fragmentary to allow the secure identification of any buildings or structures.

Mark Warrens Farm

5.2.22 This site is located just outside Study Area 1, abutting the north-western boundary of Havering. An archaeological excavation was carried out by Passmore Edwards Museum in 1988. The excavations revealed evidence both artefactual and stratigraphy that the site had been periodically occupied from the Mesolithic to the post-medieval periods. Work was conducted ahead of proposed aggregates extraction, and later work was also conducted under PPG16 conditions for that reason. Elements of particular interest which were preserved in situ were a Late Bronze Age curvilinear enclosure, an early Roman triple-ditched enclosure and the

World War II gun emplacements. Other elements included an early Iron Age fortified settlement, several windmills probably medieval; a small medieval settlement, a medieval to modern track, partly overlying the Roman road. In addition a quantity of prehistoric flintwork, particularly microcores, was retrieved by field walking.

5.3 Other key sites

Park Corner Farm

5.3.1 An aerial photograph interpretation project was conducted at this site in 2000 (Fig 5). The entire site showed crop mark evidence for archaeological features, including a series of small ditched rectilinear enclosures and pits, alongside larger linear features and pits. These area likely to be the remains of prehistoric or Roman settlement and may represent a multi-period occupation site. Further linear ditches and pits can be seen as crop marks. A large curvilinear ditch as well as linear ditches to the north may represent a former post-enclosure and modern boundaries or drains. In addition there is a very large, perfectly circular ring ditch with a terminal defined entrance on the east side. Further pits and probable settlement features such as hut circles and ditched features were located in the centre of the site.

6 Archaeological Resource Assessment: Period based assets densities

6.1 Introduction

6.1.1 Asset densities for the entire aggregates resource was compiled from the GLHER and enhanced for the project as described in the methodology. They are presented, by chronological period, in the form of the number of assets per km^2 for the Project Area and each of the four Study Areas.

6.1.2 The period based summaries describe the state of archaeological understanding of the aggregates resource in Havering by period, in order to provide a basis for the research agenda and strategy and future resource management. The data has been analysed using GIS and excel programs in order to determine whether the distribution of assets can be used as a predictive tool for identifying distribution patterns of early human activity, which may assist in future asset management.

6.1.3 The discussion focuses primarily on those assets which have been precisely dated to the relevant periods, and the key sites for each period. There are a number of assets in the GLHER which could not be dated to a specific period and these have been given a broader date range (i.e. from the Palaeolithic to the Roman period). When assessing the individual asset densities for each period, the additional ones were taken into consideration for each of period they could potentially be dated to.

6.2 Palaeolithic (700,000–10,000 BC)

Introduction

6.2.1 Palaeolithic archaeology is the study of the Pleistocene geological epoch and is closely linked with geological and palaeoenvironmental studies (Quaternary Science). The period is normally divided into chronological periods based on oxygen or marine isotope stages (OIS or MIS), equivalent to periods of climatic and environmental change. Stadials (cold or glacial phases) are identified by even OIS/MIS numbers and interleave with interstadials (warm phases), identified by odd OIS/MIS numbers (Ruddy forthcoming).

6.2.2 The Palaeolithic period is traditionally divided into Lower, Middle and Upper Palaeolithic on the basis of the material culture. The Lower (700,000–250,000 BC) and Middle (250,000–40,000 BC) Palaeolithic is characterised by the presence of hand axes and flint tools or flakes. The specific hand axe industries which define the Middle Palaeolithic (Mousterian) are very poorly represented in the London region and therefore this term is rarely used.

6.2.3 It is now confirmed that Britain was occupied before the Anglian Glaciation (*c* 480,000–420,000 BP). Recent discoveries from a site at Happisburgh in Norfolk in July 2010, recovered evidence for the first known settlement in northern Europe. More than 70 human-made flint tools and flakes were unearthed on the Happisburgh foreshore. The finds are the earliest known evidence of humans in Britain, dating at least 100,000 years earlier than previous discoveries. The previous evidence for the earliest Britons was uncovered from a site in Pakefield, Suffolk, in 2005. It suggested that humans reached Britain about 700,000 years ago, during a brief period when the climate was similar to the Mediterranean today. Before this, early humans where thought to have lived only in areas south of the Pyrenees and Alps. The tools at Happisburgh were dated to between *c* 866,000–814,000 and 970–936,000 BP, around 100,000 years earlier than the finds at Pakefield. The flints were probably left by hunter-gatherers of the human species Homo antecessor who inhabited the flood plains and marshlands that bordered an ancient course of the river Thames. The flints were then washed downriver and came to rest at the Happisburgh site (Parfitt *et al* 2010).

6.2.4 No definite evidence of occupation of this date has been discovered in the Greater London region and in general, there is still comparatively little material known from London. For much of this period the London region remained arctic tundra. The main types of archaeological evidence are lithic artefacts, sometimes associated with faunal remains. Evidence in the London region appears to be specifically associated with the river valleys (Thames and its tributaries), which acted as a focus for hominin and human activity. The majority of Lower Palaeolithic artefacts in Greater London were found in gravel deposits during the 19th century, when gravel extraction was undertaken by hand. These artefacts are mostly redeposited which means that there is only very little known about the stratigraphic context of many artefacts, but some can be associated with certain gravel terraces. Excavations of Lower Palaeolithic sites in the Greater London area have not located major deposits of this period, and undisturbed material is rarely encountered (MoLAS 2000, 33). Due to the depth of relevant geological strata, finds are often made during mechanised gravel extraction, without context, which causes lot of the artefactual information to be lost (Swift *et al* forthcoming).

6.2.5 The Upper Palaeolithic (*c* 40,000–10,000 BC) is associated with the appearance of the anatomically modern humans, and is characterised by blade-based lithic industries and a more complex form of social organisation (MoLAS 2000, 30). Hunter-gatherers focussed on the hunting of migrating animal herds with movement of settlement depending on seasons. Evidence dating to this period is very scarce in the whole of Britain. In Greater London, the evidence of this phase of the Palaeolithic too, consists of a few stray finds which are not conclusive to indicate settlement patterns (MoLAS 2000, 46–7).

Palaeolithic asset densities

6.2.6 Lower/Middle Palaeolithic remains are typically found within Pleistocene geological deposits and usually comprise stone tools, faunal remains and palaeoenvironmental data. Structural remains of this date are not found, and human remains are very rare. Lower/Middle Palaeolithic assets are often residual (i.e. located outside the deposit or layer in which they were originally deposited) and *in situ* sites of tool manufacture or butchery are consequently very important.

6.2.7 A handful of diagnostic flint tools were recovered from key sites in the area (see below). These include the tip of a handaxe from the fill of a Roman pit at a site at Moor Hall Farm and several rolled flakes from the Neolithic ring ditch at Great Arnold's Field. Of most interest is a small unstratified handaxe from the subsoil at Hunt's Hill Farm. A number of other Lower Palaeolithic handaxes have been discovered within the Project Area during gravel quarrying.

6.2.8 Assets dating to the Lower Palaeolithic period within the Project Area are shown in Figure 6. These comprise:

- **2 Objects** (handaxes)

6.2.9 These are limited to Study Area 2 where the asset density equals 0.2 assets per km^2. The overall asset density for the whole Project Area is 0.05 assets per km^2 with (Table 1). There are no assets specifically dated to the Middle or Upper Palaeolithic in the Project Area.

6.2.10 There are 10 assets within the Study Areas which have not been dated to a particular phase within the Palaeolithic period, and were generally dated as 'Palaeolithic' (Fig 6):

- **8 Objects** (7 axes, 1 lithic implement)
- **1 Domestic**

- **1 Industrial** (lithic working site)

6.2.11 These assets area located within Study Area 2 and 4. This equals an overall asset density of 0.3 assets per km^2 for the Project Area, and an asset density of 0.3 assets per km^2 for Study Area 4 only, and a density of 0.4 for Study Area 2 only.

6.2.12 In addition, 103 assets have been recorded which could not been dated to particular period. These have been classified as 'unknown date' (see 6.13). There are various asset types in this group, including 10 objects which could potentially be of Palaeolithic date. For the Lower Palaeolithic this would up the total to 12 Objects and the asset density would be 0.3 assets per km^2 in the overall Project Area. For the general Palaeolithic period this would change the number of objects to 18, a total asset number of 20 and a density of 0.5 assets per km^2 in the overall Project Area (Table 1).

Key sites

Hunt's Hill Farm

6.2.13 One of the earliest finds recovered from the excavations at Hunts Hill Farm was a small unstratified Palaeolithic handaxe from the subsoil. The piece has been robustly flaked into a pointed form from a cobble of local gravel flint, the original knapper having skillfully incorporated a natural hole at the butt.

Moor Hall Farm and Great Arnold's Field

6.2.14 The earliest finds from Moor Hall Farm were fragments of Early Palaeolithic handaxes from the Thames gravels. These include the tip of a handaxe from the fill of a Roman pit at Moor Hall Farm, and several rolled flakes from the Neolithic ring ditch at Great Arnold's Field.

Southend Arterial Road.

6.2.15 The evidence dating to this period was discovered during the construction of the Southend Arterial Road in 1924 which revealed several sections through high terrace gravel (surface level 30m OD), Boulder Clay and London Clay. The section was recorded at several points. It was suggested that the "flint industry" attested in the fine gravel represents a "living and working site on the banks of the former Ingrebourne" producing flint implements. Three hand axes in the Warren collection of the British museum are thought to have come from this site. Warren describes "the best implement" as "of cordate form slightly unsymmetrical, short, broad & thin without 'twist' and agrees with the final Acheulian tradition of the Lower Mousterian".

Conclusion

6.2.16 Palaeolithic assets are sparse across the Study Areas, which reflects the situation in the Greater London area in general. The majority of finds comprise flint tools and hand axes. Four key sites within the Study Area have shown evidence of Palaeolithic activity, although the majority of the evidence is not within its original context.

6.2.17 The limited data available makes it difficult to establish activity patterns within Havering. Deposits do survive in the Havering region and future aggregates extraction work has the potential to add to the knowledge of this period in Britain. The data provides some indication of areas with a higher probability to contain important and/or currently unknown assets. These are in general areas associated with the river valleys, which acted as a focus for hominin and early human activity. In general, assets are potentially present within any Pleistocene geology. Key known sites are typically located on River Terrace Gravels. Mechanised gravel extraction is a main factor in the discovery of Palaeolithic artefacts, but the artefacts

recovered lack any stratigraphical information and any evidence of context is generally destroyed during the process.

6.2.18 Where in situ or minimally disturbed Palaeolithic deposits are identified within fluvial gravels, then excavation would be desirable, although intensive geo-archaeological investigation linked to geo-morphological investigation might help identify those areas that contain gravels likely to have been targeted. This could limit the need for expensive open area excavations. Single heavily reworked finds from the lowest terraces would not carry the same significance and thus not necessarily lead to excavation.

6.2.19 Evidence for the Upper Palaeolithic typically lies on or close to the surface of Devensian gravels and may potentially be lost during the initial surface strip for any development taking place on the gravel. Archaeological survey, including both fieldwalking and geotechnical investigations, may help to identify potential sites of significance for this period.

6.2.20 The assessment has shown that there is some, although on present understanding, limited potential for the recovery of assets of this period. Any such finds might be of high significance and possibly of National or International importance, if discovered, and thus may present some restrictions to extraction. Surface finds may actually be the only representation of Upper Palaeolithic habitation and initial topsoil stripping without any sort of archaeological survey would result in the removal and loss of any such significant evidence.

6.2.21 Potential areas of research are arising from this assessment and any further extraction work undertaken within the gravel bearing geologies are dealt with in Section 10.3.2 and 11.16.

6.3 Mesolithic (10,000–4000 BC)

Introduction

6.3.1 Following the Last Glacial Maximum (*c* 18,000 BC), the environment of the Project Area was probably open arctic-alpine tundra landscape until *c* 10,000–*c* 9500 BC. Then, with the climatic improvement at the end of the last glaciation (Devensian), this tundra was superseded by forest (Rackham and Sidell 2000, 20–2). This period of climatic change created a new environment and mobile hunter-gatherer communities exploited this in a completely different manner. This led to the development of new exploitation strategies and thus different tools, so during the Mesolithic period (*c* 8000–*c* 4000 BC) these hunter-gatherers produced a new range of flint tools including axes and tiny projectile points or microliths.

6.3.2 Evidence of human activity is largely characterised by finds of flint tools and waste rather than structural remains. Traces of Mesolithic sites usually only survive in valley floor or floodplain edge locations and are often not in a stratified contexts.

6.3.3 The environmental conditions during this period can be reconstructed from plant pollen which are preserved in the buried peat and clay. Pollen from Enfield Lock in the Lea valley illustrated the spread of a pine forest replaced by mixed hazel and elm woodland. Oak and then lime trees dominated the woodland in the later Mesolithic, and was home to wild cattle, roe, boar and deer. Eventually Britain was cut off from the continental Europe following a rise in sea levels (Darvill 1997).

6.3.4 Evidence for diet during the Mesolithic period for the Essex area is limited. However, the species hunted are likely to have included aurochs, elk, red deer, roe deer and wild pigs, while plant foods collected certainly included hazel nuts (Jacobi 1980, 14). Food resources obtained from the nearby Thames estuary could have included birds, shell-fish, fish and perhaps seals. The river valleys would have been especially favoured in providing a predictable source of food (from hunting and fishing) and water, as well as a means of transport and communication.

6.3.5 Mesolithic sites are characterised by flint implements and core axes as well as other

stone, bone and antler artefacts. Mesolithic implements were found on sites in East London along the A13 road and Stratford, indicating the presence of hunter gatherers in the wooded landscape that had replaced the tundra as the climate warmed (Swift *et al* forthcoming).

Assets densities

6.3.6 There are 9 assets dating to the Mesolithic period within the Project Area all of which are located within Study Area 4 (Fig 7). Assets comprise:

- **7 Objects**
- **2 Unassigned**

6.3.7 This equals an overall asset density of 0.2 assets per km^2 for the Project Area and an asset density of 0.4 assets per km^2 for Study Area 4 only. Where the finds description states several flints or flint scatter, these were counted as 1 object.

6.3.8 If adding the 10 undated objects identified in 6.13 the number of objects would be 17 and the total number of assets 19. This would change the asset density 0.5 assets per km^2 (Table 1).

Key sites

6.3.9 Finds of diagnostically Mesolithic flints within the Project Area are limited and comprise a handful of unstratified or residual blades. The concentrations of Mesolithic assets are associated with some of the key sites of this period within Havering.

Moor Hall Farm

6.3.10 Mesolithic microlithic flint implements and a flint adze were found during the excavations at this site, although there was no evidence for occupation at this period. It is though that axe and adze finds oft this type found in the region imply woodland clearing. It is likely that by this date the area was covered by woods which were being partly cleared or thinned during this period, maybe to improve the grazing and therefore the hunting potential of selective areas.

Great Arnold's Field

6.3.11 The central pit within the Great Arnold's Field Neolithic ring ditch contained a number of flints, some of which on stylistic grounds cannot be precisely dated, but are all considered to be either of Later Mesolithic (*c* 6500–4100 BC) or Early Neolithic (*c* 4100–3400 BC) date. The stratified flints consisted of a blade core and two retouched blades.

Manor Farm, Hunts Hill Farm, Great Sunnings Farm

6.3.12 At Manor Farm, Hunt's Hill Farm and Great Sunnings Farm, there are very few finds of blade cores and other potentially Mesolithic finds. This suggests some degree of infrequent human activity at these sites.

6.3.13 At Hunt's Hill Farm a single broken broad-blade microlith, dated to the earlier Mesolithic period (*c* 8000–6500 BC), was discovered redeposited within the construction trench of a Norman hall house. Other finds include a microlith and several blade cores from Manor Farm.

Conclusion

6.3.14 Mesolithic material is not particularly well represented, and is often confined to the upper courses of the Thames tributary streams. The range of tool types associated

with this period indicates hunting and food processing, and small groups would have exploited resources available along the river margins.

6.3.15 Finds from the Study Areas are not within fully stratified contexts and the majority of evidence dating to this period within the region comprises isolated finds. As with the earlier Palaeolithic period, the distribution of assets does not provide a clear understanding of the nature and extent of Mesolithic occupation and other activity within Havering at present, but does nevertheless suggest higher potential in the aggregate areas from which they were recovered. Mesolithic assets are closely linked to gravel extraction and the distribution of known Mesolithic assets provides an indication of where further Mesolithic remains may be present. Deposits in the Havering region generally have the potential to add to the knowledge of this period.

6.3.16 On the terrace edges, sites of this period often lie close to the surface and could be lost during the initial surface strip. Thus early intervention through some form of archaeological survey, primarily fieldwalking, may recover evidence of domestic activity. Within the floodplain, sites of this period often lie under several metres of alluvium and peat areas intensive geo-archaeological investigation might identify those areas that contain gravels likely to have been targeted for Mesolithic inhabitants and thus limited the need for expensive open area excavations. It should also be noted that extraction activity also requires dewatering of an area. Thus there is potential to impact upon waterlogged remains on other areas of an extraction operation which may not be directly targeted for extraction, and also in areas directly adjacent to the extraction site.

6.3.17 Any evidence of activity of this period would be of high to medium significance (depending on the type of assets) as this would provide information about the early human activity and transition of Palaeolithic societies into the Mesolithic period.

6.3.18 The inclusion of early prehistoric assets greatly enhances our understanding of the importance of the gravel soils to peoples of this period. It demonstrates that careful consideration should be given to the investigation of this period during any planning process.

6.3.19 Potential areas of research are arising from this assessment and any further extraction work undertaken within the gravel bearing geologies are dealt with in Section 10.3.3 and 11.16.

6.4 Neolithic (4100–1700 BC)

Introduction

6.4.1 The Neolithic period is traditionally seen as the time when hunter gathering gave way to farming and settled communities, and forest clearance occurred for the cultivation of crops and the construction of communal monuments. Pollen records indicate forest clearance over large areas of the British Isles during this period. The Lower Thames valley experienced a dramatic environmental change characterised by the extensive formation of peat in lowland areas. During this period, sea levels rose and the land bridge to the continent disappeared. Palaeoenvironmental analysis of deposits from the area has revealed a complex record, indicating changes in the vegetation cover and hydrology between 3,000 BC and 1,500 BC. These changes were characterised by the colonisation of yew woodland on the peat surface and drier conditions, possibly the result of local modifications in drainage, leading to localised drier conditions, or utilisation of slightly drier gravel islands within a wider wet environment.

6.4.2 The light soils of the river valleys such as the Thames appear to have attracted early farming settlement. The scattered farming communities that developed in the East London area during this period were probably engaged in pastoralism, with agricultural activity supplemented by hunting and gathering. Much of the landscape was still wooded, but clearings made by early farming communities provided land for agriculture (Swift *et al* forthcoming).

6.4.3 Farming activities probably revolved around small single farmsteads. The archaeological evidence for structures is generally poor and often only comprises post holes, pits and scatters of household debris. Farmstead settlements were characteristically found on well-drained soils on low hills and river valleys. The adoption of farming was linked to a more sedentary lifestyle and the development of complex ritual and symbolic behaviour, which led to the construction of various landscape monuments including ring ditches and cursus within the Greater London area (Framework Archaeology 2006, 52–4).

6.4.4 One definite earthwork monument of this type has been found has been found within the Study Area at Great Arnolds Field, and another possible example at South Hall Farm.

Asset Densities

6.4.5 There are 38 assets dating to the Neolithic period within the aggregates resource, and these discoveries are limited to Study Area 4 (Fig 8). The following Asset Types were identified:

- **3 Domestic**
- **9 Agriculture**
- **2 Water**
- **11 Objects**
- **5 Religious Ritual and Funerary**
- **8 Unassigned** (including 5 cropmarks)

6.4.6 This equals an asset density of 1.7 assets per km^2 for Study Area 4 only and an overall asset density of 1 asset per km^2 for the entire Project Area.

6.4.7 In addition to those assets which are known to be of Neolithic date, there are a further 67 unspecified prehistoric assets with a provisional date range from the Neolithic to the Iron Age (see 6.7) which could potentially include Neolithic assets. Some of these may represent archaeological activity (e.g. settlements, cemeteries etc) or diffuse remains spread across a larger area (e.g. trackways, field systems, field boundaries etc). This would equal a total number of 105 assets, representing an overall asset density of 2.8 assets per km^2 for the whole Project Area. There are also a number of unassigned cropmarks which were identified by the NMP. Without further investigation it is difficult to assess these cropmarks or make any conclusion as to their function and exact date, but they are an additional indicator for the occupation of the area during this period.

6.4.8 There are a further 103 assets of unknown date (see 6.13), including 28 ring ditches and/or ditched enclosures. These would increase the total number of assets to 141 and the asset density would increase to 3.7 assets per km^2 for the Project Area.

6.4.9 If taking into account the total sum of definite and potential numbers of assets, the total would add up to 208 assets across the Project Area and the asset density would increase to 5.5 assets per km^2 (Table 1).

Key sites

Great Arnold's Field

6.4.10 A ring ditch was recorded, constructed around the middle of the 4th millennium BC at Great Arnold's Field, 2km east of Rainham, overlooking the Common Watercourse. It is thought to represent a small earthen monument or henge (Swift *et al* forthcoming). The site was first identified as a ring ditch cropmark on aerial photographs in 1957. Excavations in 1963 confirmed that the feature was a circular

ditch with an internal diameter of just over 15m.

6.4.11 A second, much smaller ring ditch, enclosing an off-centred pit was examined some 75m to the north-east, while a further ring ditch lay 500m to the south-east, but was removed without record. Although there is no direct evidence, it is likely that these monuments were laid out in clearings carved out of the local tree cover. Over 400 sherds of pottery were recovered from the ditch fills and a lithic assemblage of 240 pieces of struck flint was also recorded. A considerable amount of unstratified material was recovered, most of which was probably derived from the ploughed out upper portion of the ring ditch and its associated features (Swift *et al* forthcoming).

South Hall Farm

6.4.12 A length of causewayed ditch reported during work carried out at South Hall Farm, Rainham, a little to the west of Great Arnold's Field, may belong to another probably larger, monument (Bond 1988, 36). Other undated ring ditches, visible as cropmarks, have been identified along the Common Watercourse in the area and could be associated.

Conclusions

6.4.13 Although the number of assets in Havering during this period is still limited, there is a slight increase in comparison to earlier periods. All identified Neolithic assets are located in Study Area 4, the largest of the Study Areas, and also the one with the highest number of extraction sites. The assets comprise artefacts and artefact scatters, but also one funerary object. The most important asset identified is the ring ditch at Great Arnold's field and a potentially similar monument located at South Hall Farm.

6.4.14 Evidence from these key sites indicates that a potentially significant group of Neolithic sites existed along the valley of the Common Watercourses, and at points overlooking the local Thames floodplain. Groups of similar sites are known from Chelmsford to the north (Brown 1997), in the Orsett/Mucking area to the east (e.g. Framework Archaeology 2006, 43–59).

6.4.15 There are a large number of assets that may date to this period, particularly artefacts as well as ring ditches and enclosures, which are known to occur during this period. A number of unassigned cropmarks, possible representing barrows or enclosures, have also been recorded in the area. The distribution of assets indicates that the river valleys continue to be the focus of settlement, although this pattern may be distorted by the spread of past extraction and archaeological investigation. In general, it appears that the area had become an important focus of occupation and it is likely that more finds dating to this period will be present in the Study Areas.

6.4.16 Archaeological investigation ahead of gravel extraction has identified significant assets in the Study Area and the assessment demonstrates the high potential for the recovery of such assets on the gravel aggregates. Remains of this period could be of high significance as they would provide important evidence of early human settlement and agricultural activity as the ELG project shows. Archaeological survey, including both fieldwalking and geotechnical investigations, may help to identify potential sites of significance for this period. However, the identification particularly important sites would present some constraints to extraction due to the expense required to excavate and record archaeologically *in situ* deposits of this period. As for the pervious periods, geoarchaeological surveys would be much better techniques for identifying sites, or the locations in which sites might be found. Fieldwalking surveys are equally as important for identifying settlements.

6.4.17 Potential areas of research arising from this assessment and any further extraction work undertaken within the gravel bearing geologies are dealt with in Section 10.3.4 and 11.16.

6.5 Bronze Age (2000–600 BC)

Introduction

6.5.1 The Bronze Age is characterised by technological change, when copper and then bronze eventually replaced flint and stone as the main material for everyday tools. It is seen as a period of increasing social complexity and organised landscapes, probably due to increasing pressure on available resources. The construction of round barrows is associated with the appearance of a particular ceramic form of 'beaker'. In the later Bronze Age, burial practice takes the form of cremated remains in pottery 'urns'. Remains of Bronze Age agricultural fields and trackways have been found with greater frequency than evidence of Neolithic agriculture. In some cases remains of Bronze Age agricultural landscapes include domestic sites, but these are rare.

6.5.2 Extensive areas of rectilinear field systems were being established across south-east England, which implies that large areas of woodland had already been cleared and that the agriculture was becoming more intensive, perhaps as a response to rising population levels.

6.5.3 The first defended settlements or 'ring works' were also established towards the end of this period and bronze weaponry has been recovered either from the Thames or numerous hoards. This implies that the level of conflict within society was increasing.

6.5.4 There is a widespread development of agricultural intensification during the Late Bronze Age. This is evidenced by numerous discoveries of ditched field systems and droveways. These field systems are sometimes associated with ring work settlement sites (Yates 2001, 65–73).

6.5.5 The period is dominated by an expanding range of settlement evidence encompassing an array of domestic, storage and other structures as well as economic and environmental data. The later part of the period is characterised by the introduction of novel metal objects (shields, buckets and cauldrons) and by the adoption of a finer quality of pottery geared to the presentation and serving of food within a society increasingly concerned with status and display (Swift *et al* forthcoming)

Asset densities

6.5.6 The aggregates resource contains 90 Bronze Age assets (Fig 9), The following asset types are represented:

- **1 Defence**
- **4 Objects**
- **20 Agriculture and subsistence**
- **5 Domestic**
- **14 Religious Ritual and Funerary**
- **3 Hoards**
- **3 Transport**
- **2 Industrial**
- **3 water**
- **35 Unassigned** (including 7 cropmarks)

6.5.7 This equals an overall density of 2.4 assets per km^2 for the overall Project Area. As with the Neolithic period, Bronze Age assets are concentrated on Study Area 4 with an asset density of 3.9 assets per km^2. There are two assets in Study Area 3 which

shows activity for the first time during this period. Asset density for this Study Area is 0.8 assets per km^2.

6.5.8 A further 67 assets are potentially dated to this period (see 6.7), which would make a total of 157 assets, equivalent to 4.2 assets per km^2 for the overall Project Area.

6.5.9 There are a further 103 assets of unknown date (see 6.13), including 28 ring ditches and/or ditched enclosures. These would increase the total number of assets to 193 and the asset density would increase to 5.1 assets per km^2 for the Project Area.

6.5.10 If taking into account the total sum of definite and potential numbers of assets, the total would add up to 260 assets across the Project Area. The asset density would increase to 7 assets per km^2 for the Project Area (Table 1).

Key sites

Hunt's Hill Farm

6.5.11 Several post built structures are thought to represent the remains of roundhouses. A curvilinear gully, of unknown function was also recorded (Swift *et al* forthcoming).

Whitehall Wood

6.5.12 A rectilinear Bronze Age field system was discovered at Whitehall Wood. The evidence for occupation at Whitehall Wood consisted of various shallow scattered postholes, post pits, gullies and pits of uncertain function as well as associated flintwork (rough chunks and flake cores).

South Hornchurch

6.5.13 An enclosed settlement was recorded at South Hornchurch. It comprised a central round house had a large porch aligned on the enclosure entrance.

Conclusion

6.5.14 Compared to the earlier prehistoric periods, there is a significant rise in the number of assets during the Bronze Age. Whilst previous periods have produced assets in Study Area 2 and 4 only, there are now a very small number of assets occurring in Study Area 3. As with the previous periods, the focus of assets continues to lie within Study Area 4. Assets within Study Area 3 comprise isolated find spots whilst Study Area 4 in comparison, has produced more substantial assets contained within a stratigraphical context.

6.5.15 It is also noticeable that the range of asset types has increased from earlier periods and now includes hoards, agriculture and subsistence, transport and defence, which reflects the increasingly complex social structures. A ringwork in the form of a circular ditched enclosure including one central structure and four- and six- post structures within was discovered at Hornchurch, representing the first known type of defence within the Borough of Havering.

6.5.16 A large number of unspecified prehistoric assets could potentially also be dated to this period. These include cropmarks such as ring ditches, enclosures and ring works, and a number of these appear to have been established at this time in the area. The status and function of these remains unclear, though the location of many on low eminences or gravel terraces suggests that visibility may have been an important consideration, and they appear to be linked with agricultural intensification, concentrations of metalwork and craft activity (Yates 2001, 65, 78). Some of these assets are found in Study Area 1, an area that has few assets in earlier periods. Although it is difficult to draw any conclusions as to the date and purpose of these features, it should be noted that these could be barrows, ritual monuments or domestic features which would be affected by any future gravel extraction and could hold significant evidential value for this period.

6.5.17 The asset density map (see Fig 9) shows a focus of settlement in Study Area 4; this

may represent real patterns to some degree, but it is also likely that this is due to the level of past investigation activity in certain areas. The high number of undated assets across the Project Areas implies that the actual number of assets may be higher and more widely distributed for these periods.

6.5.18 Archaeological investigation ahead of gravel extraction has consistently identified Bronze Age assets (ELG project) and this assessment demonstrates the high potential for the recovery of Bronze Age assets on the gravel aggregates. Domestic or related assets would be of high significance by enhancing our understanding of settlement patterns during this period. These sites and any outlying remains associated with them are likely to be a significant constraint to development due to the expense required to excavate and record archaeologically *in situ* deposits of this period. Where particularly important sites are present, extraction may be resisted because of the requirement to preserve remains of high significance. However, this also means that our understanding of the possible location of Bronze Age assets is better making the early identification of potential Bronze Age sites more likely with the concomitant action being that mitigation is more easily definable.

6.5.19 Potential areas of research arising from this assessment and any further extraction 10.3.5 and 11.16.

6.6 Iron Age (*c* 750BC–AD 43)

Introduction

6.6.1 During the Iron Age, the climate deteriorated with colder weather and more rainfall. The period is characterised by expanding population, which necessitated the intensification of agricultural practices and the utilisation of marginal land. Hillforts were established in lowland Britain, linked to tribal land ownership.

6.6.2 Field systems, enclosures and other agricultural features occur quite regularly during this period, and remains of post-built structures such as domestic round houses, are also found. Towards the end of the Iron Age there is evidence of increasing trade with continental Europe in the form of foreign coins and pottery types. The rivers, such as the Thames and its tributaries, continue to have been used for offerings, and deposits placed in pits and waterholes at Hunt's Hill Farm and Great Sunnings Farm indicate a degree of ritual and belief within everyday routine (Swift *et al* forthcoming).

6.6.3 It is thought that the density of settlement was increasing during the period and the best documented sequence from the area comes from Hunt's Hill Farm. The evidence indicates that the area was continuously occupied from the Late Bronze Age until the end of the Iron Age, which implies the existence of stable and successful communities within the area. Environmental evidence from Hunt's Hill indicates both arable and pastoral farming. It is thought that a mixed farming strategy was in place (Swift *et al* forthcoming). This pattern is consistent with the evidence from other parts of southern Britain (Swift *et al* forthcoming; Hingley & Miles 1984, 64–5).

Asset density

6.6.4 The Iron Age assets are shown on Figure 10 and comprise:

- **6 Water and drainage**
- **2 Transport**
- **2 Object**
- **7 Religious Ritual and Funerary**
- **13 Domestic**
- **3 Defence**

- **12 Agriculture and subsistence**
- **2 Industrial**
- **22 Unassigned** (including 6 cropmarks)

6.6.5 There are 69 Iron Age assets in the Project Area, equivalent to an asset density of 1.8 assets per km^2 for the overall Project Area. As with previous periods, the assets are concentrated in Study Area 4, the area of the greatest extraction/investigation, where the asset density equals 3 assets per km^2.

6.6.6 There are a further 67 unspecified prehistoric assets (see 6.7), which if of Iron Age date would make a total of 136 potential assets, equalling an overall density of 3.6 assets per km^2 for the Project Area.

6.6.7 There are a further 103 assets of unknown date (see 6.13), including 28 ring ditches and/or ditched enclosures. These would increase the total number of assets to 172 and the asset density would increase to 4.6 assets per km^2 for the Project Area.

6.6.8 If taking into account the total sum of definite and potential numbers of assets, the total would add up to 239 assets across the Project Area. The asset density would increase to 6.3 assets per km^2 for the Project Area (Table 1).

Key sites

Hunt's Hill Farm

6.6.9 There was evidence for settlement within a fortification, consisting of various timber buildings and a well, plus two areas of associated settlement external to the fortification. A series of round houses were recorded, several appearing to lie within a ditched enclosure potentially intended as a defensive structure. A number of (undated) postholes were interpreted as either raised granaries or small domestic shrines (Harding 1974, 78, 110). A group of postholes and other features may have formed a large, broadly circular, enclosure just over *c* 30m in diameter, interpreted as a possible stock corral. Other features included a sequence of waterholes and perhaps a remnant of a more extensive field system. It is thought that the indigenous Iron Age population constructed this defensive structure. Clearly weaving was carried out nearby, judging by the associated finds. Kiln waste recorded might imply a barn or granary.

Moor Hall Farm

6.6.10 Traces of a small unenclosed settlement with round houses and a field system were recorded, which was apparently continuously occupied from the Earlier Iron Age. During the later Iron Age the farmstead was fortified and enclosed in two phases. The first phase was a single-ditched enclosure which was later backfilled and replaced by a more substantial double-ditched enclosure.

Great Sunnings Farm

6.6.11 At Great Sunnings Farm, a small farmstead probably existed in the Earlier Iron Age. Parts of several probably rectangular ditched enclosures may have been for stock, and a round structure of unknown function, with a diameter of *c* 16.5m, was recorded. Part of a penannular gully is interpreted as a round house. The settlement at Great Sunnings was dominated by two adjoining trapezoidal enclosures. This settlement was abandoned during the Early Roman period, when the enclosure ditches were infilled and a field system was laid out across the site. Surviving internal structural remains were severely truncated due to post-medieval ploughing. There were a few contemporary pits and a probable (unlined) well. Possibly the larger eastern enclosure was principally used as a livestock pen, while the western one contained a farmstead.

Manor Farm

6.6.12 Evidence of Earlier Iron Age settlement consisting of one round house, represented by a fragmentary penannular gully, and a few scattered pits was recorded. The only evidence of Later Iron Age activity was one ditch. The presence of this ditch suggests that during this period, the site was being utilised as part of a field system.

Other sites

6.6.13 Outside the Project Area a number of fortified Iron Age sites were established during this period. The nearest was at Uphall Camp, Ilford, where a massive fort was built in the 2nd century BC (Greenwood 1989; 2004). The fort lies between the joining of two watercourses, the River Roding to the west and Loxford Water to the south. About half of the area within the earthworks has been investigated and has revealed nine round house structures and numerous small pits and postholes. Uphall Camp is the largest known settlement of its kind in the region, and is likely to have been an important tribal or political centre. The fort was abandoned during the 1st century BC (Hill *et al* 2004, 373).

6.6.14 Uphall Camp was clearly a major centre within the region, and was sited strategically to control the River Roding. A few other large defended enclosures of this type are known, as at Woolwich on the Thames (Greenwood 1997, 158; Wait and Cotton 2000, 106).

Conclusion

6.6.15 As with the previous periods, evidence for Iron Age activity is concentrated in Study Area 4. Evidence suggests that a number of earlier settlements and field systems simply continued in use during this period and the assets density map seems to confirm this picture, showing a similar pattern in the distribution of assets as with the previous Bronze Age period. A few additional defence assets appear in this period, possibly indicating a more complex social system and pressure.

6.6.16 The past investigations in connection with aggregates extraction (ELG) have produced a number of important sites and finds within the borough which show continuity of occupation from the Bronze Age or earlier and into the Roman period. These are the settlements at Whitehall Wood and Hunts Hill Farm which have been identified during past investigation work and the East London Gravel Project. Of these, Hunt's Hill Farm provides the best documented sequence.

6.6.17 The evidence indicates that a rich and complex prehistoric landscape existed in the area east of modern London and suggests that the aggregates extraction areas have a high potential to provide further evidence dating to this period.

6.6.18 Archaeological investigation ahead of gravel extraction has identified assets and the assessment demonstrates the high potential for the recovery of assets on the gravel aggregates. The evidence from the East London Gravel sites indicates some continuity from the late Bronze Age and provides significant evidence for this period. They also show that sites dating to these periods and any outlying remains associated with them are likely to be a significant constraint to development due to the expense required to excavate and record archaeologically *in situ* deposits of this period. However, through an increased academic focus on the prehistoric periods our understanding of the possible location of Iron Age assets has increased and therefore, like the Bronze Age, mitigation is more easily definable.

6.6.19 It should be noted that as with previous periods, a large number of assets recorded in the database is only broadly dated as Prehistoric, e.g. much of the cropmark evidence might possibly be of Iron Age date.

6.6.20 Potential areas of research arising from this assessment and any further extraction work undertaken within the gravel bearing geologies are dealt with in Section 10.3.6 and11.16.

6.7 General Prehistoric (c 700,000 BC- AD 43)

6.7.1 There are 67 assets in the database which have a broad 'later prehistoric' (Neolithic, Bronze and Iron Age) date range assigned. These are considered together here as a group. Assets dating to this period are shown in Figure 11 and comprise:

- **12 Objects**
- **6 Agriculture and subsistence**
- **2 Domestic**
- **2 Religious Ritual and Funerary**
- **5 Transport**
- **40 Unassigned** (including 15 enclosures, 15 ring ditches)

6.7.2 The assets density map of the general prehistoric period shows activity in all four study areas. Study Area 4 remains the focus of activity as discussed above and is also the Study Area with the highest number of identifiable asset types. The majority of unassigned assets of these periods comprise cropmarks. All assets shown in Study Areas 1 and 2 are unassigned cropmarks. This is quite an important result of this assessment as it is a strong indication that the distribution of assets for the prehistoric periods discussed above is indeed a reflection of the focus of previous investigation work, rather than a real picture of activity during the prehistoric period. The maps show that there is a high potential for finds dating to the Prehistoric period in Study Area 1 and 2 (Table 1).

6.8 Roman period (AD 43–410)

Introduction

6.8.1 Within approximately a decade of the arrival of the Romans in AD 43, the town of Londinium had been established on the north bank of the Thames where the City of London now stands, *c* 15km west of Havering. Londinium quickly rose to major prominence and became a commercial centre, and the hub of the Roman road system in Britain. Small settlements were typically located along the major roads (MoLAS 2000, 150). The Roman Road from London to Colchester ran across the northern part of the borough, roughly along the modern A118 (Fig 12), through the centre of Study Area 1. It follows the edge of the higher ground overlooking the marshes.

6.8.2 It is thought that the countryside did not change significantly during this period and that earlier Iron Age farmsteads remained in use with people continuing living and farming in traditional fashion. Occupation at sites such as Hunts Hill and Great Sunnings Farm continued as before, although at Moor Hall Farm field systems appeared to replace the enclosure.

6.8.3 There are few Romano-British villas around London, and most of these were located in Kent. These villas were large farming estates established because of the rich farming land in this area. It is unknown whether the farms on the river terraces were owned locally by people who saw little or no need to engage in Romano-British patterns of social display, or whether absentee landlords were using rents and tithes from lands here to live in Roman style elsewhere.

6.8.4 In the later Roman period, agricultural activities appear to increase and the field systems seem o have been reorganised to certain degree, indicating a slight shift from a defensive to a more domestic landscape. The excavations on the East London Gravel sites confirm this overall trend towards agrarian activity and a reorganisation of the field system in the later Roman period. At Hunts Hill Farm, the fields were subdivided into smaller units and it has been suggested that this was

linked to a system of more intensive farming (Swift *et al* forthcoming).

Asset density

6.8.5 The Roman assets comprise (Fig 12):

- **8 Water and Drainage**
- **3 Transport**
- **25 Objects**
- **7 Religious Ritual and Funerary**
- **17 Domestic**
- **12 Agriculture and subsistence**
- **22 Unassigned** (including 6 cropmarks of potential enclosures)

6.8.6 There are 94 Roman assets in the Project Area, equivalent to an overall asset density of 2.5 assets per km^2. Again, the map shows a concentration of assets within Study Area 4, the largest Study Area where most of the extraction and past archaeological investigation work has taken place.

6.8.7 There are a further 103 assets of unknown date (see 6.13). These would increase the total number of assets to 197 and the asset density would increase to 5.2 assets per km^2 for the Project Area (Table 1).

Key sites

Moor Hall Farm

6.8.8 The general absence of Roman finds and complete absence of military equipment imply that this was not a temporary Roman army camp, but was a fortified 'native' farmstead. An isolated human burial contained remains of an adult.

Hunt's Hill Farm

6.8.9 The defensive Iron Age structure at Hunts Hill Farm appears to have changed into a settlement in the Roman period. Evidence for two small Roman cremation cemeteries has been found at Hunt's Hill Farm; these interments presumably represent the remains of some of the inhabitants of these farmsteads, buried close to their homes.

Manor Farm

6.8.10 A small Early Roman cemetery of five cremation burials was found at Manor Farm, including the burial of a woman whose ashes were placed in a pottery flagon.

Other sites

6.8.11 Just outside Study Area 1, and straddling its western boundary, lays another key site, Mark Warrens Farm. Around the time of the Roman conquest a large triple-ditched enclosure was constructed here. This site was approached by a trackway, to one side of which was a later Roman flint and tile wall.

Conclusion

6.8.12 The assets density map shows activity in all four Study Areas, and a slight increase in activity in the northern part of the borough, in Study Areas 1 and 2. The evidence suggests that there is high potential for Roman assets in those study areas. The majority of assets are located, as with previous periods, in Study Area 4, the area with the highest extraction activity.

6.8.13 The map shows no significant change in asset types, settlement pattern and land use. The establishment of the Roman road network with the London Colchester road running through the north of Havering (see Fig 12), may have entailed activity further in the north of the Project Area, as shown on the assets density map in this area.

6.8.14 The defensive enclosures that had been established during the Iron Age on key sites such as Hunts Hill Farm, Moor Hill Farm and Sunnings Farm fell in disuse and at e.g. Hunts Hill Farm were replaced by a field system (Greenwood *et al* 2006). The evidence seems to indicate a slight shift from a more defensive type of settlement towards a focus on a domestic landscape and in the later Roman period most of the sites were used as farmland.

6.8.15 A more detailed analysis of these assets would contribute greatly to our understanding of the development of the region as well as the country during this period. The resource assessment shows a slight increased number of assets which also means that the potential for the recovery of assets dating to this period is higher. However, despite that fact that our understanding of this period is enhanced by the survival of documentary evidence, assets identified through archaeological investigations ahead of extraction activity still remain significant in that they help to either confirm or deny assumptions based upon surviving documentary sources.

6.8.16 Finds of this period would potentially be of high significance and these sites and any outlying remains associated with them, are likely to be a significant constraint to development due to the expense required to excavate and record archaeologically *in situ* deposits. Nevertheless, our increased understanding of the period means that our ability to predict areas of significance is better which ensures more appropriate mitigation measures.

6.8.17 Potential areas of research arising from this assessment and any further extraction work undertaken within the gravel bearing geologies are dealt with in Section 10.3.7 and 11.16.

6.9 Early Medieval (Saxon) period (AD 410–1066)

Introduction

6.9.1 The Roman administration of Britain collapsed in the early 5th century AD, and *Londinium* was apparently largely abandoned. In the following decades, Germanic settlers arrived from the Continent: the early Saxon economy was based on agriculture, with small rural settlements. In London, the trading port of *Lundenwic* developed in the area now occupied by Aldwych, the Strand and Covent Garden, *c* 14km west of the site (Cowie and Blackmore 2008). In the 7th to 9th centuries, Christianity was widely adopted, and some settlements expanded into Minsters (religious centres) and royal estates.

6.9.2 Havering lay within the Hundred (a large early administrative unit) of Chafford, which had a recorded population of 8.5 people and 2.6 plough teams per square mile. From the livestock figures and number of plough teams it is apparent that within the southern half of the county, the main emphasis was on sheep farming (Rumble 1983, 30.4).

6.9.3 The settlements during this period in East London were villages and farmstead concentrated along the Thames and its tributaries. It is thought that farming was less intensive than during the previous Roman period, but only a few settlements have been excavated and uncertain as traces of occupation are hard to locate archaeologically (Greenwood *et al* 2006). By AD 604 it is documented that the area was part of the kingdom of the East Saxons.

6.9.4 Evidence indicates that there was either agricultural activity or settlement at Hunt's Hill, Manor and Moor Hall Farms during the late 4th century and it is thought that their occupation might have continued into the 5th century.

6.9.5 It has been suggested that the Barking and Havering area may have originally been one large Middle Saxon royal estate possibly run by Havering manor (Rippon 1996, 121, fig 2). In the late 7th century this large royal estate started to subdivide and eventually a rural landscape emerged which steadily became more densely populated and more intensively utilised. By the time of Domesday Book (1086) the area had become a mosaic of manors (Hooke 1997, 76–80; Swift *et al* forthcoming).

6.9.6 Most likely the settlement sites in the area of Havering were farmsteads. Evidence from other contemporary sites in the Greater London area suggests that these farmers cultivated a wide range of cereals (barley, oats, rye and wheat), pulses and a variety of fruits and vegetables (Cowie and Blackmore 2008, 159–62).

Asset Density

6.9.7 The early medieval assets (Fig 13) comprise:

- **1 Objects**
- **7 Domestic**
- **1 Defence**
- **4 Religious Ritual and Funerary**
- **3 Water**
- **2 industrial**
- **10 Agriculture**
- **9 Unassigned**

6.9.8 There are 37 recorded early medieval assets in the whole Project Area. These are concentrated in Study Area 4, the largest Study Area where most of the extraction and past archaeological investigation has taken place. This equals a total asset density of 1 asset per km^2, and 1.6 assets per km^2 for Study Area 4.

6.9.9 There are a further 103 assets of unknown date (see 6.13). These would increase the total number of assets to 140 and the asset density would increase to 3.7 assets per km^2 for the Project Area (Table 1).

Key Sites

Hunt's Hill Farm

6.9.10 At Hunt's Hill Farm a row of east–west probable graves were found; probably due to adverse soil conditions no bones or even body stains were recorded. Objects recovered from the Hunt Hill graves included an iron knife blade, and a glass bead. It seems likely that these possible graves had been dug to respect the line of an earlier Iron Age enclosure ditch. An oval pit, interpreted as a waterhole, as well as field ditches and scattered pits were recorded.

Manor Farm and Whitehall Wood

6.9.11 Evidence of activity, consisting of the possible base of a hearth or oven, a linear feature and a ditch, was found at Manor Farm. Excavations at Whitehall Wood revealed scattered pits, postholes, perhaps the remains of timber structures or animal remains. This occupation appears to represent the reuse of an abandoned prehistoric and Roman site.

Other sites

6.9.12 Further evidence of early medieval occupation has been recorded on the GLHER in Study Areas 2 and 3, but no excavations are associated with these sites. A

settlement is recorded at Tylers Common in Upminster (Study Area 2) and at Ford Lane in Hornchurch (Study Area 3). Documentary sources attest the settlement of Wochunda at Cranham, in the north-east of Study Area 4. The GLHER also records an early medieval Burh at Wennington, in the south-west of Study Area 4. This is based on documentary evidence.

Conclusion

6.9.13 The distribution of assets shown on the density maps confirms the shift in the pattern of rural settlement, when the earlier sites were abandoned. There is a significant decrease in the general density of assets compared to the Roman period. An intensive landscape study of the Deben area in South Suffolk revealed a dispersed pattern of Early/Middle Saxon settlement, with a lower density of sites than that in the late Roman period. The asset density maps of the Study Areas in Havering reflect a similar pattern.

6.9.14 It is also noticeable that the majority of evidence comes from the excavated key sites in the area. It is possible that any remains have largely been removed by subsequent heavily mechanised ploughing in the late 19th and 20th centuries. It is also likely that the early medieval settlement would have been swallowed up by later medieval occupation.

6.9.15 The asset density map shows potential for this period in the Project Area and seems to confirm that the evidence is mainly found in the course of archaeological excavations that took place e.g. prior to gravel extraction. Fieldwalking would also help in recording such assets although visibility is an important factor and only certain types of assets would be picked up whilst other buried assets would not be apparent and would remain underrepresented.

6.9.16 The assessment shows that there is some potential for the discovery of early medieval assets within the gravel geologies, and as other evidence for this period is very limited, these assets are therefore of great significance and would present a considerable constraint to development due to the expense required to excavate and record archaeologically *in situ* deposits. Our archaeological understanding of this period is limited and therefore is our ability to identify areas of significance within the gravel aggregate geologies.

6.9.17 Potential areas of research arising from this assessment and any further extraction work undertaken within the gravel bearing geologies are dealt with in Section 10.3.8 and 11.16.

6.10 Later Medieval Period (AD 1066–1485)

6.10.1 Around the 9th and 10th century, the local parochial system had begun to replace the earlier Saxon Minster system, with formal areas of land centred on nucleated settlement served by a parish church.

6.10.2 Rural settlement continued to shift and change during this period and villages such as Rainham formed. The capital of London expanded and the surrounding countryside continued to develop in response to the demands of an increasing population. The late medieval landscape of London’s hinterland is still little understood archaeologically, as many villages are now located beneath modern towns, but settlement appears to have been more in the north and west of London. The countryside around London saw an increase agricultural production, domestic livestock and woodland management. As a consequence of most of the occupation of the period now being under modern settlements, any future quarrying is most likely to encounter evidence of agricultural activity such as field boundaries, and dispersed farms and deserted settlements outside these areas.

6.10.3 The name 'Havering' devolves from the Royal Liberty of Havering, to which Edward IV granted a charter in 1465. The modern borough takes its name from this ancient demesne, although it covers areas that were not part of the old Royal Manor

(Havering council website). The modern borough of Havering comprised nine historic parishes, comprising Havering atte Bower, Romford, Hornchurch, Upminster, Cranham, the southern part of Great Warley, Rainham, Wennington and North Ockendon. Most of the historic settlement centres (the villages and hamlets), have subsequently been subsumed in modern urban development and so lie outside the study areas. The main potential is for secondary settlement, in the form of the sites of farmhouses and homesteads, along with evidence of land management (i.e. agricultural ditches and banks).

6.10.4 **Havering-atte-Bower** forms the northern part of the borough of Havering and the settlement is located between Study Area 1 and 2, but outside both study areas. King Edward the Confessor is the first notable person to have a connection with the area. He occupied the royal house in the village of Havering atte Bower (VCH *Essex* VII, 9-17).

6.10.5 **Romford** first recorded in 1153–4, probably means 'wide ford', from which the river Rom took its name by back-formation. The chapel of St. Andrew, Romford, first mentioned in 1177, stood east of the Rom, on the south corner of Oldchurch Road and South Street. Twelfth-century Romford may have stood west of St. Andrew's chapel, amid or beside the ruins of a Roman town, but the Oldchurch site has not been excavated, and no Roman or medieval remains, apart from the chapel, have been recorded there (VCH *Essex* VII, 56–64). Parts of the manor were probably located within Study Area 1 in the north-east of the borough of Havering. The GLHER records the medieval settlement of Romford in the south-east corner of the study area.

6.10.6 The ancient parish of **Hornchurch**, which was conterminous with the royal manor and liberty of Havering was divided into eight wards. 'Romford side', comprising the five northern wards, became independent of Hornchurch, gradually forming the separate parishes of Romford (four wards) and Havering. 'Hornchurch side' comprising the three (later two) southern wards, remained under Hornchurch parish vestry, and from the earlier 19th century constituted the parish of Hornchurch. Hornchurch village grew up on the gravel terrace below and west of the parish church. South of it were Hornchurch marshes, to the north the heavy London Clay. The river Rom, continuing as the Beam, flows south to the Thames, forming Hornchurch's western boundary. South-west of the old village it is joined by the river Ravensbourne, formerly Bolles or Bowles brook, coming from Gidea Park in Romford. The River Ingrebourne, which also flows south to the Thames, is Hornchurch's eastern boundary, with Upminster and Rainham (VCH *Essex* VII, 25–31). Part of Study Area 3 and the north-western part of Study Area 4 (west of the Ingrebourne River), were probably located within the manor of Hornchurch.

6.10.7 In medieval **Upminster** there seem to have been three clusters of settlement: the village itself and the hamlets of Hacton and Corbets Tey. The later village probably lay along the Hornchurch Road (now St. Mary's Lane), and centred on the ancient parish church, which stands at the junction with Corbets Tey Road. South of the Hornchurch Road and on the western boundary of the parish, stood Bridge House on the site of the present Hornchurch stadium in 1375 (VCH *Essex* VII, 143–153). The southern part of Study Area 2, as well as some of the northern and north-eastern part of Study Area 4, was probably located within the manor of Upminster.

6.10.8 There were two manors in **Cranham** in 1086. Ockendon (*Wochenduna*) was part of the fee of the bishop of London. The manor of Cranham, which occurs in the 13th century, possibly represents the estate formerly held by Odo of Bayeux. John de Beauchamp first let the manor as farm to Thomas de Haya in the 13th century. The north-eastern part of Study Area 4 was probably located within the manor estate of Cranham.

6.10.9 **Great Warley** (south): The ancient parish lying immediately south of Brentwood, and comprising 2,890 acres, was one of several long narrow parishes which sloped from the wooded ridge into the Thames plain; In 1934 the parish was divided

between the urban districts of Brentwood and Hornchurch (VCH *Essex* VII, 163–174). The settlement of Great Warley is located outside the Borough of Havering, to the east of Study Area 2, but part of the ancient manor estate probably fell within the eastern apart of Study Area 2.

6.10.10 **North Ockendon** is a small parish, its medieval name of Ockendon Setfountayns derived from the lords of the manor. In 1935 the parish was divided between two urban districts: the south-west corner was added to Thurrock, the rest to Hornchurch (in 1965 Hornchurch became part of the London borough of Havering). The pattern of settlement in North Ockendon consists of a nucleated village and outlying farms. Of the latter, Baldwins, in the south-west of the parish and formerly moated, is the oldest. The main road or street from Brentwood to Grays divided the parish, and was crossed by a road running east from Bulphan to Upminster and Romford. The village developed at this crossroad (VCH *Essex* VII, 110–117). The south-eastern part of study area4 was probably located within the manor estate of North Ockendon.

6.10.11 The ancient parish of **Wennington** was located in the Havering marshes, bounded west and north by Rainham, east by Aveley and south by the Thames. The grouping of the village, church, and manor house along the high road, close to the marsh and wharf, and the elements of the parish name, suggest early sea-borne settlement. It became part of Havering in 1965 (VCH *Essex* VII, 180–190). The very southern part of Study Area 4 probably fell within the manor estate of Wennington.

6.10.12 Two roads from the east met at the **Rainham** village green and crossed the Ingrebourne before dividing to Dagenham and Hornchurch. Rainham bridge was first mentioned in 1234 (VHC *Essex* vii, 126–134). The southern part of Study Area 4 partially fell within the manor estate of Rainham.

6.10.13 The number of medieval moated and manorial sites within the Project Area confirms that there was a complicated and fragmented pattern of landholding, a trend that was underway by 1086, judging by the multiple entries for many Domesday manors. It seems that there was no simple pattern of nucleated villages surrounded by open fields or woods, instead there was a mixed pattern of villages and dispersed farmsteads, probably with a few cottages attached for each farm's labour force. It is also clear that the pattern of rural settlement within the Project Area changed during the medieval period, as the farmstead or manor at Hunt's Hill was abandoned soon after *c* 1300 and Launders Manor by *c* 1400. Both these sites were arable during the post-medieval period; the presence of ridge and furrow at Hunt's Hill suggests that the area may have been converted to fields during the medieval period (Rumble 1983, 36–27).

Asset Density

6.10.14 The later medieval assets (Fig 14) comprise:

- **5 Transport**
- **8 Religious**
- **12 Objects**
- **66 Domestic**
- **25 Agriculture and subsistence**
- **19 Unassigned**
- **3 Civil**
- **3 Gardens Parks and Urban Spaces**
- **1 Recreation**
- **1 Maritime**
- **1 Water**

- **1 Defence**
- **1 Industrial**

6.10.15 There are 146 later medieval assets in the whole Project Area, equivalent to a total asset density of 3.9 assets per km^2. The density map shows a significant increase of assets across the Project Area particularly for Study Area 1 and 2 which had only shown sparse numbers of assets throughout previous periods.

6.10.16 There are a further 103 assets of unknown date (see 6.13). These would increase the total number of assets to 249 and the asset density would increase to 6.6 assets per km^2 for the Project Area (Table 1).

Key sites

Great Arnolds Field

6.10.17 Excavations at Great Arnold's Field revealed the western portion of a rectangular ditched enclosure with an entrance in its north-east corner. Presumably within the enclosure were a hall house and various agricultural buildings, the remains of which had been truncated by cultivation. One agrarian building of unknown design and antiquity, which was perhaps connected with this complex, was 'Launder's Barn', situated *c* 500m east of this complex. This barn collapsed during the 1950s (Ransome 1978a, 132).

Hunts Hill Farm

6.10.18 Excavations at Hunt's Hill Farm revealed remains of an east-west aligned building, probably timber framed. It is thought that his represented a hall house with a ditched enclosure, which is interpreted as high status manorial farmstead (Rippon 1996, 121). This house appears to have been the central building of a farmstead, which was apparently abandoned sometime in the 13th century.

Other sites

6.10.19 The GLHER records the Manor House of Uphavering in the north-west of Study Area 1. This is based on documentary evidence of 1387-95. The house called 'Great Gobions' was demolished between 1680 and 1700 and replaced by a later house called 'Little Gobions'. This was demolished *c* 1899 and little is known about the medieval buildings.

Conclusion

6.10.20 The asset density map shows a considerable growth and increase of assets across all of the Study Areas, particularly 1 and 2, which had only shown sparse assets densities in previous periods. Whilst the early medieval period has shown a general decrease in activity compared to the previous Roman period, the asset density increases again during the later medieval period and assets are distributed throughout the study areas.

6.10.21 The number of domestic assets is now almost six times higher than during the early medieval period, and also higher than all other assets. This reflects a growth of settlement activity, probably associated with farming and agricultural communities. The number of agricultural assets across the Project Area has also increased although overall, the number of known agricultural assets is still relatively low. It is likely that evidence of medieval agriculture, in the form of ridge and furrow corrugated earthworks, have largely been removed by subsequent heavily mechanised ploughing in the late 19th and 20th centuries. A number of cropmarks have been found in the area which can not be dated without further investigation, but they possibly represent medieval field boundaries.

6.10.22 Many medieval sites were focussed around a parish church and later developed into larger urban areas, which were excluded from this assessment as these do not represent potential future gravel extraction areas. The overall number of medieval assets is therefore likely to be higher than this is reflected by the available data.

6.10.23 The resources assessment indicates that there is potential for the discovery of later medieval assets within the gravel geologies. The significance of such assets would vary. Assets pertaining to the early-medieval/medieval transition would be of high significance, given the paucity of early medieval assets. On the other hand, later medieval assets would be of lesser significance given the increase in documentary sources and supporting archaeological data from excavations in urban areas, currently excluded form this assessment. Transition assets may present a considerable constraint to development due to the expense required to excavate and record archaeologically *in situ* deposits of this period. Our archaeological understanding of this period is limited and so therefore is our ability to identify areas of significance within the gravel aggregate geologies.

6.10.24 Potential areas of research arising from this assessment and any further extraction work undertaken within the gravel bearing geologies are dealt with in 10.3.9 and 11.16.

6.11 Post-medieval period (1485–1900)

6.11.1 The main settlements in the borough were Romford, Upminster, Hornchurch and Rainham. Settlement in the 16th and 17th centuries followed the earlier pattern: the villages and hamlets continued to expand slowly, and isolated farms were built. Until the 19th century the settlements remained small country towns and occupations were mainly those connected with agriculture or with the small crafts and trades of a village. (VCH *Essex* VII, 39-45). The transformation occurred with the arrival of the railway in 1885 (VCH Essex VII, 143-153) and the first middle class suburban developments were built in the late Victorian and Edwardian period. The garden suburbs of Upminster, Emerson Park and Gidea Park (also known as Romford Garden Suburb) were spurred on by the building of the railway lines.

6.11.2 In the 1930s the District Line was electrified and extended to Upminster with new stations at Elm Park and Upminster Bridge. Also at this time new industries near the area, such as the Ford Motor Company plant at Dagenham, caused a new wave of mostly working class developments along the route of the new Underground line. In addition to this, to the north of the borough, the large housing estates of Harold Hill and Collier Row were constructed to deal with the housing shortages and early slum clearance programmes in central London.

6.11.3 The London Borough of Havering was created in 1965 by the combined former area of the Municipal Borough of Romford and Hornchurch Urban District, which had been transferred to Greater London from Essex by the London Government Act 1963. The name originates from the Royal Liberty of Havering which covered broadly, but not exactly, the same area and had been abolished in 1892.

Asset Density

6.11.4 The post-medieval assets (Fig 15) comprise:

- **10 Water and drainage**
- **9 Transport**
- **13 Religious Ritual and Funerary**
- **1 Recreation**
- **10 Objects**
- **34 Industrial**
- **2 Gardens Parks and Urban Spaces**

- **91 Domestic**
- **2 Defence**
- **9 Civil**
- **42 Agriculture and subsistence**
- **18 Unassigned**
- **1 Maritime**
- **3 Health and welfare**

6.11.5 There are 245 post-medieval assets in the whole Project Area, equivalent to a total asset density of 6.5 assets per km^2. The map shows a further increase of assets across the whole Project Area, particularly Study Area 4, whilst the asset density in the other three Study Areas remains almost unchanged.

6.11.6 There are a further 103 assets of unknown date (see 6.13). These would increase the total number of assets to 348 and the asset density would increase to 9.2 assets per km^2 for the Project Area (Table 1).

Key sites

6.11.7 There are no noticeable key sites in the Study Areas during this period, due to the nature of the current projects. Most important settlements were later developed into larger urban areas such as Romford, Hornchurch, Upminster and Rainham. These have been excluded from the Project Area as these have no potential for further gravel extraction. The four Study Areas are located outside areas of large scale urban development.

Conclusion

6.11.8 The Project Area is typical of a rural area on the urban fringe. Development was slow and focused on agriculture until the arrival of the railway lines. The domestic/agricultural assets reflect a similar picture as in the medieval period. The assets map also shows a high number of industrial assets, the majority of which are landfill sites across the borough. These indicate a level of quarrying that had started to increase during this period, with quarries that had fallen into disuse being filled.

6.11.9 The rise in assets reflects the range of changes in building fabrics, styles etc, which affects the survivability of many assets. For example greater ranges of building type have survived through consistent reuse because of the more durable building materials used. Assets of this period could include remains of industrialisation, technology, transport and buildings associated with manufacture or raw material production. This comprises engineering, architecture, economics and the social history of manufacturing/extractive industry as well as the transport and utilities sector.

6.11.10 Generally it is more difficult to identify assets of this period within gravel extraction areas as these are most likely to be located within or in the proximity of the excluded urban areas of the borough (see 3.2.14). The gravel extraction areas would have a potential for assets related to agricultural activity, e.g. field boundaries or ridge and furrow.

6.11.11 The resource assessment shows that while there is potential for the identification post-medieval assets within the gravel bearing geologies, their significance varies. For the earlier centuries of this period, such assets may have greater significance as supporting documentary evidence may be sparser, but this would be the reverse for the later part of the period when documentary, especially cartographic, evidence increased. However, assets identified through archaeological investigation have great potential to enhance our understanding even where documentary evidence is common. This assessment it creates a visual representation of the distribution of assets across the Study Area. Thus although our archaeological understanding of

this period may be relatively limited, our ability to identify areas of significance within the gravel aggregate geologies is supported by our increased understanding through documentary sources.

6.11.12 Potential areas of research arising from this assessment and any further extraction work undertaken within the gravel bearing geologies are dealt with in Section 10.3.10 and 11.16.

6.12 Modern period (1901-present)

6.12.1 The modern period covers the span of time from 1901 until the present day. This period encompassed enormous social, political and industrial change including universal suffrage, the Welfare State and two World Wars which had a significant effect upon the nation. The GLHER provides a record of those modern assets considered to be of particular historic interest e.g. wartime batteries and important buildings.

Asset densities

6.12.2 The modern assets (Fig 16) comprise the following asset types:

- **27 Agriculture and Subsistence**
- **14 Gardens**
- **3 Health and Welfare**
- **1 Religious Ritual and Funerary**
- **2 Industrial**
- **21 Defence**
- **34 Domestic**
- **1 Commemorative**
- **7 Water supply and Drainage**
- **25 Unassigned**
- **3 Transport**

6.12.3 There are 138 modern assets within the aggregates resource with a density of 3.7 assets per km^2.

6.12.4 There are a further 103 assets of unknown date (see 6.13). These would increase the total number of assets to 241 and the asset density would increase to 6.4 assets per km^2 for the Project Area (Table 1).

Key sites

6.12.5 Hornchurch Airfield is located in the north-west of Study Area 4. This is the site of an airfield initially established in 1915 for the Royal Flying Corps as Suttons Farm. It was the location of many of the fighters who flew against the Zeppelin raids at the beginning of World War I. The site was considered ideal not just because it was flat, but because it crossed the path of raiders making their way up the Thames estuary of by way of the coasts of Kent, Essex or Suffolk. The new landing ground was set up next to the farm buildings at Sutton's Farm, and was known as RAF Suttons Farm.

6.12.6 In 1918 there were over 300 men and 24 women based at Sutton's Farm, supporting three Squadrons of aircraft. On December 31st 1919 RFC Sutton's Farm closed and the land returned to agricultural use. However in 1922 the RAF began an expansion program and RAF Sutton became a two squadron airfield. The near aerodrome took nearly four years to be designed and built and was opened as RAF Sutton's Farm on April 1st 1928. In July the name changed to RAF Hornchurch to

make it easier to find on public transport.

6.12.7 Throughout the 1930s the station was at the forefront of the development of a system of air control, experimenting with the latest in oxygen equipment and air radio systems. During World War Two Hornchurch was a Sector control station and was pivotal in defeating the Luftwaffe during the Battle of Britain. Towards the end of the war and after it the importance of the airfield rapidly declined and its status was unofficially downgraded, with the Operations Centre stood down and closed on February 18th 1944, as the squadrons were deployed closer to the forwards airfields. This may have been partly due to its modest size, which had been adequate for the smaller aircraft of the 1920s and 30s but was increasingly insufficient for modern aircraft. The lack of tarmac runways at the site, unlike many other RAF aerodromes, would also have been a significant factor in the decision to downgrade Hornchurch In 1944 the base was occupied by a repair unit which helped to clear bomb sites and repair V1 damaged properties, and Hornchurch also became the base for 6221 Bomb Disposal Flight. After the war the airfield was briefly put on a 'care and maintenance basis' in 1947, and became a training establishment. In 1949 the air field facilities began to be demolished and dismantled, starting with the 12 Blister Hangers. With increasing industrial discontent RAF Hornchurch became a staging post for service personnel covering the striking dockers in an operation known as Operation Homeland. On 9th April 1962 the base was close and much of the land sold to Hoveringham Gravels. Extractions started in the 1960s, with the area subsequently used as a rubbish tip, and by 1979 it had been 'landscaped' to form Hornchurch Country Park, which opened in 1980.

Conclusion

6.12.8 Modern occupation patterns are largely visible in current and recent maps and a large amount of material is available on changing patterns of land use and activity. Consequently this period is very well understood. The assets number seems to be very low for this period, but instead of a record of known occupation, the GLHER provides a record of those modern assets considered to be of particular historic interest (e.g. wartime batteries and important buildings) and those which might otherwise be mistaken for earlier and more significant remains (e.g. earthworks associated with golf courses).

6.12.9 The GLHER includes a number of modern defence assets associated with World War One or World War Two which are significant for our understanding of the physical aspects of these wars and complement the large number of primary documentary sources and synthetic secondary histories. These assets have variable historic significance, but would probably require archaeological investigation and recording prior to removal and some (particularly where groups of associated defence assets are present) are likely to be of national importance. Permission is unlikely to be given for assets of national importance to be removed and in many cases they are statutorily protected.

6.12.10 The Modern period has seen limited archaeological investigation, which is partially due to the limited significance that has until recently been attributed to it by the archaeological sector. The increased range of surviving documentary sources has generally been the reason given for the limited recording of this period. This attitude has changed in the last thirty years that archaeological features of modern date are being more consistently recorded and studied.

6.12.11 The significance is limited. Nevertheless, assets identified through archaeological investigation have great potential to enhance our understanding even where documentary evidence is common. Therefore, while our archaeological understanding of this period may be relatively limited, our ability to identify areas of significance within the gravel aggregate geologies is supported by our increased understanding through documentary sources. Furthermore, this assessment creates

a visual representation of the distribution of assets across the Study Area during this period, aiding such predictions of significance.

6.12.12 Potential areas of research arising from this assessment and any further extraction work undertaken within the gravel bearing geologies are dealt with in Section 10.3.11 and 11.16.

6.13 Unknown Date (700,000 BC to Modern)

6.13.1 There are a number of assets within the Project Area that can not be assigned to a specific period. These were grouped together as unknown date and range from the early prehistoric period to the modern period. There are listed here separately as a group but they have also been taken into consideration in the discussion of each period above:

- **1 Water and Drainage**
- **64 Unassigned**
- **7 Transport**
- **10 Objects**
- **8 Domestic**
- **8 Agriculture and Subsistence**
- **5 Religious Ritual and Funerary**

6.13.2 There are 103 assets of unknown date within the aggregates resource with a density of 2.7 assets per km^2.

Cropmarks

6.13.3 A number of cropmarks of unknown date and probable archaeological nature have been identified in the Project Area. Some archaeological investigations of cropmark sites have been carried out in advance of gravel extraction in the Project Area, and these have confirmed the nature and date of the features, including sites at Moor Hall Farm, Rainham (1979–81); Whitehall Wood, Upminster (1982–3); Great Sunnings Farm (1983); Manor Farm, North Ockendon (1983–4); and Hunt's Hill Farm, Upminster (1990–97).

6.13.4 The form and morphology of other features can provide an indication of their likely date, although site-specific field investigation would be required to confirm the date, nature, survival and significance of such features. Whilst many have been removed by gravel extraction, there is still a high density of features visible as cropmarks outside these areas. Areas such as the fields to the north-west of Hacton, and the fields in the south of Study Area 2 and the north-east of Study Area 4, have a high potential for archaeological remains. The existence of these cropmarks needs to be borne in mind if the gravel is ever extracted from these sites.

7 Summary

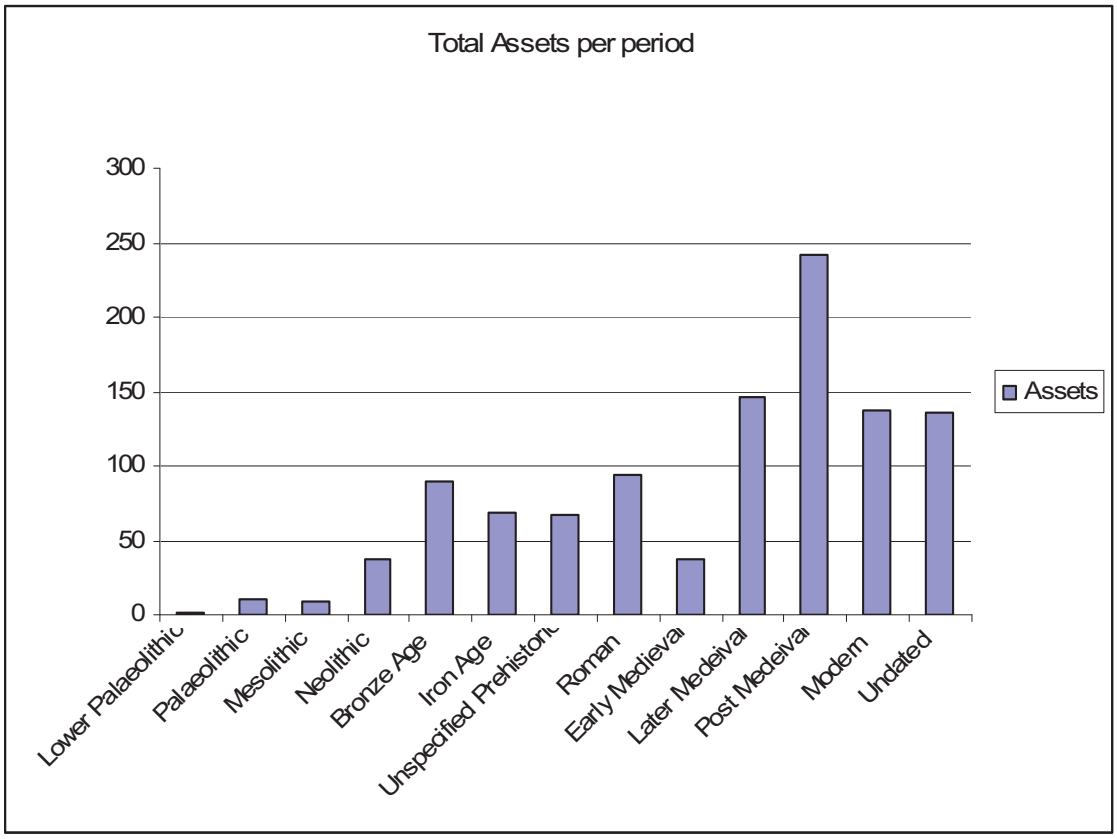
7.1.1 A total of number of 1172 assets has been recorded in the database across the Project Area (all four Study Areas). Of these, 128 assets are of unknown date and 67 have been given a general prehistoric date (Neolithic to Iron Age). The overall density for all periods and all assets across the entire aggregates resource is 31.8 assets per km^2. Study Area 4, in the south-eastern part of the borough, contains the majority of past aggregates extraction sites with an average of *c* 3km² of quarried landscape. For comparison, in Study Area 1 the quarried areas cover *c* 0.2 km^2 of land, in Study Area 3 the area covers *c* 0.6 km^2, and only 0.003 km^2 in Study Area 2.

7.1.2 There have been a number of past investigations across the four Study Areas overall, but the level of investigation various considerably. A number of fieldwalking projects have been carried out in Study Area 2 and parts of the borough have been surveyed by the NMP. This includes all of Study Area 4 and the southern parts of Study Areas 2 and 3. Study Area 1 has not been mapped by the NMP. The majority of investigations have been carried out in Study Area 4, a considerable number of these in connection with the East London Gravels Project, which has significantly increased our understanding of the history in this area.

7.1.3 The general trend is a steady rise in asset density from the earliest to the most recent historic periods. The number of assets drops with the early medieval period, before it rises again significantly in the later and post-medieval periods. It should be noted that there will be some degree of imbalance represented in these figures; older assets, for example, are more likely to be removed by past activity; they may be deeply buried (precluding discovery) and are also more likely to suffer from dating uncertainty. They are therefore less likely to be recorded and probably underrepresented.

7.1.4 Graph 1 below summarises the total number of assets by period across the project area:

Graph 1: Total number of assets by period



7.1.5 The Graph makes some irregularities in the general trend of increased asset density more apparent. These may indicate anomalies within the data resulting from investigation practices or genuine aspects of past occupation and activity. There is a high Bronze Age asset density in comparison to the Neolithic period, and to some extent, the Iron Age period. This increase reflects increasing population and utilisation of the area from the Neolithic to the Bronze and Iron Age which leads to a higher variation and number of asset types, such as agriculture and subsistence, defence and hoard. Another reason is a large number of Bronze Age enclosures and ring ditches recorded in the GLHER database. These are often visible as cropmarks and very likely to be identified and recorded due to their visibility and attraction for investigators. Other Bronze Age assets, as well as remains of the Neolithic and Iron Age periods, are likely to be underrepresented because they remain buried and are therefore harder to identify and date.

7.1.6 The number of assets sees a slight rise again during the Roman period. This might be related to the distinctive nature of Roman artefacts; they are more likely to be detected as chance finds, during metal detection and fieldwalking surveys. The significant rise in the number of 'objects' as an asset type, recorded in the GLHER, supports this.

7.1.7 The low asset density of the early medieval period reflects the limited understanding of the archaeology of this period. Early Medieval features are often difficult to identify and settlement is often dispersed and thus less obvious.

7.1.8 The modern period has a relatively low asset density, although this period is very well understood from documentary and cartographic sources. The assets are too recent to be considered of archaeological interest. This reflects current and past perceptions of the role and purpose of the GLHER, and whether such assets have heritage significance.

7.1.9 Table 1 below tabulates the asset densities (number of assets) per km^2 across the entire Project Area (all four Study Areas). It also highlights the potential asset density when adding undated and general prehistoric assets to the baseline numbers.

Table 1: Number of assets per km2 for each period across the overall Project Area

	Asset Density per km^2	**Asset density including 'undated'**	**Asset density including 'general prehistoric'**	**Total Asset Density**
Lower Palaeolithic	0.05	0.3		0.3
Palaeolithic	0.3	0.5		0.5
Mesolithic	0.2	0.5		0.5
Neolithic	2.8	3.7	2.8	5.5
Bronze Age	2.4	5.1	4.2	5.1
Iron Age	1.8	4.6	3.6	6.3
General Prehistoric	0.6			0.6
Roman	2.5	5.2		5.2
Early Medieval	1	3.7		3.7
Medieval	3.9	6.6		6.6
Post-Medieval	6.5	9.2		9.2
Modern	3.7	6.4		6.4
Undated	2.7			2.7

8 Archaeological Resource Assessment: Spatial Trends

8.1 Introduction

8.1.1 The distribution of assets across the four Study Areas varies considerably. There are several potential reasons for this variation. Current knowledge of past human activity is derived from, and influenced by, the extent, location and nature of antiquarian interest and past archaeological investigation, both of which are influenced by modern development. This 'distortion' in the data is not consistent across all four study areas. To reduce the impact of this variability, and provide a more consistent basis for comparing the asset densities of different study areas, they have been compared against those of the entire Project Area (see Tables 1 and 2).

8.1.2 Due to extensive truncation caused by medieval and later agriculture within the Project Area, the remains of any ground level buildings and any shallow features would have been partially or completely removed, so there is a bias towards the survival of the deeper features such as pits and sunken-featured buildings.

8.1.3 Visibility of assets also plays a role in the recorded assets distribution across the Study Areas. Enclosures and ring ditches for example, are often visible as cropmarks or landscape features and very likely to be identified and recorded due to their visibility and attraction for investigators. Other assets are likely to be underrepresented because they remain buried and are therefore harder to identify and date.

8.1.4 For later periods, especially the post-medieval period there is a bias in data because of general extraction areas being rural rather than urban/suburban. Urban areas have been excluded from this assessment as they do not form areas of potential future extraction.

8.1.5 Study Area 4 also profits from the past work undertaken as part of the East London gravels project. The investigations have provided significant evidence for intensive multi-period occupation in the south of Havering which may suggest that there is a high potential of archaeological assets which would be lost without investigation.

8.2 Asset densities of the Study Areas

8.2.1 The archaeology of the Project Area and current understanding of the asset densities is highly variable. Particular spatial and chronological aspects of the asset densities are discussed in more detail by Study Area, below. It is anticipated that all Study Areas would benefit from the general research priorities although areas where some NMP has taken place would only require limited additional survey.

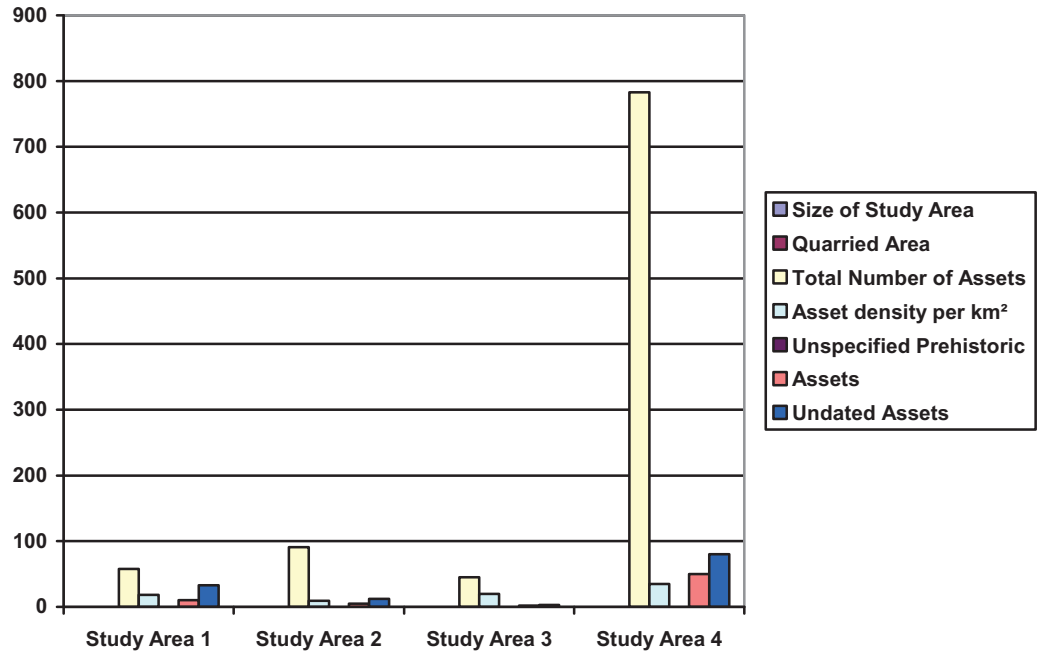
8.2.2 Occupation and land management was probably widespread across the gravel terraces and these figures are probably a reflection of extraction activity as well as the size of Study Areas in general. Generally, Study Area 4 has the highest number of assets across all periods, followed by Study Area 3. Study Areas 1 and 2 have the lowest number of assets.

8.2.3 Table 2 and Graph 2, below, show the overall asset density within the Study Areas along with the proportion of quarried landscape for each area. It also highlights the proportion of assets out of the overall number for each of the Study Areas.

Table 2: Overall asset density (including undated assets) within the Study Areas

	Study Area 1	Study Area 2	Study Area 3	Study Area 4	Total Project Area
Overall area size	3.1km²	9.8km²	2.3km²	22.4km²	37.6 km²
Quarried Area	0.2km²	0.003km²	0.6km²	3km²	3.8km²
Proportion of Quarried landscape	6%	0.03%	26%	13.4%	10.1%
Number of dated Assets	58	91	45	783	977
Number of Unspecified Prehistoric Assets	10	5	2	50	67
Number of Undated Assets	7	12	3	81	103
Total number of all recorded Assets	75	108	50	914	1147
Proportion of assets out of overall Total	6.5%	9.4%	4.4%	79.7%	100%
Asset density per km² (dated assets only)	18.7	9.2	18	35	26
Asset density per km² (total)	24.2	11	21.7	40.8	30.5

Graph 2: Overall asset densities across the Study Areas



8.2.4 Table 2 highlights that generally, there is a trend towards higher density in areas of gravel extraction and this distribution may be directly connected with the level of past work in these areas and is thus probably not representative of the real number of assets:

8.2.5 Study Area 4, which is the largest of the four areas, has the highest number of assets (40.8 assets per km²). Study Area 3 is the smallest out of all (2.3 km²), but has a relatively high asset density of 21.7 km²; in comparison, this is almost double the density of Study Area 2 (which has a size of 9.8 km²). The quarried landscape in each of these areas indicates a degree of correlation: an area of 3 km² has been quarried in Study Area 4, and although this only represents 13.4% of the total landscape (for this Study Area), it is the largest area of quarrying out of all four areas. In Study Area 3, an area of 0.6 km² has been quarried. Study Area 2, in contrast, has not seen significant extraction activity (only 0.003 km² has been quarried in the past) and also has the lowest asset density with only 11 assets per km².

8.2.6 There are, however, some irregularities highlighted in Table 2 above: Study Area 1 is the third largest (3.1 km²), with a smaller area of quarried landscape than Area 3 in comparison; but the asset density is the second highest after Study Area 4. No dated assets have been recorded here until the beginning of the Roman period and the majority of assets date to the post-medieval period. A number of ring ditches and earthworks noted as cropmarks were also recorded in this area. This indicates that the asset density in this Study Area is strongly related to archaeological interest and that these were recorded by chance, during fieldwalking, due to their visibility.

8.2.7 Table 3, and Graph 3 and 4 highlight the density of assets across the periods. The distribution maps indicate that the earlier periods a generally underrepresented in Study Area 3 and the hiatus of activity starts with the later medieval period (see Section 16). In contrast, Study Area 4 has been subject to repeated investigations prior to aggregates extraction, which have provided invaluable information and dating evidence on the archaeological resource across all periods in this area. These figures could indicate that investigations have not been carried out sufficiently prior to extraction in Study Area 3 and that information was lost during the process. It could also represent a real lack of archaeological resources in this area, although, given the high level of assets in Study Area 4 close by, this seems less likely.

8.2.8 For the early prehistoric periods, i.e. Palaeolithic and Mesolithic, finds are made up mostly of single objects (Graph 3) which emphasises the importance of fieldwalking for these periods. The number of assets is particularly low until the Mesolithic and increases slightly during the Neolithic period, when additional asset types appear: water and drainage, religious ritual and funerary and particularly agriculture and subsistence. This corresponds with the changing social structures that develop with the beginning of this period.

8.2.9 A further increase of assets is noticeable from the Neolithic to the Bronze Age, which can partially be explained by the further increased number of asset types (e.g. agriculture and subsistence, defence, hoard), indications for the more complex social structures developing during this period. The asset density is overall higher in comparison to the Iron Age period. As aforementioned, this can partially be explained with a higher visibility of certain asset types that are typical for this period. Some asset types increase during the Iron Age, e.g. domestic assets more than double in comparison to the previous Bronze Age.

8.2.10 The later medieval period brings a significant rise in assets and additional asset types such as gardens and parks, civil, indicate the changing requirements of the communities in the areas (Graph 4).

8.2.11 The most significant increase in asset is as to be expected during the post-medieval period (Graph 4). There is a general rise in agricultural assets but particularly industrial assets have increased in number, mostly representing landfill sites. Here is also some increase in the domestic assets, but this is insignificant and

comparatively low. This is not a reflection of the real picture but due to the exclusion of urban areas from the aggregates assessment. For the modern period a particular rise in defensive assets is noticeable across this area.

8.2.12 The following section discusses particular aspects of the asset densities by Study Area in more detail. The asset densities and distribution by period and type are tabulated in Table 3 and highlighted in Graphs 3 and 4. The asset density maps in Section 16 show the distribution of asset types for each period across the Study Areas.

Study Area 1

8.2.13 This is the second smallest of the four Study Areas with a size of 3.1km². The asset density for dated assets is 18.5 assets per km², and the total assets density is 24.2 per km². An area of 0.2 km² has been quarried in the past, representing 6% of the landscape in this Study Area.

8.2.14 No dated assets have been recorded here until the beginning of the Roman period. There are, however, 10 assets which were given a broader general prehistoric date range. All of these assets represent ring ditches or earthworks noted as cropmarks. This indicates that the asset density of dated assets is strongly related to archaeological interest and activity, rather than representing a real picture of distribution. The assessment of the area indicates, that there is a higher archaeological potential than the number of dates assets suggests. These would be at risk by any potential aggregates extraction carried out in the area.

8.2.15 The dated assets remain sparse during the Roman and only one domestic asset is recorded in this study area, close to the River Valley. Assets disappear entirely again during the early medieval period. During the later medieval period, the number of settlements increases slightly, but the most significant number of assets do not appear until the post-medieval period.

8.2.16 The Study Area would benefit from more systematic field survey and targeted excavation to confirm possible sites such barrows and ringditches or enclosures from the Neolithic period onwards. No NMP survey has taken place in this area, and this would contribute to the asset identification.

Study Area 2

8.2.17 Study Area 2 is the second largest after Study Area 4. The number of assets reaches a density of 9.2 assets per km² for undated assets only, and 11 assets per km² in total. An area of only 0.003km² has been quarried in the past, representing 0.03% of the landscape in this Study Area. All of the quarried areas were recorded from historic OS maps and there are no BritPits recorded here.

8.2.18 The Study Area has been subject to NMP which has provided additional information on the archaeological potential of the Study Area. There is some activity in this area during the Palaeolithic period: a sparse number of objects as well as one domestic asset are recorded. Then there follows a gap until the Roman period, but the number of assets remains very low and comprises mainly objects and one domestic asset. This picture does not change until the later medieval period: the asset density increases significantly, particularly the significantly higher number of domestic assets indicates a change in settlement patterns. There is a small number of unspecified prehistoric as well as assets of unknown date in this study area. Some of these represent ring ditches and earthworks recorded as cropmarks during the NMP project. As with Study Area 1, they indicate that the density of assets is higher than so far recorded and any aggregates extraction in this area would potentially destroy archaeological assets.

8.2.19 The Study Area would benefit from more systematic field survey and targeted excavation to confirm possible sites such barrows and ringditches or enclosures from the Neolithic period onwards, identified by the NMP survey. A number of field

surveys have been carried out in this Study Area which would have contributed to the asset identification in the past.

Study Area 3

8.2.20 This is the smallest of all Study Areas (2.3 km²) but has a comparatively high asset density of 18 assets per km² for dated assets and 21.7 km² in total. An area of 0.6 km² has been quarried in the past (26% of the Study Area). The assessment of the area indicates that Study Area 3 has the second highest asset density after Study Area 4.

8.2.21 The area shows some lower scale activity from the Bronze Age onwards, but as with Study Area 1 and 2, the hiatus of activity also starts with the later medieval period, when the first settlements are recorded in this study area. There are 2 unspecified prehistoric assets recorded in the database. In relation to the area size, a relatively large area has been quarried in this Study Area in the past, implying that the high asset density is related to the extraction activity. The asset density indicates that mitigation in advance of gravel extraction can provide valuable information of the archaeological resource. Additionally to the dated assets recorded in this area, there are a number of undated assets which would be at risk by any potential aggregates extraction. This Study Area would benefit from more systematic field survey and NMP survey to cover the entire area.

Study Area 4

8.2.22 This has by far the highest asset density of all Study Areas and is very well understood across all periods except the Palaeolithic and Mesolithic. There are 783 assets in an area of 22.4 km². The asset density is 35 assets per km² for dated assets, and 40.8 per km² in total. The Study Area has been subject to NMP and repeated investigations by antiquarians and archaeologists which have provided considerable information on the archaeological potential of the study area. Some of the most important key sites excavated in the Borough are located in Study Area 4, most of these in advance of gravel extraction. Nonetheless the Study Area would benefit from more systematic field survey and targeted excavation to confirm possible sites such barrows and ring ditches or enclosures from the Neolithic period onwards, identified by the NMP. The asset density of this Study Area indicates that mitigation in advance of gravel extraction can provide valuable information of the archaeological resource and is and indicator of the amount of assets that could be lost or removed without appropriate mitigation strategies.

Geographic distribution

8.2.23 The Project Area is dominated by the River Beam, which runs through the western part of Havering, and the Ingrebourne in the centre of the Borough. The valleys of these tributaries of the Thames dissect the river terraces and have influenced the landscape. The alluvial floodplain in the south of Havering lies outside the four Study Areas but would traditionally have been less attractive to early settlement. Occupation would have been focussed on the fertile gravel terraces north of the Thames and along the river valleys. Rivers, such as the Ingrebourne or Beam were favoured in providing a predictable source of food (from hunting and fishing) and water, as well as a means of transport and communication. The distribution of assets from the Mesolithic onwards, supports this picture as the assets are concentrated along these two main River valleys and their smaller tributaries. There is no clear picture for the Palaeolithic period but the known assets are all residual and thus can not provide a clear picture of geological preferences of activity during this period. This geological distribution of assets remains the same until the Later Medieval period, when the settlement pattern changes and settlements becomes wider spread across the Project Area.

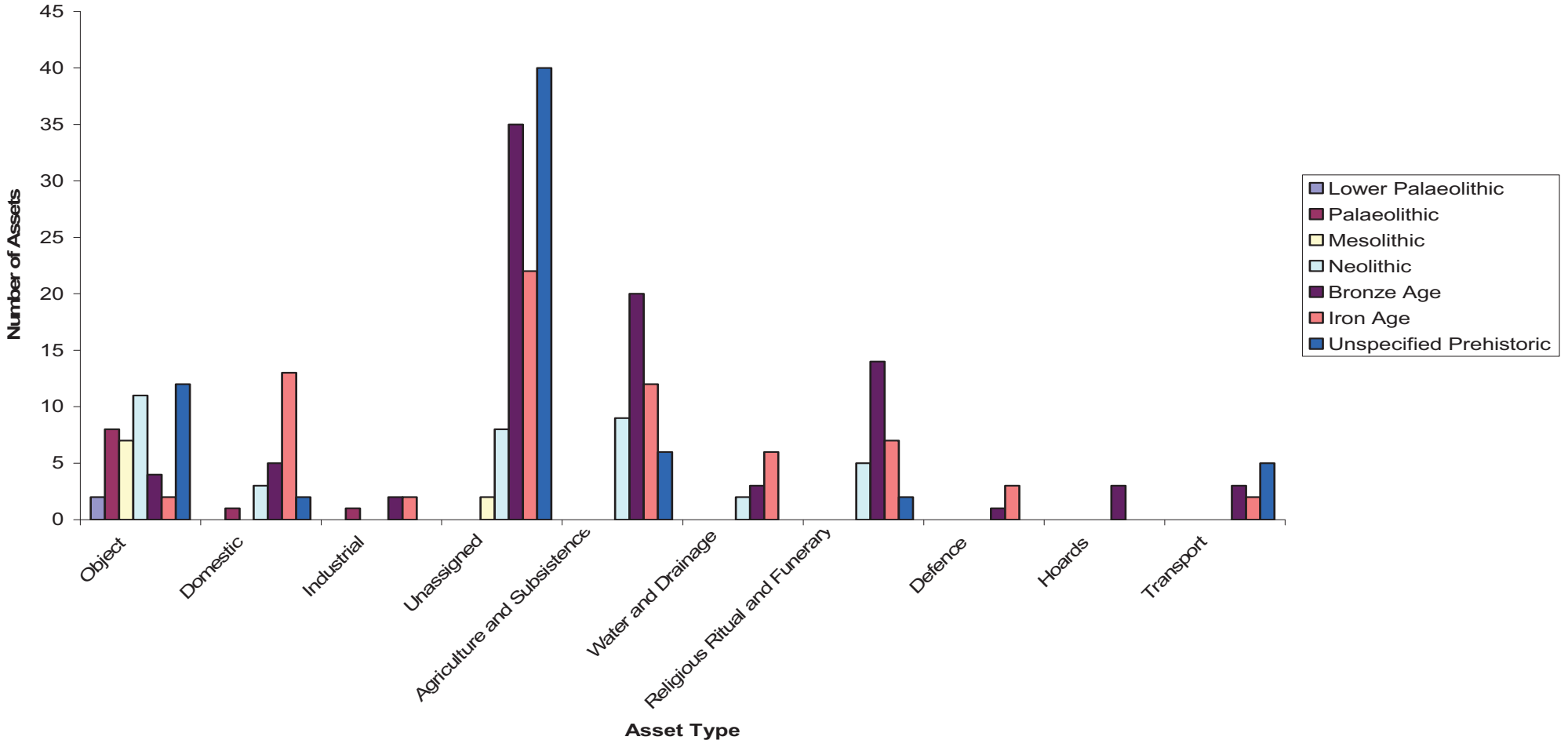
Geological distribution

8.2.24 The aggregates geology of the Project Area is dominated by deposits of river gravel, in places overlain by brickearth. Parts of Study Area 2 in the north-east are located on London Clay. Due to the nature of the aggregates resource it is not possible to make an assessment of the Geological distribution. Generally, there are fewer assets on the area located on London clay but it is not certain whether this reflects a genuine lack of activity or archaeological activity in the area. The gravel terraces in the south of the borough have the highest asset densities.

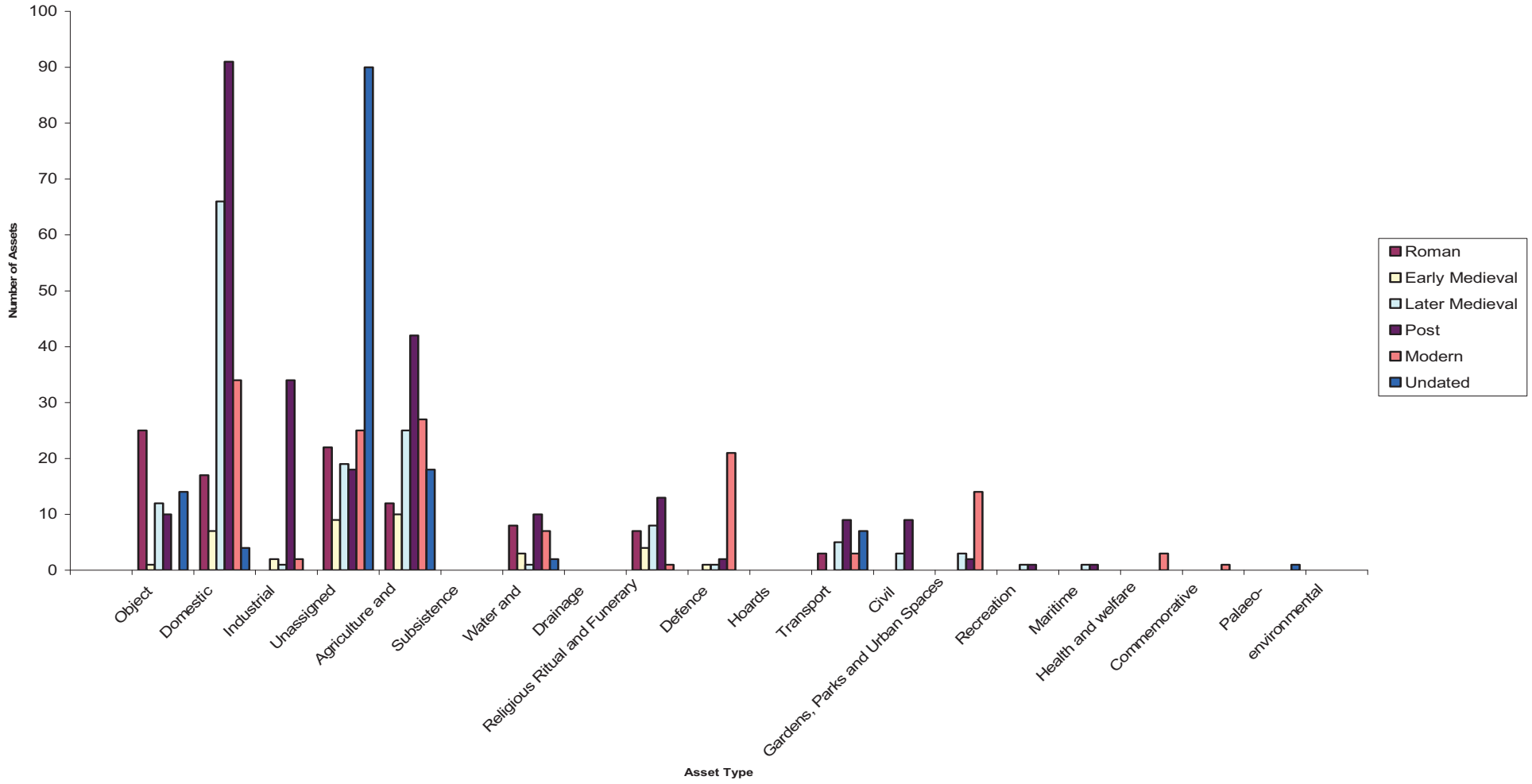
Table 3*: Overall number of Asset Types across all periods*

Asset Type	Period												
	Lower Palaeolithic	Palaeolithic	Mesolithic	Neolithic	Bronze Age	Iron Age	Unspecified Prehistoric	Roman	Early Medieval	Later Medieval	Post Medieval	Modern	Undated
Object	2	8	7	11	4	2	12	25	1	12	10		10
Domestic		1		3	5	13	2	17	7	66	91	34	8
Industrial		1			2	2			2	1	34	2	
Unassigned			2	8	35	22	40	22	9	19	18	25	64
Agriculture and Subsistence				9	20	12	6	12	10	25	42	27	8
Water and Drainage				2	3	6		8	3	1	10	7	1
Religious Ritual and Funerary				5	14	7	2	7	4	8	13	1	5
Defence					1	3			1	1	2	21	
Hoards					3								
Transport					3	2	5	3		5	9	3	7
Civil										3	9		
Gardens, Parks and Urban Spaces										3	2	14	
Recreation										1	1		
Maritime										1	1		
Health and welfare												3	
Commemorative												1	
Palaeo-environmental													
Total	2	10	9	38	90	69	67	94	37	146	242	138	103

Graph 3: Number of Asset Types throughout the periods (early and later Prehistoric)



Graph 4: Number of Asset Types throughout the periods (Roman to Modern)



9 Limitations of the Assessment

9.1.1 The definition of aggregates Study Areas generally proved to be relatively straightforward though some decisions were by their nature somewhat arbitrary. It was felt that the use of these Study Areas allowed for a better structuring of the discussions that followed.

9.1.2 The work on the GLHER to enhance the data held was extremely useful but also threw up a few issues. The GLHER is an agglomerated record of archaeological activity and references from documentary sources, which are depended upon on a number of conditions. Archaeological references generally refer to interventions such as evaluations and fall into three camps, interventions drive by the advent of PPG16/PPS5, interventions at commercial developments prior to PPG16/PPS5 but which were allowed by the developer and interventions as a result of research. Historical references can be the result of many reasons and thus are prone to many problems.

9.1.3 The main problem encountered within the GLHER from documentary references is that it is likely that have been entered inconsistently, i.e. they are reliant upon the depositor and any underlying reasons for the deposition itself. Furthermore, such a database is created from various sources, for example research or donation, and as such the quality and quantity of references will vary. Thus it is extremely likely that due to the quantity of records that may be deposited, many will not have been checked or confirmed before they are entered. The database is also open to changes in interpretation, dating of particular features, for example barrow burial mounds, changes and this might not be reflected in the date ranges used in the GLHER data base. It was however already fully appreciated that the nature of the GLHER meant that the data was of a variable quality. It was obviously essential to prioritise the work to produce the best result within the time available and this focused on those enhancements that would facilitate the production of period based reports upon which to base the assessment of the archaeological resource, and the period studies.

9.1.4 Archaeological references are also dependent to some level on the quality of the work undertaken, poor recording results in poor references. However, they are less prone to inconsistency; it is an obligation of the planning process that a record of the results of any archaeological intervention required as a part of planning consent be deposited with the GLHER. However, this is not necessarily a requirement for archaeological work undertaken as research and it is possible that some independent work may never be deposited with the GLHER. Furthermore, develop led archaeological tends to create bias' as archaeological work tends to focus where development is being undertaken. Also development, including aggregates extraction, is typically concentrated in particular areas which are of interested for development and industries, but which perhaps have not initially been interesting from the view point of archaeological research. On the other hand it opens up areas for archaeological investigations that would per se not be a focus point of research and thus make a whole new approach to archaeological research possible.

9.1.5 The correction and validation of the GLHER data described above does not address underlying data imbalances within the GLHER. The GLHER is a record of activity that has produced archaeological information, rather than a record of the geographical distribution of archaeological evidence. This activity has included archaeological research, as well as development that has led to archaeological interventions such as 'rescue' excavations, and, since the advent of PPG16/PPS5, planning-led enquiries. Any development, including aggregates extraction, is typically concentrated in particular areas which are of interested for development and industries, and not necessarily interesting from the view point of archaeological

research. This on the other hand opens up areas for archaeological investigations that would per se not be a focus point of research and thus make a whole new approach to archaeological research possible.

9.1.6 This report has used the available GIS data to try and interpret the relationship of sites and finds to their landscape/geology. GIS are able to store, manipulate and combine multiple data sets, making complex analyses of the landscape possible. It should be noted that this is a simplified representation of reality, attempting to model the asset density by data collection and by identifying key variables and/or patterns. This was used to think through problem formulation, as a means of testing hypothetical predictions, and also as a means to generate new data. We should be aware, however, that there are specific pitfalls and potentials inherent in the archaeological data and research process when using spatial technologies and GIS data. Errors, inaccuracy and imprecision in the underlying spatial datasets will affect the analysis and the conclusions and solutions provided. Any errors within the GLHER database will automatically have a significant effect on the GIS analysis. With each new imported dataset, the GIS inherits those errors which then combine and mix in an unpredictable way with errors already present. Careful long-term planning is necessary to keep such errors to a minimum. Another issue is that the data will have to be simplified in order to enable any data processing. For archaeological data this is not always easy or even possible. Date and type of assets are often unclear and their assessment dependent on many other factors; these datasets will either have to be excluded from the analysis, or simplified to allow processing in GIS. Either way, this will lead to the loss of valuable information, and/or the loss of the unknown. For these reasons, a completely accurate and precise solution by GIS analysis is difficult to achieve.

9.1.7 The resource assessment itself formed the core of the project. Within the short time available to produce this assessment it was realised that there is a need for further work. The period sections had to be very brief and concise and in the amount of time available only a very brief overview could be provided for each period, and these are essentially an analysis of the results of the data enhancement in GIS and the asset mapping.

10 Research Strategy & Agenda

10.1 Introduction

10.1.1 The gravels sites, whether fluvial or glacial, have enormous potential for future research. There is however a variable differential preservation of palaeo-environmental evidence. At present, it is not possible to identify meaningful distributions within the borough as the record has evolved over many years from chance discoveries and a wide range of projects covering differing areas with different methodologies. Future research strategies will need to address this issue.

10.1.2 The following research strategy and agenda has been developed following the assessment of archaeological resource within aggregate areas, the *Research Framework for London Archaeology 2002*.

10.2 General research priorities

10.2.1 The following general research priorities have been identified. These would have positive impact upon understanding of multiple periods across the study areas. This would allow assessments of the impacts of future aggregates extraction projects to be made with greater certainty.

National mapping programme

10.2.2 The aim of English Heritage's National Mapping Programme (NMP) is to enhance the understanding of past human settlement, by providing primary information and synthesis for all archaeological sites and landscapes visible on aerial photographs or other airborne remote sensed data. NMP is a key component of English Heritage's capacity to investigate and understand the historic environment at the landscape scale, and underpins other priority projects and programmes. NMP projects that have already been completed have transformed our knowledge of past land-use by mapping whole archaeological landscapes for the first time, with more than 50% of the sites not having been previously recorded.

10.2.3 Only the southern part of the borough has been surveyed by the NMP. The NMP survey has increased the number of known assets, particularly for periods with very low asset densities, where understanding was limited. The NMP provides a systematic method of identifying all visible assets across the aggregates resource and could provide a consistent basis for the identification of higher and lower asset density areas. The extension of NMP across the rest of the borough is therefore a priority.

Re-assessment of assets

10.2.4 A large proportion of the assets were initially identified and excavated by antiquarian researchers. Despite the good quality of many investigations, some assets remained undated while others require re-assessment in view of modern developments in artefact typologies and developments in scientific dating.

Targeted investigation

10.2.5 Although NMP can identify all visible assets, in most cases such assets cannot be dated without more detailed archaeological investigation. Targeted fieldwalking, evaluation and excavation can provide a better understanding of such assets and the periods to which they belong, and reduce the risk of unforeseen discoveries during future extraction.

10.3 Period Based Research Topics

10.3.1 The general research priorities would have a positive effect on understanding of the archaeology of all periods across the aggregates resource. However, all the periods have particular research needs. The following period discussions will briefly surmise the present situation identified by the resource assessment and only refer to the Agenda proposals where relevant.

Palaeolithic

General Research questions

10.3.2 Understanding of the Palaeolithic period is limited by the very low density of assets across the aggregates resource. Key research needs for the Lower/Middle Palaeolithic period include:

- A review of Palaeolithic entries within the GLHER to revise the dates of those which, by virtue of their nature, associations or physical position, cannot be Palaeolithic.
- A re-examination of artefacts (if possible) where uncertainty remains as to their date.
- Typological and technological review of existing artefacts and assemblages to improve understanding of the chronological framework.
- Targeted investigation of mapped Pleistocene deposits (including mapped and unmapped Plateau and Terrace Gravels).
- Identification and investigation of sites with faunal and palaeoenvironmental remains to determine the ecology of past environments and improve dating frameworks.
- Large scale systematic fieldwalking is an appropriate tool to increase the understanding of this period

Mesolithic

10.3.3 Understanding of the Mesolithic period is limited. Current asset densities suggest that Mesolithic assets are concentrated around the river valleys and coast, but this is probably due to the greater visibility of such assets in areas of erosion. Particular research needs for the Mesolithic include:

- A review of Mesolithic entries within the GLHER to revise the dates of those which, by virtue of their nature, associations or physical position, cannot be Mesolithic.
- A re-examination of artefacts and associated archive (if possible) where uncertainty remains as to their date.
- Reassessment of assets, particularly flint artefacts and artefact assemblages.
- Further investigation into palaeoenvironmental deposits to improve understanding of the ancient environment.
- Large scale systematic fieldwalking would help to increase the understanding of this period

Neolithic

10.3.4 Evidence of Neolithic activity within the Project Area is limited. Mesolithic and Neolithic period known asset distributions are similar, and are evident around the river valleys. Particular research needs for the Neolithic period include:

- A re-examination of artefacts and associated archive (if possible) where uncertainty remains as to their date.
- Targeted survey and investigation of possible Neolithic assets and concentrations of assets to confirm their date and nature.
- Targeted investigation of possible barrows and/or ring ditches dating from the Neolithic to the Iron Age period onwards identified during the NMP.
- Elucidating the nature of Mesolithic to Neolithic transition.
- Reconstructing the environment and ecology on a regional basis.
- Researching the potential for categorisation of settlement sites.
- Examining the influence of landscape, establishing whether the Thames confluences were considered important settings for different types of monument.
- Gathering and analysing data to understand the subsistence economy.

Bronze Age

10.3.5 Understanding of Bronze Age activity within the Project Area is limited. Key research needs for the Bronze Age include:

- The extension of NMP across the rest of the borough
- Systematic fieldwalking and metal detecting survey to identify foci of Bronze Age activity and provide a reliable context for understanding the relevance of chance finds and the distribution of individual objects.
- Targeted investigation of sites identified during NMP, fieldwalking and metal detecting surveys to establish the relationship between the surface evidence provided by these techniques and the underlying archaeological remains.
- Further investigation of suspected Bronze Age settlement sites to confirm their date and precise nature.
- Palaeoenvironmental research to investigate Bronze Age change in the landscape, and whether this may relate to land clearance and increasing agriculture.
- Re-evaluating the core/periphery model proposed for the Thames valley in the Bronze Age and relationships between Upper and Lower Thames and between river valleys and hinterland.
- Re-evaluating burial evidence, including undated inhumations and cremations.
- Clarifying mechanisms that prompted agricultural intensification.
- Understanding the relationship between wooden trackways in the floodplain and the settlements to which they presumably led.
- Identifying the roles that ring forts played in the developing settlement hierarchy of the Bronze Age.

Iron Age

10.3.6 Understanding of Iron Age assets is limited across the aggregates resource. The relationship between the Iron Age and Roman period requires further research, with some sites demonstrating continuity and other change at the end of the Iron Age. Key research priorities for the Iron Age include:

- Extension of the NMP across the rest of the Borough.
- Investigation of any earthworks and ring ditches identified during NMP

- Targeted investigation (field survey and excavation) of features and clusters of features identified during the NMP in order to improve dating and understanding of both sites and diffuse ancient landscape features.
- Targeted field survey in areas where significant Iron Age sites (particularly burial sites, but also settlement) have been recorded previously.
- Targeted fieldwalking and metal detecting survey of those areas where clusters of objects indicate that significant Iron Age sites may be present.
- Investigation of processes of change and continuity between the Iron Age and Roman period when sites of this date are investigated.
- Investigation into changes in the historic landscape between the Bronze Age and Iron Age, including territorial and settlement distribution and landscape management.
- Examining the evidence for a phase of renewed agricultural intensification in the London region at the time.
- Elucidating various elements in the settlement pattern from the small rectilinear enclosures to the larger enclosed sites and their relationship with the surrounding landscape.

Roman

10.3.7 The Roman period is fairly well understood in general. There is a good understanding of the chronological framework and artefact typologies. Key priorities for Roman research include:

- Targeted, systematic field survey of those areas with apparent concentrations of Roman objects in order to confirm if these concentrations are genuine.
- Targeted investigation (including field survey and excavation as appropriate) of possible Roman sites.
- Publication of those sites which have been excavated but where publication has not proven possible before.
- Further investigation of smaller native sites to provide further information on the type, origin and duration of these assets.
- Investigation into the relationship between the Roman and early medieval periods, whether sites were generally abandoned at the end of the Roman period and if the sometimes violent abandon of the villas towards the end of the Roman period was mirrored in sites of other social status.
- Investigation into the relationship between the Roman and Iron Age including evidence for continuity and change in settlement and land-use.
- Exploring cultural interactions between Briton and Roman.
- Understanding the relationship between *Londinium* and the *hinterland.*
- Defining relationships between landscape, river, and settlements.
- Studying the impact of settlement on the environment.
- Researching the evidence of climatic conditions and climate change.
- Investigation into the location of Roman Romford
- Investigation into the existence of a 2nd Roman Road and posting station at Romford

Early medieval Period

10.3.8 Key priorities for migration and early medieval research include:

- Targeted, systematic field survey (including metal detecting and fieldwalking) in order to identify early medieval sites.
- Targeted investigation (including field survey and excavation as appropriate) of possible early medieval assets. This should include assets identified from NMP, from documentary and place-name evidence and from artefact scatters and metal detecting.
- Investigation into settlement patterns and the nature of early medieval settlements.
- Studying the transitions between late Roman and early Saxon, including the reasons and implications for shifting settlement patterns.
- Understanding regional relationships.
- Investigation into the transition from medieval manor to post-medieval and late post-medieval/ modern farm

Later medieval

10.3.9 The later medieval period is relatively well understood as the archaeological evidence is supported by documentary sources. The distribution of settlement and land use is relatively well understood. Key research needs for the later medieval period include:

- Extension of fieldwalking and systematic metal detecting
- Further investigation of later medieval assets identified from documentary research in order to confirm their location, nature and origin.
- Understanding the nature and extent of urban development and the social and economic relationship of the core to its region.
- Addressing a regional understanding of rural development through synthesis and comparison with other regions.
- Investigation into the transition from medieval manor to post-medieval and late post-medieval/ modern farm

Post-medieval

10.3.10 The post-medieval period is very well understood. Many buildings survive from this period and documentary and map evidence provides considerable information on settlement patterns and land use. The rural settlement pattern of the later medieval continued into the post-medieval period and a number of large houses developed fashionable landscaped parks. Key research needs for the post-medieval period include:

- Dating structures and landscape features wherever possible
- Further investigation of known parks and gardens.
- Investigation into the relationship between surviving listed buildings, demolished structures and other surviving remains in areas post-medieval activity to categorise and improve understanding of settlement morphology and relationships between what survives and what has been removed.
- More integrated approach to the study of documents, maps, standing buildings and archaeological remains.
- Investigation into the transition from medieval manor to post-medieval and late post-medieval/ modern farm
- Investigating in the role of leisure and recreation in daily life, both within the household and public amenities.

Modern

10.3.11 The modern period is very well understood, but asset densities remain variable because of questions of which modern remains should be considered heritage assets. For earlier periods heritage assets are typically 'those which have survived' but assigning heritage assets for the modern period requires identifying those 'which should be conserved' and is therefore a more complex issue. Those assets which have been include a number of defence assets, many of which relate to the defence during World War II. Other assets include commemorative assets, such as war memorials, listed buildings, earthworks identified through NMP survey and significant religious buildings. Key research needs include:

- Active preservation and investigation of World War II assets as required by their deterioration with age.
- Extension of NMP mapping across the rest of the borough and cross-referencing of identified cropmarks and earthworks against current mapping to identify those assets which are of modern origin.
- Oral histories to place documentary resources and physical remains into their cultural context.
- Systematic approach to understanding modern buildings, structures and landscapes, their development over time and what makes them appropriate for designation.
- Identification of non-Christian places of worship and religious sites and consideration of their significance
- Identification of civilian defence assets (e.g. air raid shelters)
- Recording of large and important structures which are still in use (e.g. breweries, industries and sites of scientific research) to provide evidence for the assets of the future.
- Investigation into suburban growth and the expansion of the suburbs
- Investigating in the role of leisure and recreation in daily life, both within the household and public amenities.

11 Mitigation

11.1 The archaeological impact of aggregates extraction

11.1.1 Aggregates extraction typically results in the entire removal of any buried or above ground heritage assets (i.e. archaeological and built heritage) or historic landscape (i.e. woodland, earthworks, hedgerows and field systems). This impact derives from two main phases:

- Preliminary topsoil strip and enabling works – Archaeological deposits would potentially be located immediately beneath the topsoil. Removal of the topsoil exposes any archaeological remains that may be present immediately beneath the topsoil. Exposed remains may then be damaged by subsequent movement of vehicles and plant involved in construction activities (i.e. through rutting and compaction) and the construction of new ground surfaces and site amenities (e.g. offices, rest areas, processing plants etc). In addition, it is possible that topsoil removal without archaeological supervision may result in overstripping, which would have a direct impact upon archaeological remains located beneath the topsoil, or understripping, where archaeological features are concealed beneath a thin layer of topsoil but are then exposed and unprotected from subsequent activities.
- Aggregate extraction – which entirely removes any surviving assets, (including archaeological remains, built heritage and historic landscape features where these were not removed by the preliminary topsoil strip).

11.2 Planning Policy and guidance

11.2.1 The status of archaeological remains in the planning system is outlined in national, and local planning and minerals policy and guidance and minerals planning policy:

- Planning Policy Statement 5 (PPS5): *Planning for the Historic Environment*
- Planning Policy Statement 1 (PPS1): *Delivering Sustainable Development*
- Minerals Policy Statement 1 (MPS1): *Planning and Minerals*
- Consultation Draft replacement London Plan (October 2009)
- Minor alterations to the Consultation Draft replacement London Plan: *Gypsies and Travellers & Aggregates (September 2010)*
- Havering Local Development Framework

11.2.2 These policies and guidance establish that development and minerals extraction should take place in accord with principles of sustainable development. Where the loss of the whole or a material part of a heritage asset's significance is justified, local planning authorities should require the developer to '*record and advance understanding*' of the significance of the heritage asset before it is lost, using planning conditions or obligations as appropriate. The extent of the requirement should be proportionate to the nature and level of the asset's significance. Developers should publish this evidence and deposit copies of the reports with the relevant historic environment record. Local planning authorities should require any archive generated to be deposited with a local museum or other public depository willing to receive it. Local planning authorities should impose planning conditions or obligations to ensure such work is carried out in a timely manner and that the completion of the exercise is properly secured.

11.2.3 As a result of this planning policy, the process of archaeological investigation into a site has become well defined into a number of stages designed to define the nature

and extent of archaeological remains on a given site in order to determine whether any remains are of national significance and identify an appropriate mitigation strategy. All archaeological work should be undertaken to the standards specified by the Institute for Archaeologists (IFA 2001a; 2001b; 2001c), DCLG (2010), English Heritage (2006, 2007, 2008), and GLAAS (EH 1998, 1999) and national and local guidance.

11.2.4 Guidance on the application of planning policy to minerals and the historic environment is provided in *Mineral Extraction and Archaeology: A Practice Guide* (MHEF 2008) and *Mineral Extraction and the Historic Environment* (English Heritage 2007). Any archaeological investigation, whether invasive or non-invasive, should take consideration of the research priorities discussed in the Research Strategy and Agenda (section 8) of this project report and other relevant documents (e.g. *A research framework for London archaeology 2002*).

11.3 Desk-based assessment

Introduction

11.3.1 The initial stage of archaeological investigation is a desk-based historic environment assessment (HEA) and is sometimes included in an Environmental Impact Assessment (EIA) where one is requested by the planning authority.

11.3.2 Under the terms of PPS5 an HEA forms an initial stage of investigation of the area of proposed extraction and may be required as part of a planning submission in order for the Mineral Planning Authority (MPA) to formulate an appropriate response in the light of the impact upon any known or likely heritage assets. These are parts of the historic environment which are considered to be significant because of their historic, archaeological, architectural or artistic interest. These might comprise below and above ground archaeological remains, buildings, monuments or heritage landscape within or immediately around the site (DCLG 2010, 1, 13).

11.3.3 The HEA will set the future extraction site into its full archaeological and historical context in order to determine the likely nature, extent, preservation and significance of any heritage assets that may be present within the site or its immediate vicinity. It will assess the likely impacts from the proposed extraction upon any known or likely heritage assets and make recommendations as to the next stage of investigation. Where understanding of the archaeological remains on the site is very good and can be determined to a high degree of certainty, it may be possible to undertake archaeological mitigation immediately without further initial investigation. More usually the HEA will recommend further site-based investigation into the nature of the remains because the existing information is insufficient to determine precisely what is present on the site. This investigation may take the form of invasive or non-invasive procedures. The HEA may also include or recommend a survey of the built environment and historic research to identify relevant physical and historical aspects of the building in order to make an assessment of the importance of the building, whether it should be retained and whether further recording would be appropriate.

Predicting archaeological remains

11.3.4 The current level of understanding across the aggregates resource within Havering will have a direct impact on the accuracy of any prediction in a Historic Environment Assessment (HEA) as to the nature, date and significance of any archaeological remains within that area. In general the greater the understanding, the greater the probability of predicting at the desk-based stage the nature and significance of the remains which are likely to be present. The following factors improve understanding of the archaeological resource within a given area and so enhance the probability of predicting the nature and significance of any anticipated remains at the desk-based

stage:

- High asset density – the greater the number of assets around a site, the more evidence there is as to what might be present on it. Study Area 4 for example, has a high asset density and the archaeological resource is well understood;
- High number of past archaeological investigations – the greater the number of archaeological investigations around the site, the more evidence there is as to what might be present within it. Past investigations in Study Area 4 have contributed significantly to the understanding of the archaeology in this area. If archaeological investigations found no remains, this provides an indication that the absence of evidence reflects a genuine aspect of past occupation patterns and rather than an absence of investigation. Systematic fieldwalking and metal detecting surveys can provide a useful indication of areas with archaeological potential and areas without, such as seen in Study Area 2 for example, where fieldwalking surveys have identified areas of archaeological potential. Even the results of less systematic metal detecting can reveal possible archaeological sites where very high concentrations of assets have been recovered,
- NMP coverage – NMP identifies any archaeological remains of either earthwork or masonry type which are sufficiently large and shallow enough to have had a visible impact upon the patterns of grass and crop growth. This will include most large and complex sites of most periods as well as diffuse assets such as field systems, enclosures and boundaries. Although NMP identifies all such sites visible in air photographs, further investigation is often required to confirm their date, nature and significance. NMP cannot normally identify deeply buried sites beneath alluvium or remains of the earliest prehistoric periods (Palaeolithic and Mesolithic) and particular types of sites (e.g. cemeteries without earthwork boundaries) may also be invisible. Qualified archaeological contractor would normally be able to view, interpret and plot aerial photographs, even if NMP had not been completed, but may not be able to access as wide a range of photographs as the NMP. NMP mapping has identified a number of corpmarks across the whole area, in particular within Study Areas 2 and the north-east of area 4.

11.3.5 It would therefore be easier to predict accurately the nature and significance of archaeological remains within the Study Areas with very high asset densities. Where a very high density Study Area has been subject to NMP mapping and has had a history of intensive investigation, desk-based predictions of the nature and significance of predicted archaeological remains are likely to have a greater accuracy still. However, this may not obviate the need for non-invasive investigation or intrusive evaluation which may still be required at the discretion of the local authority.

11.3.6 In areas where understanding is low due to a low asset density, limited past investigation and an absence of NMP survey, initial non-invasive investigation and intrusive evaluation are more likely to be required because the nature and significance of the remains are less predictable at the desk-based stage.

11.4 Non-invasive techniques of evaluation

11.4.1 Non-invasive techniques may be undertaken at the same time as desk-based assessment, subsequent to it or as part of an invasive field evaluation of the potential of the site. Non-invasive archaeological techniques require minimal ground disturbance and may be an appropriate initial stage of site based investigation, particularly if a site is very large in area or if understanding of the archaeology of the area is very limited.

Walkover survey

11.4.2 Walkover survey is often undertaken as part of an initial phase of desk-based assessment but may also be incorporated into later investigations. It can be used to identify and monitor any up-standing buildings or historic landscape features (e.g. Scheduled Monuments, historic field boundaries, barrows etc), identify likely areas of archaeological interest and record features that may be periodically obscured (e.g. by tidal movement, growth of vegetation etc). Depending on the purpose of the walkover survey, the location of significant features can be documented using GPS equipment and surveyed to a standard commensurate with their significance as described in RCHME (1999b) and English Heritage (2007b) guidance.

Topographical survey

11.4.3 Topographical survey can be undertaken to record and analyse earthworks, field boundaries and other up-standing components of the historic landscape. Topographical surveys should only be undertaken following detailed historic map regression, so that the survey is informed by a clear understanding of the key landscape components.

11.4.4 The level of detail recorded should be judged according to the nature of the remains. Recording levels appropriate for specific types of assets are defined by RCHME guidance (1999b). English Heritage guidance (English Heritage 2007b) on recording archaeological landscape may also be appropriate. Survey will normally be undertaken using GPS equipment and drawings will be generated in CAD, such that the results can be incorporated directly into a digital scheme mapping.

Aerial photographic survey

11.4.5 A survey of aerial photographs might be undertaken as part of a desk-based assessment or an initial stage of a subsequent evaluation. If the site has been included in existing NMP survey, it might only be necessary to examine aerial photographs taken after the NMP was completed (if any). Aerial photographs show two different kinds of feature:

- Cropmarks – buried features are visible as cropmarks or grassmarks because the different material within them causes differential growth of the crop or grass above.
- Earthworks – The upstanding remains (either positive or negative) are visible from the air.
- Buildings – upstanding remains are visible from the air
- Natural topography

11.4.6 The following types of assets are unlikely to be identified from aerial photographs:

- Deeply buried remains – As the remains have to be sufficiently shallow to have an impact on surface growth deeply buried remains are typically invisible. Typical deeply buried remains include:
    - Palaeolithic (and sometimes Mesolithic) remains which may be within River Terrace Gravels.
    - Prehistoric and some historic remains within or beneath alluvium.
    - Remains beneath landfill or made ground.
- Small remains – Even if relatively shallow, small features and artefact assemblages are unlikely to be seen because they are not normally large earthwork features and do not affect the water retention of a large area of plants.

- Burials – Graves are normally refilled with the material dug out of them relatively soon after the initial grave digging. Consequently the grave fill is very similar in water holding properties to the surrounding area and little differential may be visible between the plants above the burial and the surrounding land.

Field artefact collection survey (Fieldwalking)

11.4.7 Surface artefact collection survey (fieldwalking) may be undertaken in fields under arable cultivation. Artefacts within the ground are disturbed by agricultural practices periodically brought to the surface by ploughing. Buried archaeological sites are detected by collecting artefacts from the ploughed field surface and plotting the distribution of different artefact types by period. Fieldwalking has often been a major means of locating Mesolithic occupation and is often the best mitigation and evaluation strategy for the earlier prehistoric periods.

11.4.8 Fieldwalking is particularly effective for the following types of site:

- Sites with very ephemeral or non-existent sub-soil features
- Sites rich in durable artefacts such as worked flint or Roman and later medieval pottery

11.4.9 Unlike geophysical survey, fieldwalking can determine the period of the site's use. Fieldwalking and geophysical survey may therefore be undertaken together in order to identify the main activity areas in a very extensive development area, but it is rarely cost-effective to use both methods purely for evaluation purposes.

11.4.10 Surveys are normally carried out using linear transects 10–20m apart. Fieldwalkers walk along each line, systematically collecting artefacts within a 2m wide sample transect. More intensive coverage can be applied over relatively small areas. Artefacts are then separated into categories and periods and artefact distribution plotted against the linear transects so that areas of artefact concentration are seen as 'hotspots'.

11.4.11 If geophysical survey (including metal-detecting) is to be carried out, it may be cost-effective to do such surveys at the same time as the fieldwalking, using the same survey transects.

Geophysical survey

11.4.12 Available methods of geophysical survey include:

- Magnetometer Survey
- Electromagnetic survey (including soil conductivity, magnetic susceptibility, magnetic viscosity, metal detecting and ground penetrating radar)
- Resistivity survey

11.4.13 The choice of method depends on the type of archaeology expected, the environment, ground conditions (including, drift and solid geology, depth of overburden above archaeological remains), survey objectives and cost. Detailed guidance on the selection of methods and sampling strategies can be found in the English Heritage (1995) guidance. The advice of a specialist is normally required before determining any geophysical survey strategy.

11.4.14 For extensive surveys in rural areas, magnetometer survey is the most commonly used and effective method, usually using a fluxgate gradiometer. Extensive magnetometer survey is capable of revealing the layout of a site in remarkable detail under suitable (magnetically enhanced) soil conditions. Resistivity survey is more effective at detecting certain types of feature, including masonry and brick foundations and is also quite commonly used. Geophysical survey of any sort is rarely an option in urban environments, or for detecting sites covered with thick

deposits of hillwash or alluvial deposits, although Ground Penetrating Radar has some applications.

Metal detector survey

11.4.15 Metal-detector survey can be very effectively used in conjunction with surface artefact collection survey (or in place of it where the land is under permanent pasture) and in the course of archaeological excavation. Concentrations of metal artefacts in the ploughsoil are often the first indication for the presence of complex archaeological sites (Roman and medieval settlements and industrial sites, for example). Some important Anglo-Saxon sites consist entirely of scatters of metal artefacts in the ploughsoil.

11.4.16 It may desirable to employ amateur metal-detector users, as a contribution to community access and involvement. However, surveys must always be carried out under the supervision of a suitably experienced professional archaeological contractor, who will record the location of the artefacts and undertake specialist artefact identification, conservation and reporting.

11.5 Invasive techniques of evaluation

Geoarchaeological techniques

11.5.1 Geoarchaeological boreholes and sampling techniques may be used as part of an evaluation or mitigation strategy to investigate geological deposits of archaeological interest, establish the geological sequence on the site, identify any geological deposits with potential to contain archaeological remains and collect palaeoenvironmental and geoarchaeological samples. Where extraction of sub-alluvial River Terrace Deposits is required, geoarchaeological investigation of the alluvial sequence is likely to be required because of the archaeological and palaeoenvironmental potential of these deposits.

11.5.2 The identification and dating of geological deposits with archaeological potential and understanding of geological sequences is particularly important for aggregates extraction sites. Geoarchaeological techniques may be used to identify the potential for such deposits to be of archaeological significance (either through the remains they contain or the potential to improve understanding and dating of the geoarchaeological sequence) and to mitigate the impacts of aggregate extraction.

11.5.3 Where geoarchaeological techniques are used as part of a mitigation strategy the aim is to develop an understanding of the geological sequence (including the date of significant deposits) and to excavate, record and analyse any archaeological remains within the geological sequence in order to improve understanding of the periods concerned.

11.5.4 The strategy for geoarchaeological investigation is likely to involve a combination of some or all of the following:

- Investigation and extraction of deposits (most frequently through the use of boreholes and test pits),
- The extraction of samples (from boreholes, bulk sampling and monoliths)
- Laboratory analysis and testing (including analysis of stratigraphic deposits, micro-artefact sieving, Optically Stimulated Luminescence dating, palaeoenvironmental analysis of pollen, insects and other environmental indicators) where appropriate.
- Topographical modelling of the surface and subsurface deposits to inform understanding of past landscapes.

11.5.5 Stratigraphic information from individual logs can be entered into a specialist

geological modelling program in order to allow borehole cross-sections through the site to be generated and topographical projections of identified surfaces to be constructed (e.g. Pleistocene gravel surface topography). Information from individual boreholes and test pits is examined and the major stratigraphic units identified. Interpretation of the geological sequence at each stage will be informed by palaeoenvironmental data, as it becomes available.

11.5.6 Geoarchaeological investigation might be required for the evaluation and mitigation of extraction impacts on River Terrace Deposits and other superficial aggregate producing geologies with potential for in situ Palaeolithic remains. Early intervention is always beneficial, and would be particularly useful at the prospection stage to allow better archaeological interpretation of geotechnical results. More work is needed to identify lower Palaeolithic sites, ideally based on information obtained from geotechnical data.

Field Evaluation

11.5.7 Following a HEA or initial non-invasive investigation, archaeological evaluation may be requested to confirm the results of the earlier work. The definition of archaeological field evaluation is a limited programme of non-intrusive and/or intrusive fieldwork (such as trial trenches or test pits across the site and archaeological boreholes) which determines the presence or absence of archaeological features, structures, deposits, artefacts or ecofacts within a specified area or site on land. Archaeological monitoring of geotechnical investigations may be included to provide information on the stratigraphic sequence and the potential for geoarchaeological and palaeoenvironmental information. If such archaeological remains are present Field Evaluation defines their character, extent, quality and preservation, and enables an assessment of their worth in a local, regional, national or international context as appropriate." (IFA, 1999). The location and distribution of the test pits and trenches would need to be agreed with the local authority. These would normally be expected to investigate any anomalies identified in earlier work and provide good coverage of the site to give the best opportunity for the identification of previously unidentified archaeological remains.

11.5.8 Field evaluation on proposed aggregate extraction sites is most likely to comprise large open test trenches. Made ground and topsoil is normally removed by machine. Further deposits may then be removed by machine until archaeological remains are identified. All machining is undertaken under archaeological supervision. Any archaeological remains are cleaned and recorded and may be sampled to obtain evidence for their date and significance. The size and distribution of the evaluation trenches would need to be agreed with the local authority and would be expected to investigate any anomalies identified during earlier non-invasive investigations.

11.5.9 The depth of the required evaluation trenches will depend upon the likely depth of any archaeological remains and the geology type. Across most aggregate geologies, archaeological remains are likely to be relatively shallow. Remains of the later prehistoric to modern periods are typically present above or cut into the top of the highest natural deposits whether these are the aggregate bearing geologies (e.g. River Terrace Deposits, Angular Flint Gravel, Chalk etc) or superficial non-aggregate geologies overlying them.

11.5.10 Certain geology types have the potential to contain archaeological remains at deeper levels. If the following geologies are present on the proposed extraction site, deeper evaluation trenches or test pits may be required:

- River Terrace Deposits, Angular Flint Gravels, Raised Marine Deposits and Blown Sand have the potential to contain Palaeolithic remains. Geoarchaeological investigation of these strata may be required to confirm

the extent and date of these deposits and if any archaeological remains are present.

- Alluvium (present above sub-alluvial River Terrace Deposits in river valleys, on floodplains, marshes or semi-inundated land) has potential for palaeoenvironmental remains and deeply buried *in situ* assets, potentially including well preserved waterlogged material. Investigation (through boreholes, test pits or deep trenches) of the archaeological and palaeoenvironmental potential of the alluvium would be required prior to any aggregate extraction

11.6 Mitigation

11.6.1 Following the completion of the evaluation phase, a historic environment mitigation strategy would be developed and agreed with the local authority. Mitigation may include any of all of the following:

- Re-design or modification of the proposals to allow for the *preservation in situ* of any nationally significant remains (whether these have been statutorily protected or have been recently identified). Nationally significant remains could potentially include elements of the historic landscape (such as Ancient Woodland or protected Hedgerows).
- Archaeological excavation to comprise *preservation by record* of archaeological remains which are not of national significance. Different excavation techniques may be suitable for different environments and types of remains.
- Geoarchaeological investigation to develop an understanding of the geological sequence (including the date of significant deposits) and to excavate, record and analyse any archaeological remains within the geological sequence.
- Watching brief – comprising intermittent attendance by an archaeologist to ensure no archaeological remains are removed without record during non-archaeological works that are unlikely to have an impact on archaeological remains.
- Standing building recording – should any standing structures of historic, archaeological, architectural or artistic interest be identified, but not considered appropriate for conservation, standing building recording is likely to be requested. This would comprise a survey of the structure undertaken before demolition, with accompanying historical research and visits during demolition (if appropriate) to identify any features not visible during the initial survey. The levels of standing building recording have been set out by English Heritage (2006) and the IFA (2001c) and vary depending on the importance of the structure.

Excavation techniques

11.6.2 The precise form of mitigation will depend upon the significance, preservation, underlying geology and depth of the archaeological remains present on site. Sites on River Terrace Deposits may require geoarchaeological investigation as in 4) below to determine the date and extent of the River Terrace Deposits. Deeper trenches might also be required to excavate any *in situ* Palaeolithic remains within the River Terrace Deposits.

11.6.3 Sites within the alluvium may require geoarchaeological and palaeoenvironmental investigation to provide answers to research questions about the past environment. Deeper trenches (as described in 4) below) may be required to excavate *in situ* prehistoric deposits if present within the alluvium:

1) Where diffuse or dispersed archaeological remains (e.g. field systems with localised settlement or ritual landscapes) are likely to be located at shallow depth (i.e. most extraction sites and particularly on River Terrace Deposits) 'general excavation' is likely to be most appropriate.
2) Where understanding of archaeological potential and significance is very good 'targeted excavation' may be most appropriate. Normally a thorough HEA, followed by non-invasive investigation and/or field evaluation would be required to confirm that the targeted areas are of sufficient archaeological significance and whether other areas require 'general excavation' or 'watching brief'.
3) A watching brief may be appropriate if proposed works (e.g. geotechnical works, preparatory excavation works, site preparation, preliminary topsoil/subsoil strip and other enabling works etc) are only anticipated to have a limited and localised impact on archaeological remains and/or in areas where preceding HEA and non-invasive investigation and/or field evaluation have identified a low archaeological potential where no significant archaeological remains are anticipated.
4) Where archaeological potential has been identified within geological deposits (i.e. River Terrace Deposits, Angular Flint Gravel, Raised Marine Deposits or Blown Sand) or alluvium; deeper excavations, geoarchaeological tests pits and boreholes may be required to mitigate the impacts upon deeper remains. These could include localised areas of deeper excavation where higher archaeological potential has been identified. On alluvium, battered or stepped trenches up to 4m below ground level (mbgl), with further machine dug (and not manually accessible) test pits in the base may be required to reach deep remains.

General excavation

11.6.4 General (also known as 'strip, map and sample') excavation is particularly appropriate for large scale extraction sites with relatively shallow rural sequences. It is particularly advantageous in recording large areas and diffuse features. It should be undertaken according to a Method Statement agreed with the local authority and in accordance with the IFA guidelines (IFA 2001):

- Strip – The topsoil or made ground is removed by machine under archaeological supervision until the subsoil or first archaeological layer is reached.
- Map – Archaeological deposits are hand cleaned to define the edges of discrete features, and a measured plan, photographic and written record is made of the visible features.
- Sample – Visible artefacts are collected to assist in dating of features and deposits. Sections (of circular or linear features) and quadrants (of large circular or sub-circular features) of large or significant features are excavated to recover artefacts and record internal stratigraphy. Certain types of features (burials, hearths, stratified remains or significant features) are hand excavated in their entirety by the archaeologist and recorded. Palaeoenvironmental sampling of buried soil horizons and bulk sampling of certain deposits will be undertaken to retrieve additional evidence.

Targeted excavation

11.6.5 Targeted excavation is most suitable where the archaeological potential of the site is well understood and localised areas of interest with significant archaeological remains have been identified. Under these conditions, archaeological investigation

can focus on a particular area of archaeological remains rather than stripping a large area, including areas of no archaeological potential.

11.6.6 Should areas of complex and deeply stratified archaeological deposits be identified, 'single context excavation' may be appropriate. Such complex and stratified deposits are unlikely to occur outside an urban environment. Single context excavation excavates each feature in its entirety and records them individually in plan. This enables the stratigraphic sequence to be reconstructed at the post-excavation stage. A written record provides additional information on the nature of contexts.

Watching Brief

11.6.7 During a watching brief an archaeologist may be required to visit the site during or prior to specific works to ensure no previously unknown or unexpected remains are removed without record.

11.6.8 There are two forms of watching brief:

- General watching brief – an archaeologist visits the site at predetermined intervals to monitor archaeologically sensitive areas where no specific remains have been identified but where there is a risk that works may have an impact on previously unknown remains.
- Targeted watching brief – an archaeologist observes certain specific locations or processes which have been identified as posing a potential risk to specific archaeological remains.

11.6.9 There may also be provision for the client to contact the archaeologist should archaeological remains be located. Should remains be identified provision would normally be required for the excavation and recording of such remains by the attending archaeologist and/or others.

11.6.10 The watching brief would need to be undertaken in accordance with IFA guidance (IFA 2001e) and the requirements of the Local Authority.

Standing building recording

11.6.11 Standing building recording may be applied to significant buildings and structures prior to demolition and clearance. The level of recording will be commensurate with the significance of the remains, and will be carried out in accordance with English Heritage (2006a; 2006b; 2007b; 2007c and 2008) and IFA (2001b; 2001c) guidelines. The 19th and 20th century development of the site is as important as earlier phases. As minimum, digital records of buildings and other structures will be included in the Project digital mapping in layers illustrating the historic development of the site. Much of this information can be obtained from digital overlays of historic map information. However, particularly important standing structures may require more detailed recording.

11.6.12 In general, baseline recording of significant structures will be undertaken to appropriate Levels as specified by EH (2006). In general, if something is deemed of heritage significance then it should be investigated and recorded, the level being dependant on its determined significance. If an asset is to be damaged, the minimum level of recording expected would be a Level 2, photographic with most basic written descriptions. If the asset is statutorily listed, locally listed or a scheduled monument then the minimum recording would be to a Level 3, which includes a basic written account, drawings and a photographic record.

11.6.13 Building survey will not be undertaken until existing documentary sources have been consulted, as adequate survey records may already exist in some cases, particularly for modern oil refinery structures.

Post excavation

11.6.14 Following completion of the fieldwork the data and artefacts recovered from the site would require post-excavation assessment and analysis to determine the potential of the data, appropriate analytical techniques and type of publication. The results of the assessment would need to be presented to the local authority and the type of analysis and publication agreed with them. On completion of the project, the publication or client report would need to be included in the GLHER.

12 Conclusions

12.1.1 This report was not intended to assess the archaeological resource of LBH as a whole. The assessment was focussed on four Study Areas which had been (or would be in the future) a focus of aggregates extraction and to make a correlation between potentially commercially valuable aggregates and zones of past human activity. Urban areas were excluded from the assessment as these would not be subject to any extraction in the future. Due to these limitations, this report can not provide an overall assessment of the archaeology of Havering. It is merely a snapshot of such archaeological data, for which information was available within the four chosen Study Areas. Within these areas, this assessment can provide patterns of distribution, settlement and human activity in general and this way, help to address issues that may arise through development and extraction industries. The approach to data analysis as used in this project has a potential to transform the way we can assess archaeological potential and its risk to developers and extraction industries in Havering. It enables us to predict areas of archaeological potential within areas of potential development.

12.1.2 This project was primarily a GIS-based data analysis of archaeological data, and entailed manipulating spatial data from a number of sources, including the GLHER, in order to show the distribution of past human activity on the aggregates resource of the London Borough of Havering, by chronological period and by asset type. Through a series of asset density maps, this has provided an invaluable overview of the nature of activity over time, which has not previously been possible. The report entailed summarising and analysing the asset density and asset distribution for each chronological period, and attempted to identify any patterns in past activity, which could be used for future heritage asset resource management. This was primarily undertaken to improve knowledge of the archaeological resource in aggregate producing areas to facilitate strategic planning decision and the management of historic environment assets within them for the LBH.

12.1.3 The project identified areas of past, present and potential future extraction from BGS mapping, historic maps, BritPits database and current minerals permissions. The overlaying of the various data sources within the ARCGIS framework indicated that the BGS mapping was relatively accurate. An enhanced and updated GLHER project database was used to generate asset density figures for an archaeological resource assessment. This considered the density of types of assets (e.g. domestic, ritual, agricultural etc) across the aggregates resource, divided by period and Study Area, and how this reflects past occupation and activity and the history of archaeological investigation.

12.1.4 This revealed some clear patterns in the asset densities of different chronological periods:

- The asset density in the earlier prehistoric periods is low (around 0.2 to 0.3 assets per km^2) until the Neolithic and Bronze Age (2.8 and 2.4 assets per km^2);
- The low Iron Age asset density (1.4 assets per km^2) may reflect wide regional changes in habitation patterns but could also reflect difficulties in identifying assets of this period;
- The low density of early medieval assets (1 asset per km^2) reflects current limited understanding of this period generally across the South East;
- The most significant rise in asset density on the aggregate areas occurs during the post-medieval period (6.5 assets per km^2). This reflects the range of changes in building fabrics, styles etc, which affects the survivability of many assets. For example domestic structures, a greater range of building

types have survived through consistent reuse because of the more durable building materials used;

- The number of Modern assets (3.7 assets per km^2) is not particularly high. This is probably explained by the present ongoing debate as to what represents an asset and thus what should recorded. At present, the GLHER provides a record of those modern assets considered to be of particular archaeological, historic, architectural or artistic interest (e.g. military features and important buildings) and those which might otherwise be mistaken for earlier and more significant remains (e.g. earthworks associated with golf courses).

12.1.5 Spatially, the archaeological resource assessment some clear patterns associated with asset density, geology, topography and asset distribution.

- The Study Areas with a history of gravel extraction have the highest number of assets, followed by those areas that have been subject to e.g. fieldwalking projects or NMP mapping
- The highest density Study Areas are associated with the southern part of the borough
- Activity is focussed along the River valleys from the Neolithic to the early medieval period.

12.1.6 This revealed some clear patterns in the asset densities of different asset types which include:

- For the early Prehistoric, findspots are the main asset type;
- The majority of assets lie in the south-east of the Study Area;
- Religious, Ritual and Funerary assets appear to be more common in the Bronze Age than the Neolithic, indicating the change in social structures during this period although the recording within the GLHER database might be a factor here as well;
- There is a marked rise in the range of asset types from the Neolithic period which probably reflects increasingly more complex social and economic structures;
- There is a slight decline in the range of asset types in the early medieval period.
- The dominance of agricultural and subsistence over industrial, particularly for the post-medieval period, demonstrate the continuing agricultural nature to the region. This would need to be compared against industrial assets within the excluded urban areas to see how much of a change their inclusion would have.

12.1.7 The analysis shows that 77.9% of all assets were recorded in Study Area 4, which also has a large, but not the highest proportion of quarrying (13.4%). 4.3% of all assets were recorded in Study Area 3, which is the smallest Study Area but has the highest proportion of quarried landscape (27.4%) and the highest density of assets in relation to the size of the area. The majority of assets recorded from Study Area 1 are cropmarks and earthworks, and not many dated assets are recorded from here. Study Area 2 has a relatively low asset density and also a very small proportion of quarried landscape. Palaeolithic evidence, however, has been recorded here, suggesting that the number of fieldwalking projects carried out in this area have contributed significantly to the recovery of assets, particularly of earlier periods, as well as cropmarks and earthworks. Study Area 4 has been subject to repeated investigations, often prior to aggregates extraction, and these have provided invaluable information on the archaeology in this Study Area.

12.1.8 The distribution maps indicate that the earlier periods a generally underrepresented

in Study Area 3 and the hiatus of activity starts with the Later Medieval period (see Section 16). In contrast, Study Area 4 has been subject to repeated investigations prior to aggregates extraction, which have provided invaluable information and dating evidence on the archaeological resource across all periods in this area. These figures could indicate that investigations have not been carried out sufficiently prior to extraction in Study Area 3 and that information was lost during the process, or they represent a real lack of archaeological resources in this area. This seems less likely, given the high level of assets in Study Area 4 close by.

12.1.9 This trend highlights the importance of several factors in recovering archaeological evidence: investigation in advance of extraction has played an important role in the recovery of assets, and where mitigation is carried out, detailed dating evidence can be collected an provide significant information of the historic landscape character of an area; in areas with a low density of investigations in advance of development/extraction, fieldwalking has played a major role in the recording of assets, although with less dating evidence as the recording largely relies on visibility of an assets. This also applies for the NMP surveys.

12.1.10 The archaeological Resource Assessment and its accompanying asset densities can input into general and period-specific research topics. These research priorities would be appropriate to any investigation into the archaeology or heritage of the aggregates resource (whether associated with proposed aggregates extraction or not) and other research agendas should also be considered.

12.1.11 The asset densities and accompanying archaeological Resource Assessment provided the basis for a Research Strategy and Agenda. This identified four general research priorities, which would have an impact on the asset densities of multiple periods across the aggregates resource:

- Geological and geoarchaeological research to identify and date the full extent of unmapped River Terrace Deposits and any archaeological potential associated with them.
- Extension of the NMP survey across the rest of the Borough.
- Re-assessment of assets recovered by antiquarians (where possible) to reflect modern typologies and development in scientific dating.
- Targeted investigation of assets of uncertain date or nature (including some identified by NMP) such as ring ditches

12.1.12 Further specific research priorities were identified to improve understanding of particular periods. These research priorities would be appropriate to any investigation into the archaeology or heritage of the aggregates resource (whether associated with proposed aggregates extraction or not) and other research agendas should also be considered:

- **Geoarchaeological investigation** for the evaluation and mitigation of extraction impacts on River Terrace Deposits and other geologies with potential for in situ Palaeolithic remains. Early intervention is always beneficial, and would be particularly useful at the prospection stage to allow better archaeological interpretation of geotechnical results;
- **Fieldwalking** can identify sites that now only exist in the topsoil and it is an important tool in recovering Palaeolithic and Mesolithic remains. The more consistent use of fieldwalking and reporting in a more standardised form would result in constantly updated picture of potential locations of significance;
- **Trial trenching** need to be done at a relevant sample rate in order to better identify the presence of significant remains. Observation of topsoil stripping during the normal working of a quarry carries is likely to remain a significant

strand in the strategy for the mitigation of extraction during the normal working of a quarry;

- **Strip, map and sample** is particularly advantageous in recording large areas and diffuse features. It should be undertaken according to a Method Statement agreed with the local authority and in accordance with the IFA guidelines.

12.1.13 The results of this project will be used to facilitate management of the impacts of aggregate extraction on archaeological remains. The report has provided a summary of the current understanding of archaeological remains and indicated those areas of Havering, where a greater density of archaeological remains would be at risk from aggregate extraction or where understanding is limited and further field investigation is required. It also provides a research agenda and strategy for any further archaeological work associated with aggregates extraction, and strategies which may mitigate the impacts of extraction on archaeological remains. The report will be circulated widely to members of the Havering Council employed in archaeology and minerals planning, to English Heritage and the minerals industry. The results of the report were further disseminated through the project seminar.

13 Acknowledgements

13.1.1 The project team wishes to acknowledge the help and support of all those who have assisted in the project: the period experts Jon Cotton, Bob Cowie and Jenny Hall who reviewed the period summaries; Peter Hall of the London Borough of Havering Development Planning Team who provided advice on aggregates geologies and current minerals permissions; Sue Smith, former Havering Conservation Officer who reviewed the report and provided advice and support on the Archaeology of Havering; Stuart Cakebread and his team at the GLHER who provided shapefiles and descriptions, checked entries and patiently answered numerous questions about the project data; Robert Whytehead (GLAAS) and Barnie Sloane (EH); the MOLA desk-based assessment team (Helen Dawson, Rupert Featherby, Guillermo Molina-Burguera, Laura O'Gorman) who provided support and advice on various issues with ArcGIS and the data processing during the preparation of the project; and the NMR who provided additional datasets.

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15 Assigning Asset Types

Agriculture and subsistence

15.1.1 This asset type included field systems, farm buildings, stables, barns, granaries, cart shed, cow sheds, brewhouse, cow houses, dairy, pigsty, kill sites, churn stand, ridge and furrow, lynchet, sheep dip, fish ponds, mill (where specified as corn or other cereal product, or where the nature of the mill is unspecified), farmhouses (Farmhouses should have Agriculture and subsistence as Asset Type 1 and domestic as Asset type 2), artefact scatters described as resulting from manuring practices.

Civil

15.1.2 This asset type included jails, County Hall's, libraries, market places, forums, boundary markers and 'boundary banks', radio stations, signal stations, Toll House.

Commemorative

15.1.3 Including war memorials, memorials to famous people

Commercial

15.1.4 Including shops, warehouses and commercial premises

Defence

15.1.5 Including beacons, forts, castles, hill forts, WWII defences, Firing Range provided there is evidence of military usage (rather than recreational gun club use).

Domestic

15.1.6 Including Roman Villas, castles, hill forts (Castles and hill forts should be both defence and domestic i.e. Defence in Asset Type 1, and Domestic in Asset Type 2), manors, settlements of all kinds, hut circles and enclosures containing hut circles, houses, coach house, boat house, garage.

Gardens and parks

15.1.7 Civil gardens for public use, private gardens and parklands, Lodges, gatehouses and garden features, folly.

Hoard

15.1.8 A new asset type added for this project to avoid ambiguity over whether hoards are ritual, defensive or industrial (i.e. metalworker's stock)

Industrial

15.1.9 Including flint working sites, mills for steel, textiles or providing power to factories, factories, blacksmiths, pottery and tile kilns.

Maritime

15.1.10 Including quays, ships, dry docks, light houses, coastguard towers/stations.

Object

15.1.11 Individual objects, metal-detected finds, flint scatters and artefact scatters.

Palaeoenvironmental

15.1.12 Another new asset type to identify natural features such as Palaeochannels, peat deposits and pollen studies which may be of archaeological interest but are not anthropogenic.

Recreation

15.1.13 Recreation sites, theatres, circuses, hotels, public houses

Religious, ritual or funerary

15.1.14 Including ring ditches, barrows, churches, cemeteries, wayside crosses, Monastic Granges

Transport

15.1.15 Including trackways, roads, bridges, railways, stations, mile stones, navigations, canals

Unassigned

15.1.16 Asset type used where the GLHER contains insufficient information to determine an alternative asset type (e.g. Linear features, enclosures, pits).

Water and drainage

15.1.17 Including drainage ditches, water management features, mill ponds, aqueducts, navigations and canals.

16 Figures

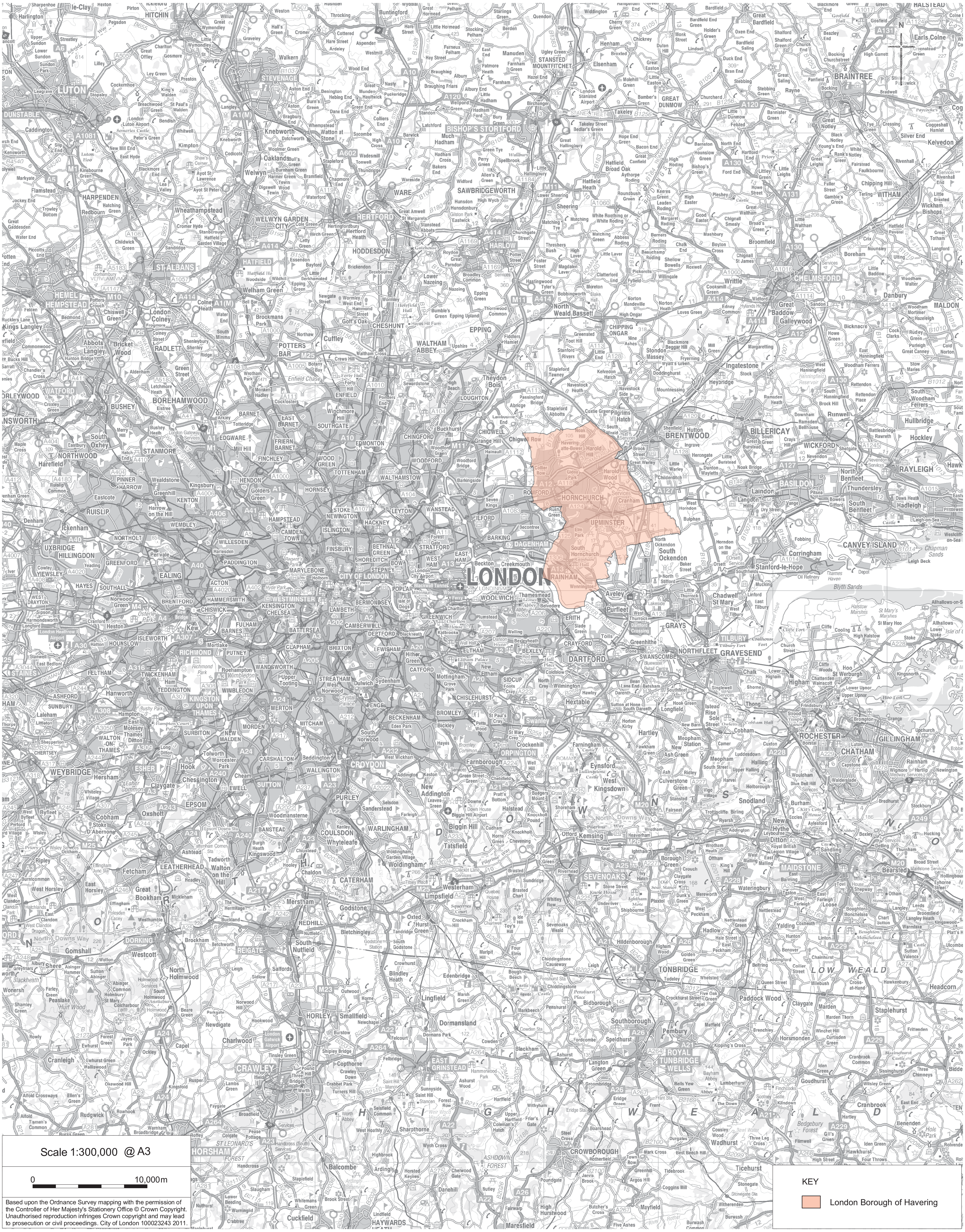

Fig 1 Project area: London borough of Havering

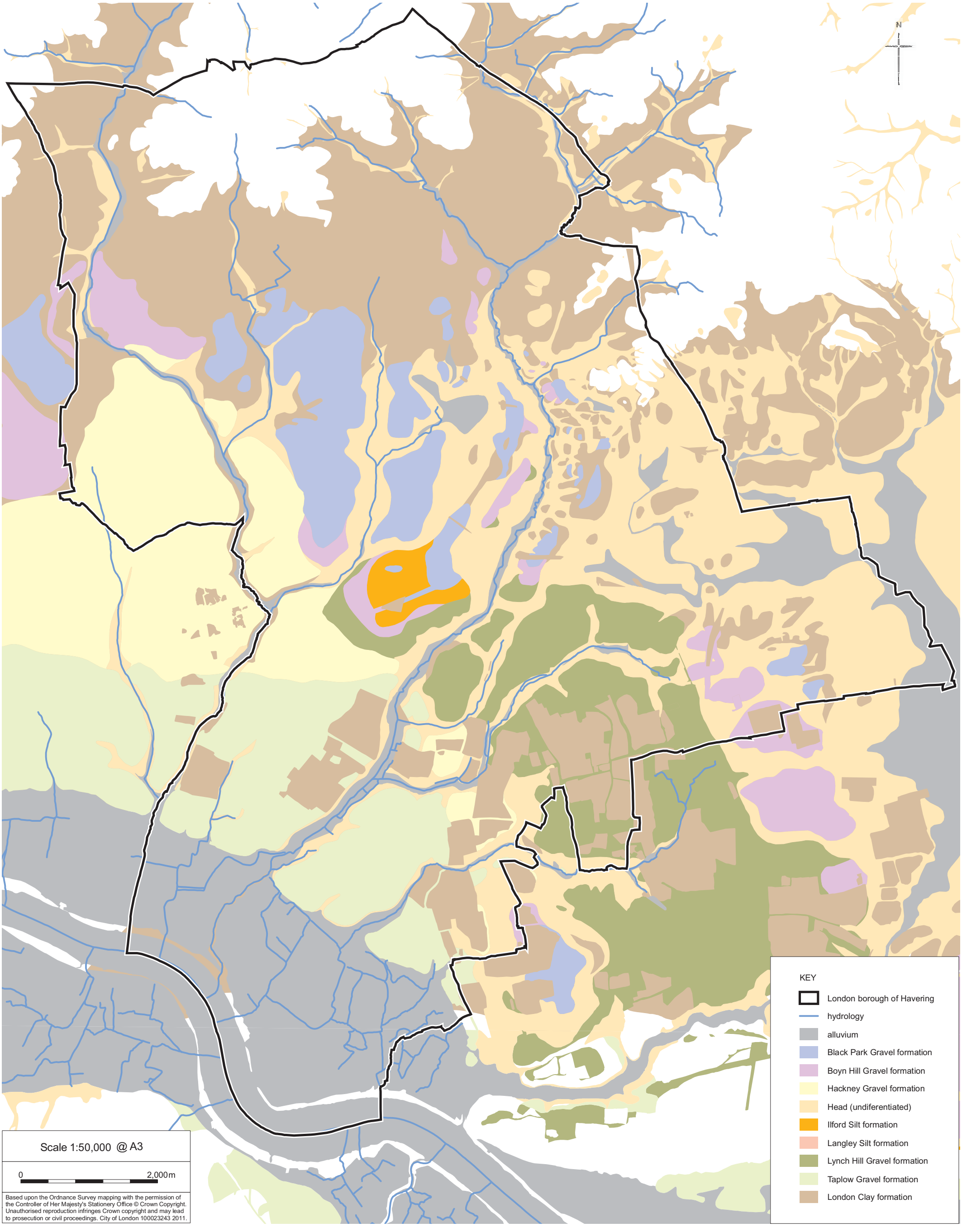

Fig 2 General geology of Havering

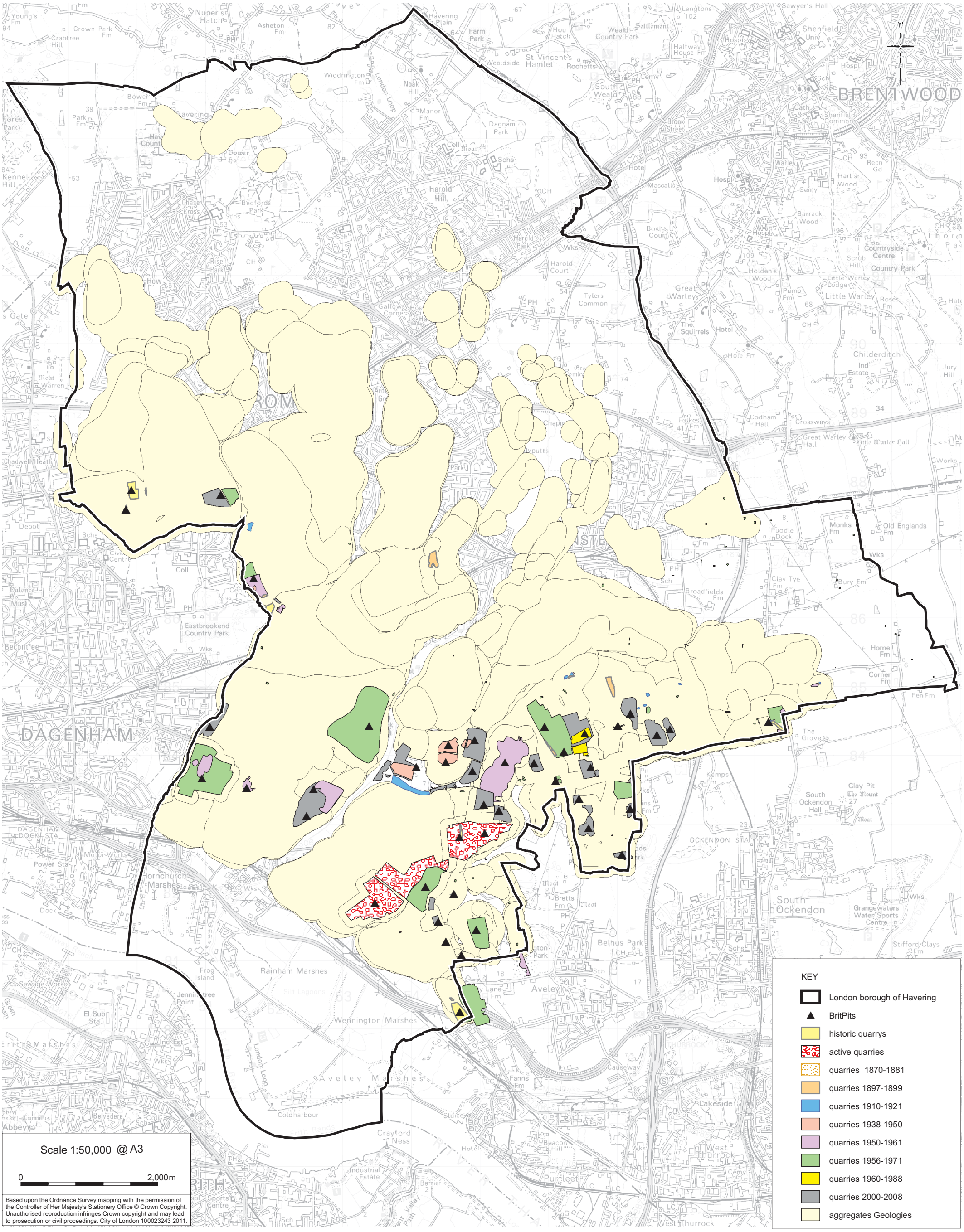

Fig 3 Areas of Past and Present Extraction

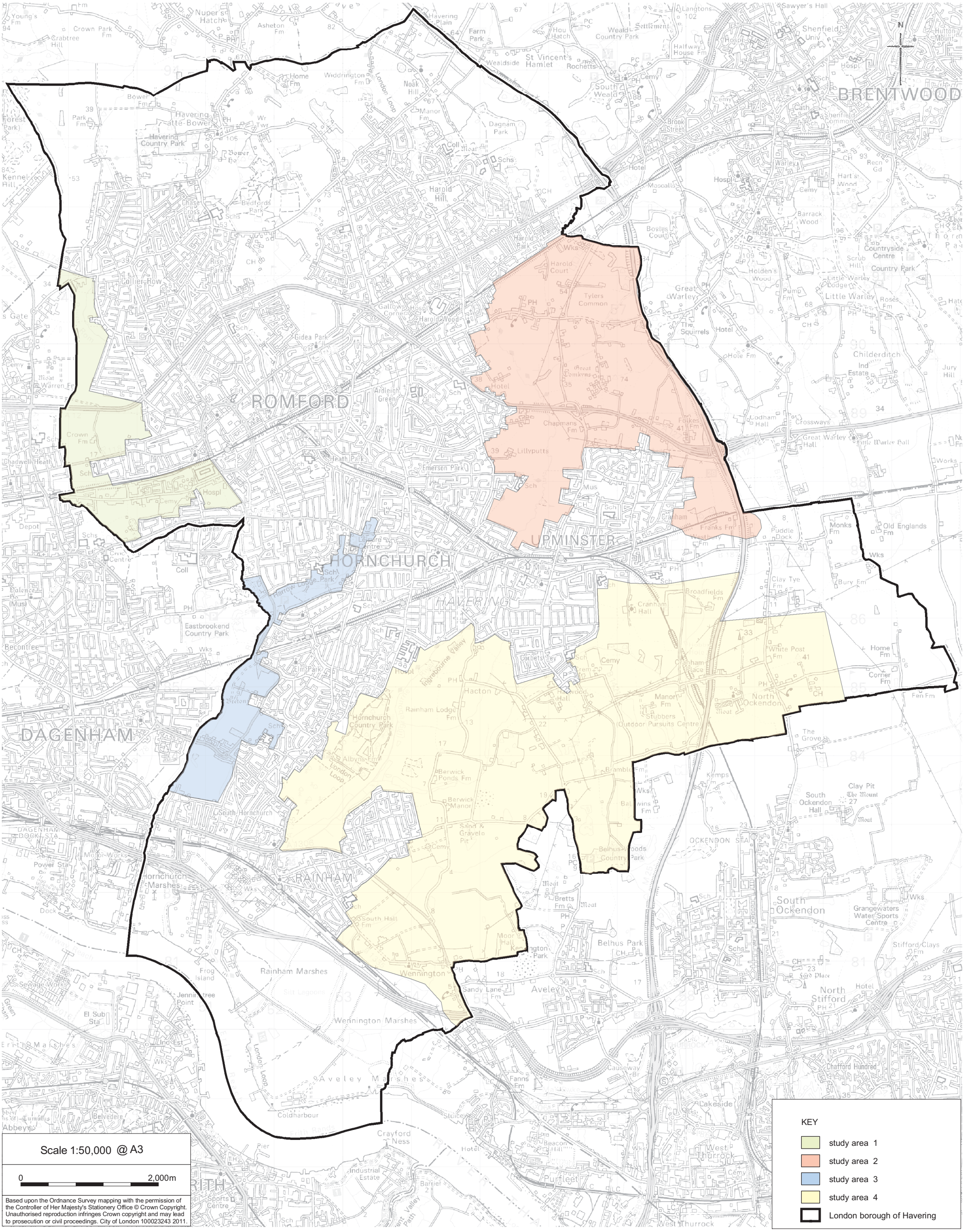

Fig 4 Study Areas

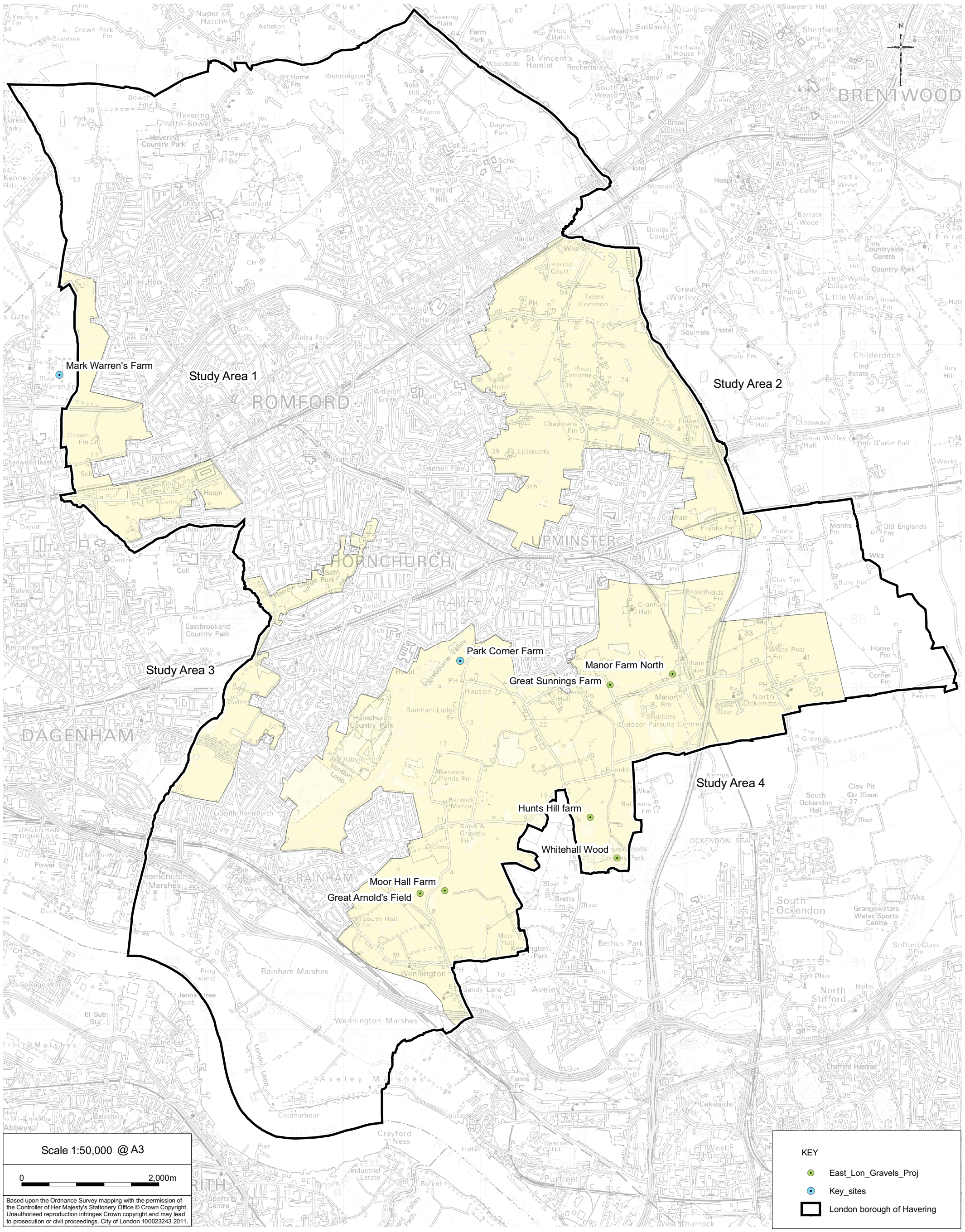

Fig 5 East London Gravels Project and other key sites in Havering

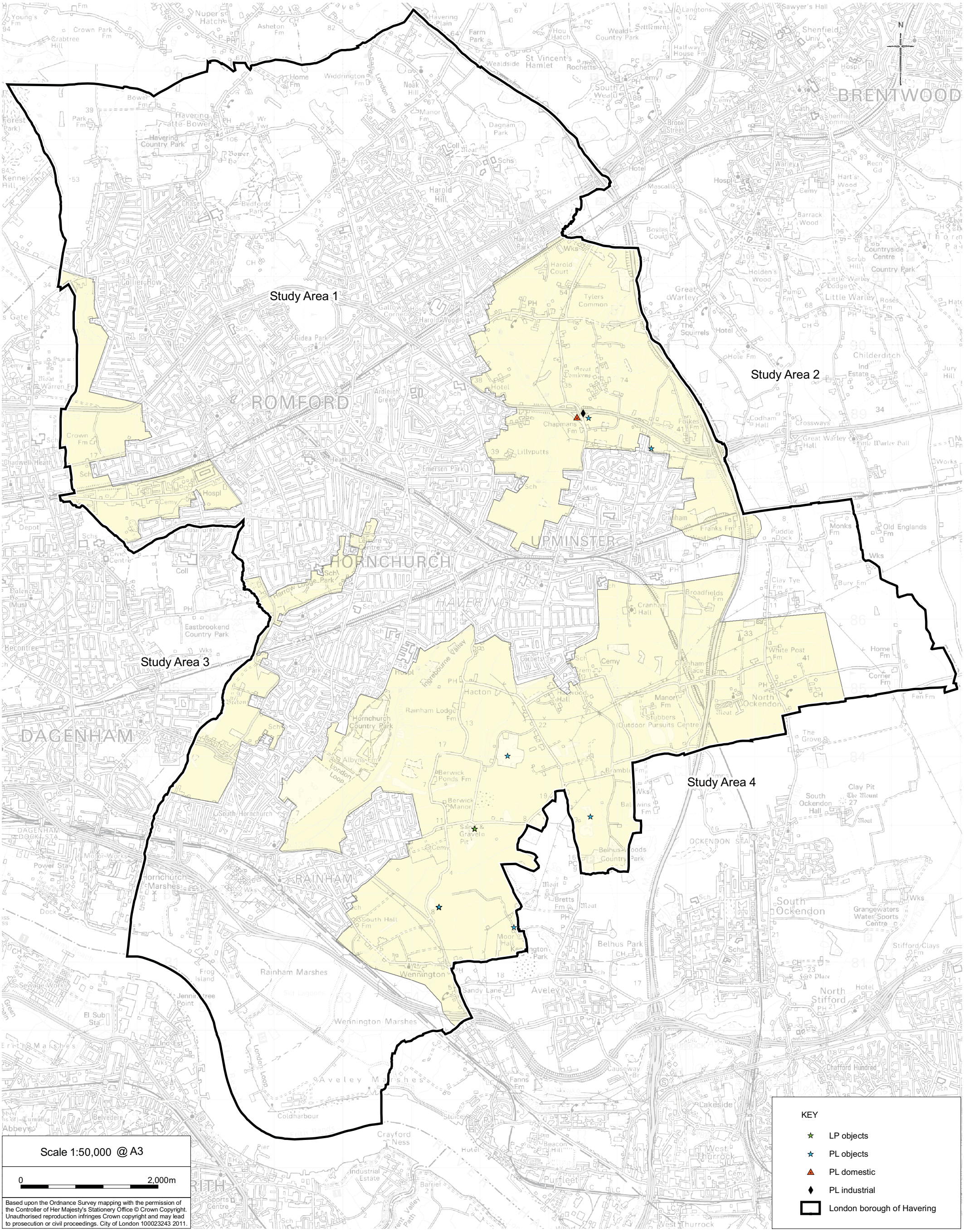

Fig 6 Lower Palaeolithic (LP) assets and general Paleololithic(PL) assets

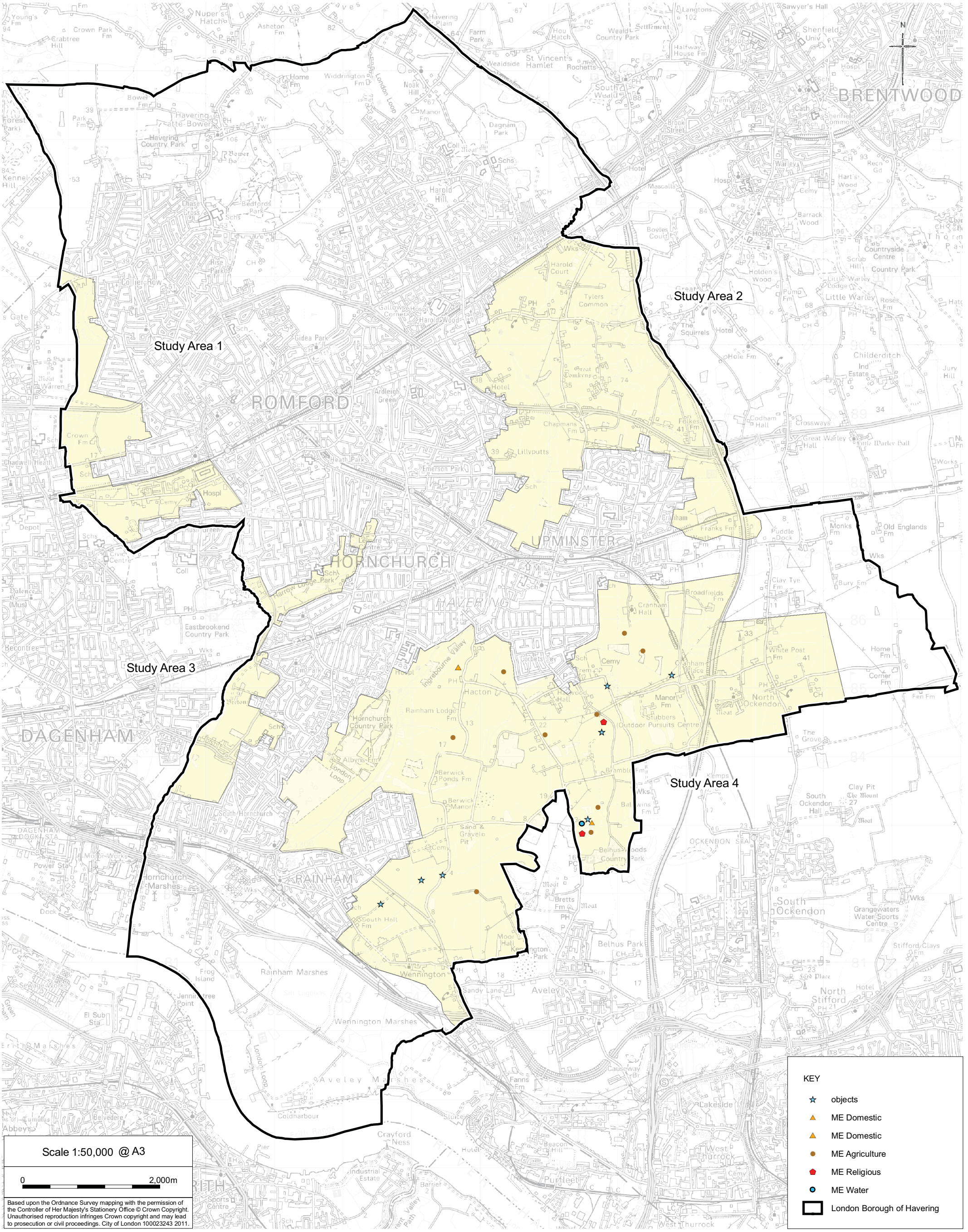

Fig 7 Mesolithic assets

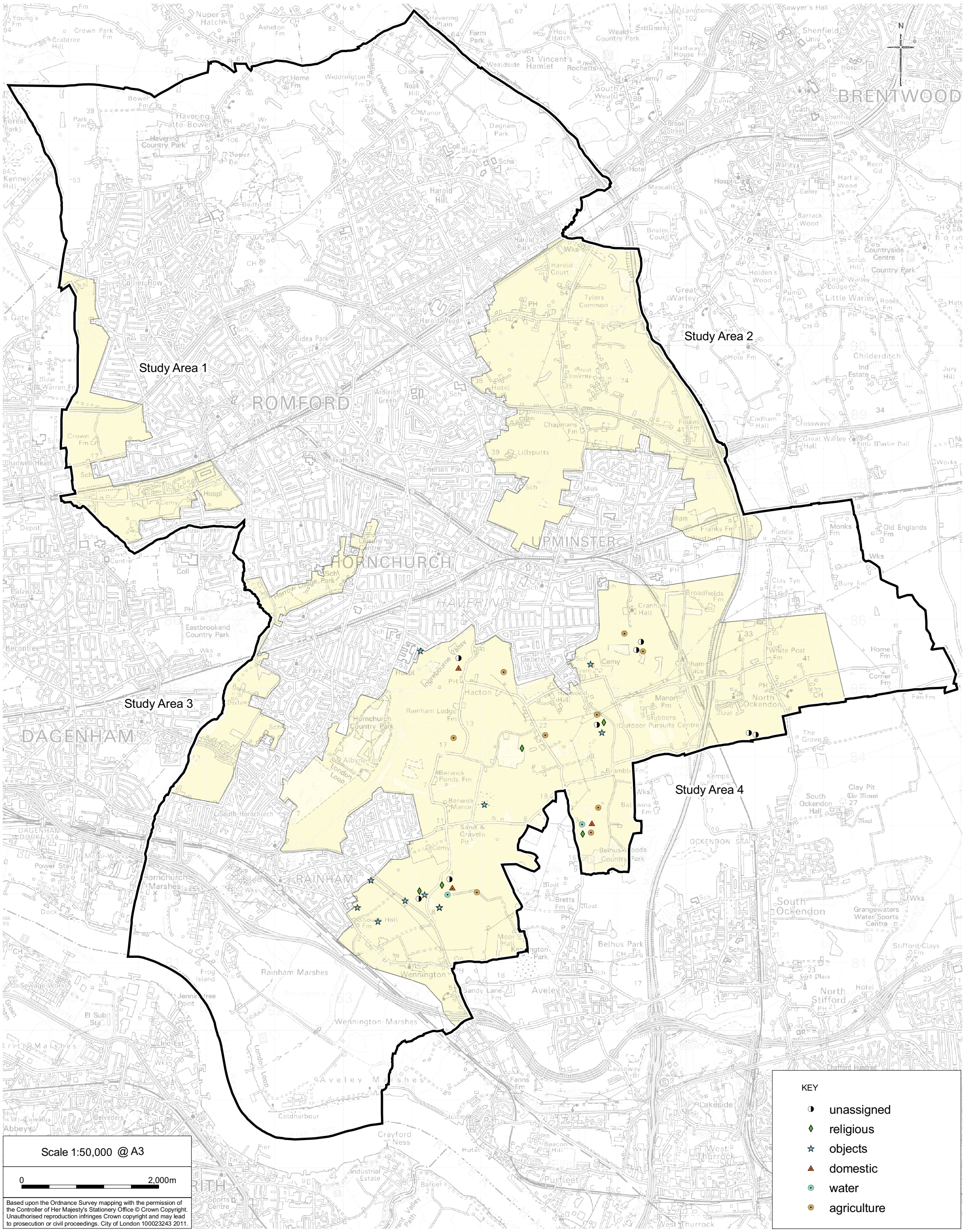

Fig 8 Neolithic Assets

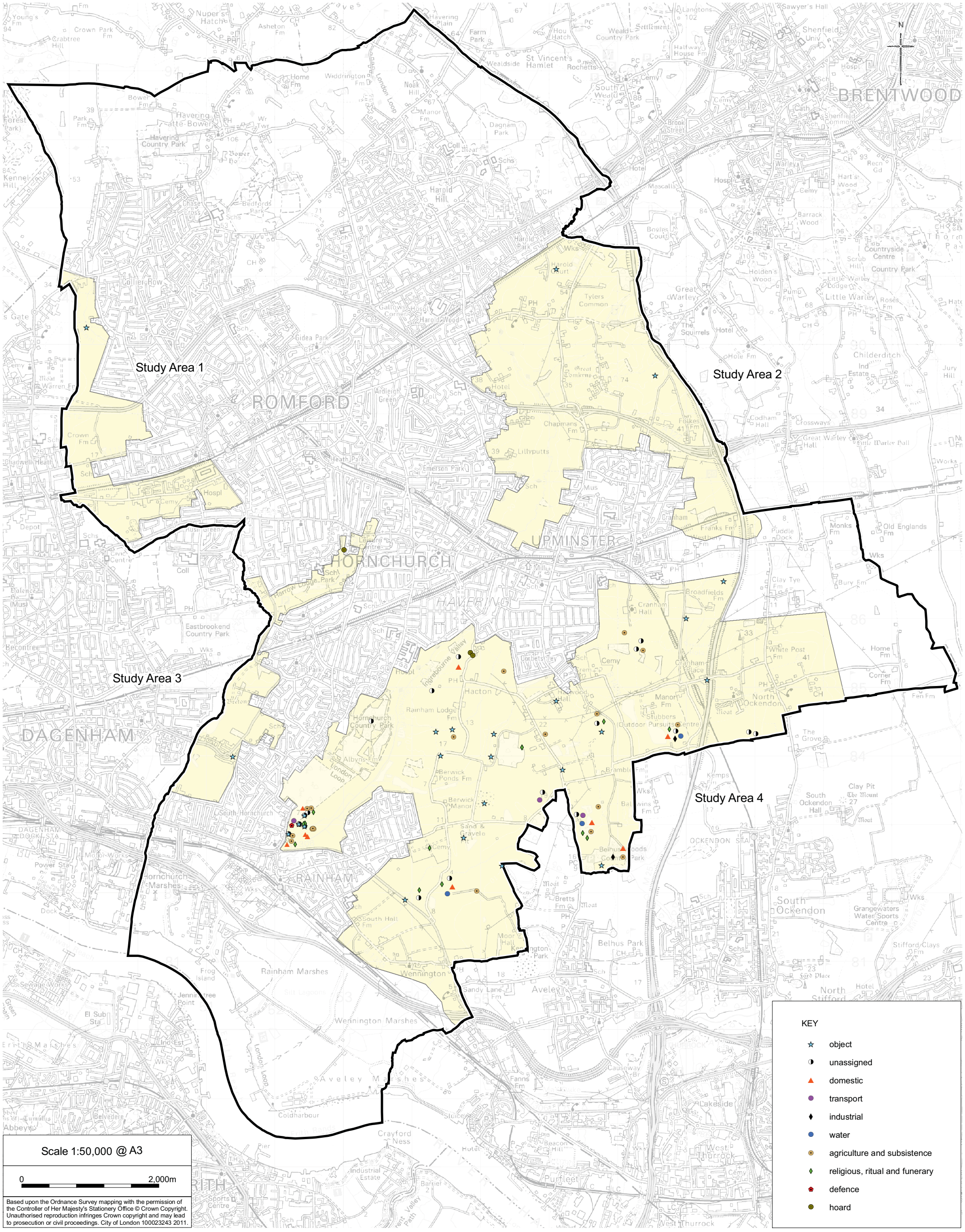

Fig 9 Bronze Age assets

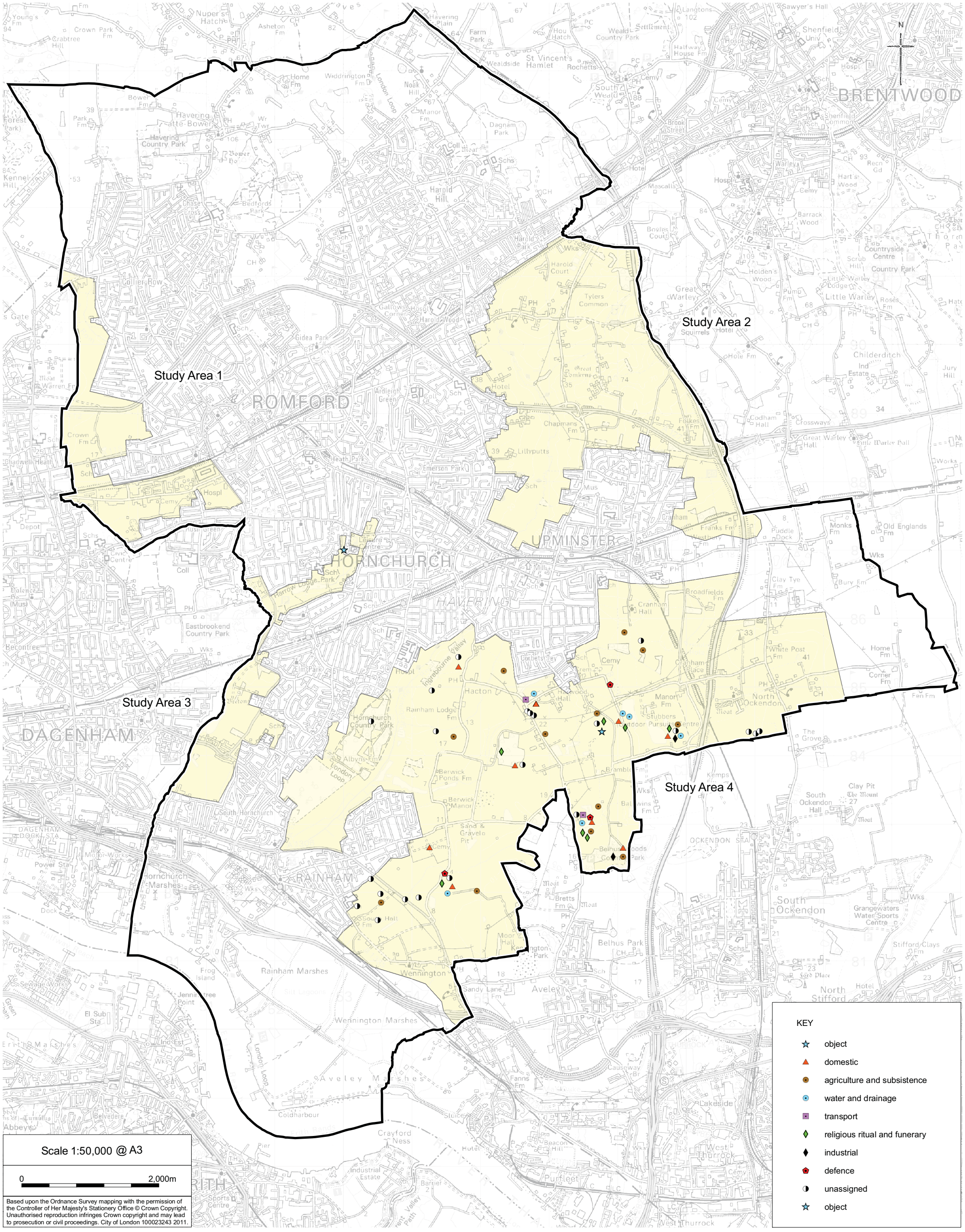

Fig 10 Iron Age Assets

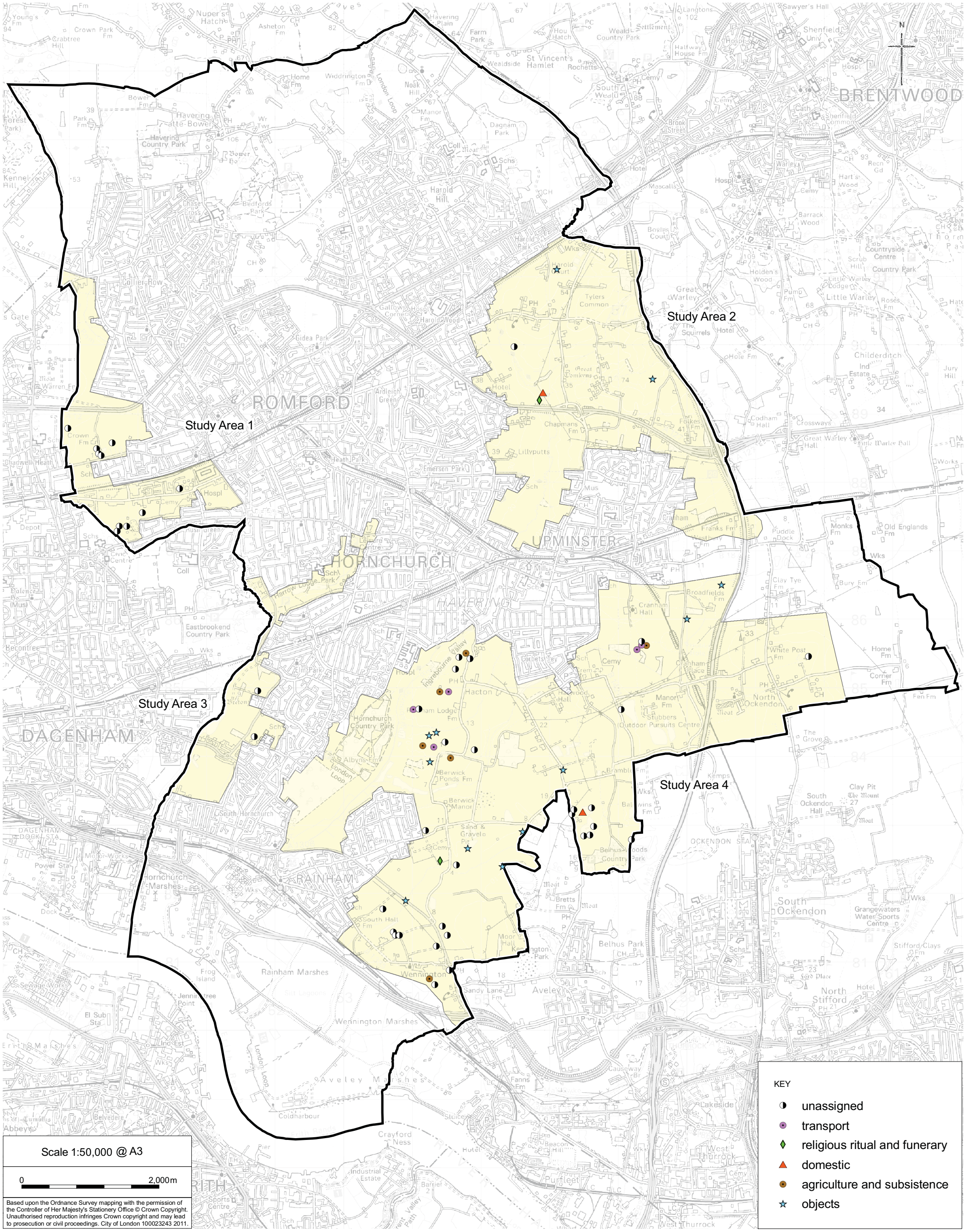

Fig 11 Unspecified prehistoric assets

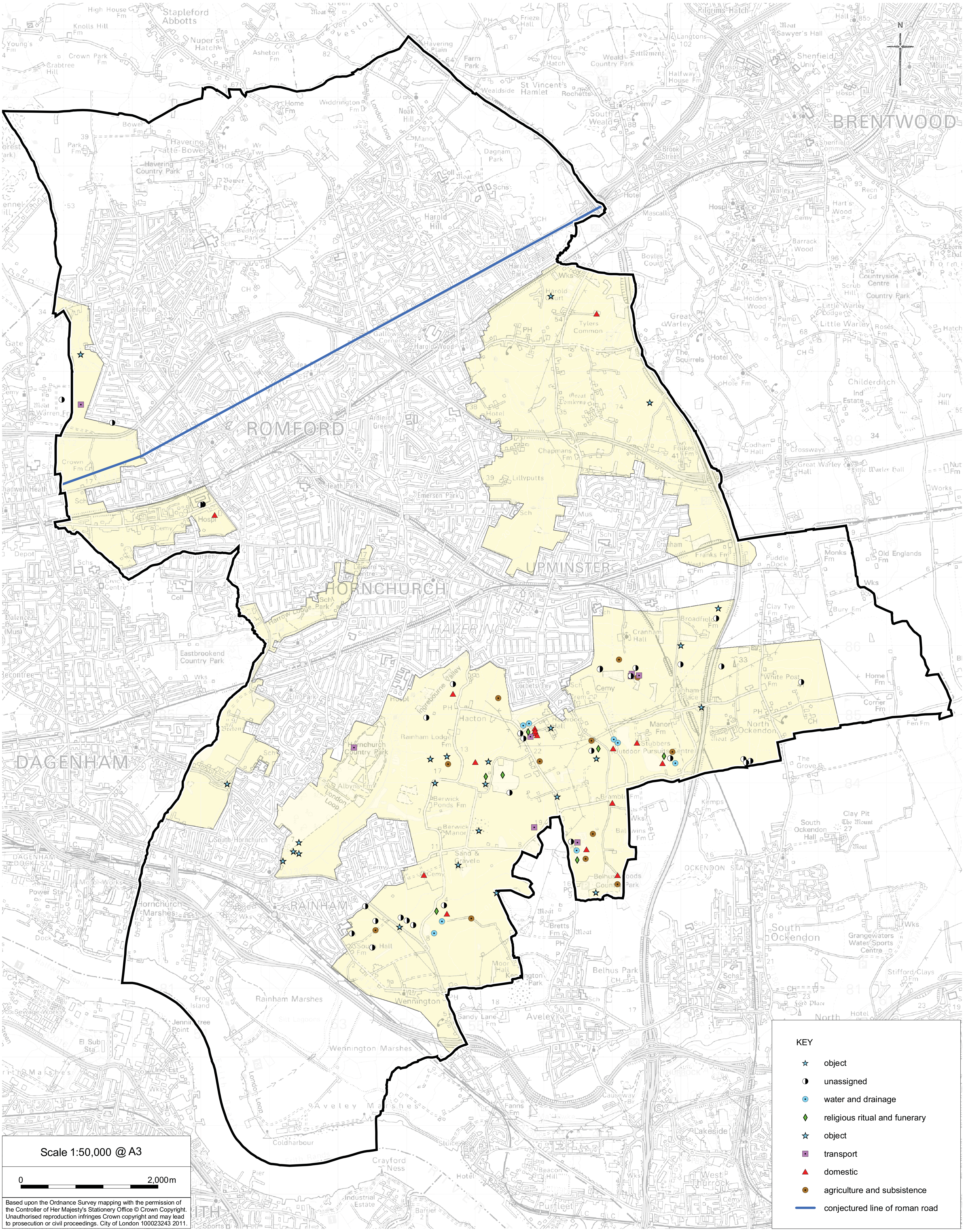

Fig 12 Roman assets

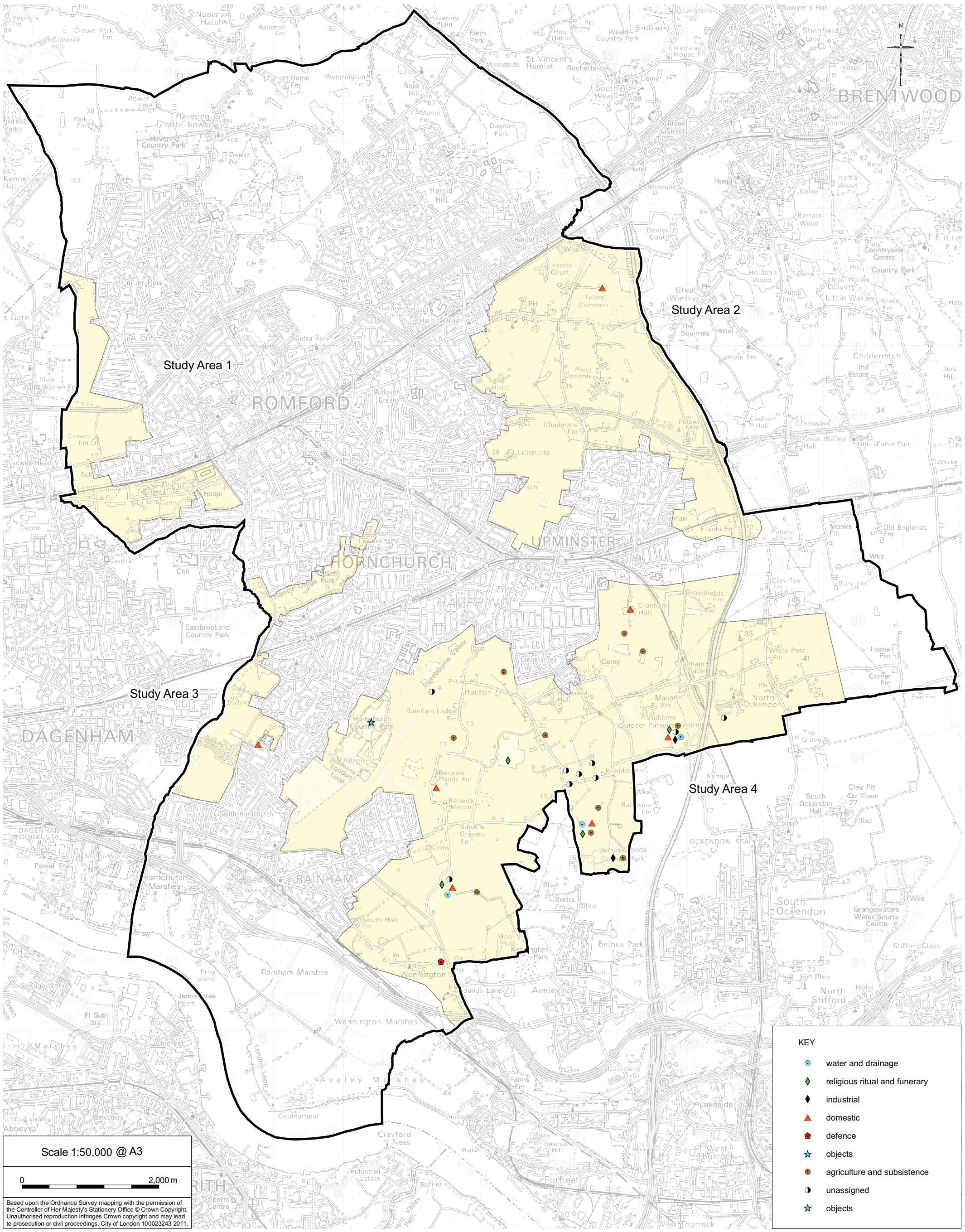

Fig 13 Early Medieval assets

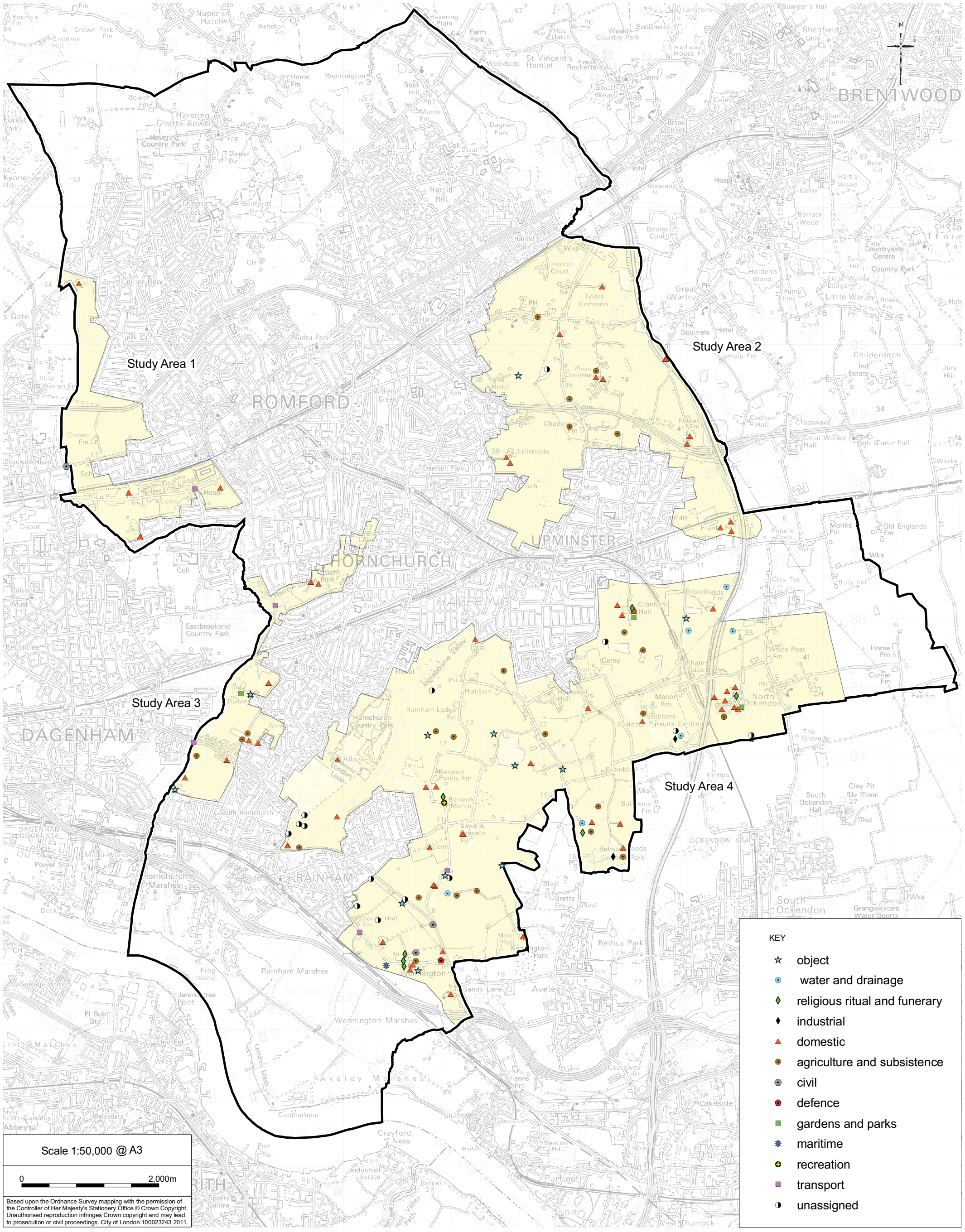

Fig 14 Medieval assets

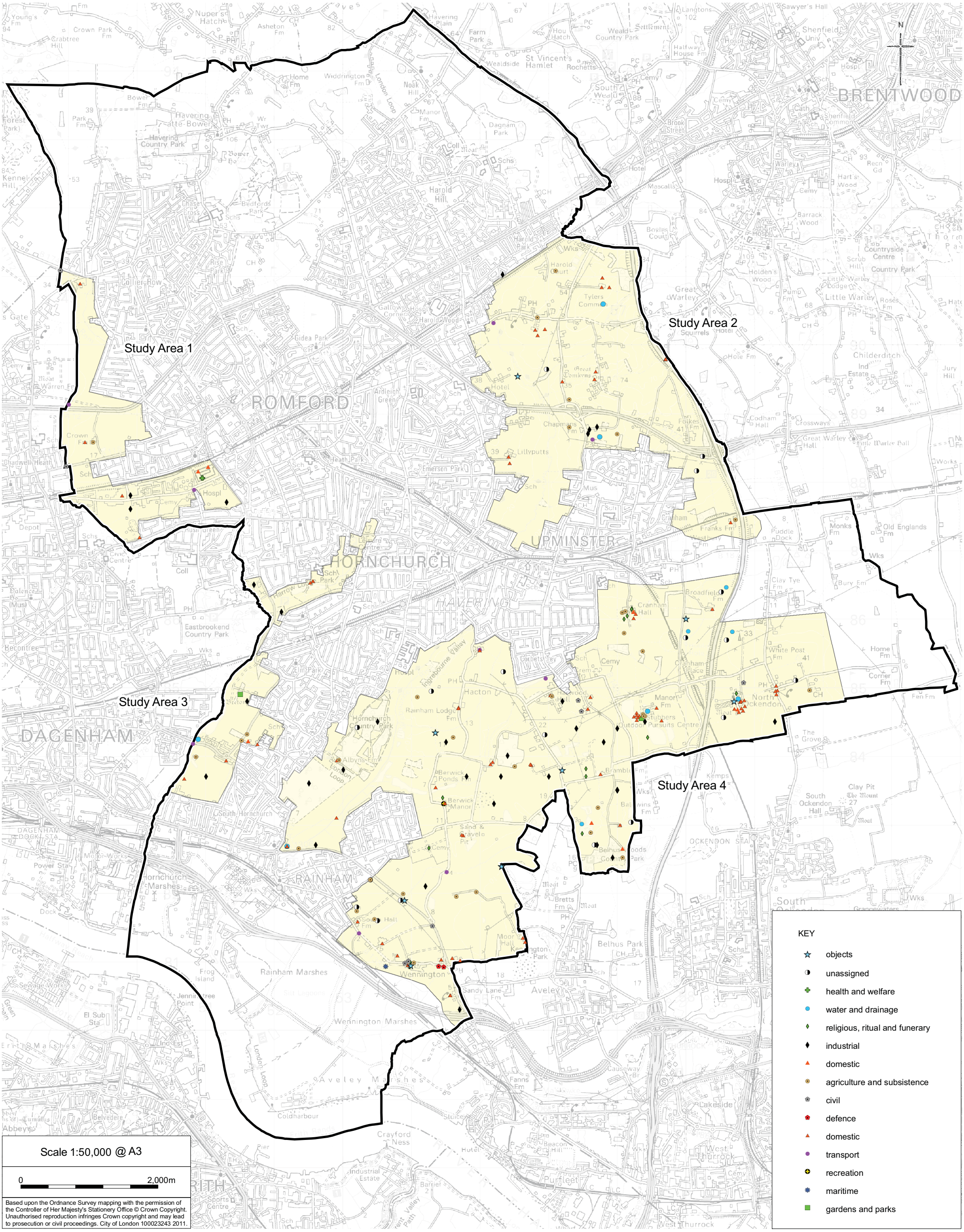

Fig 15 Post-medieval assets

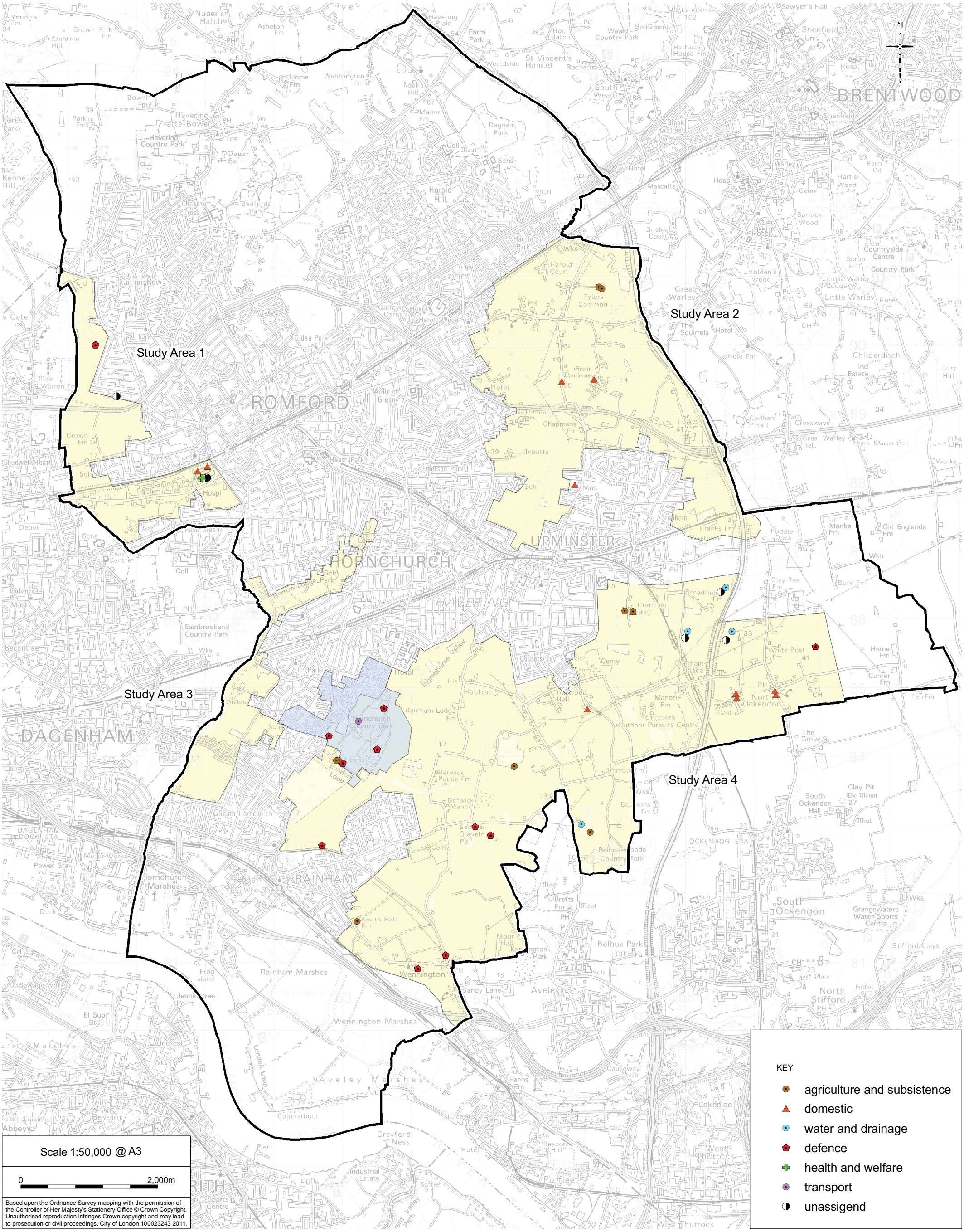

Fig 16 Modern assets

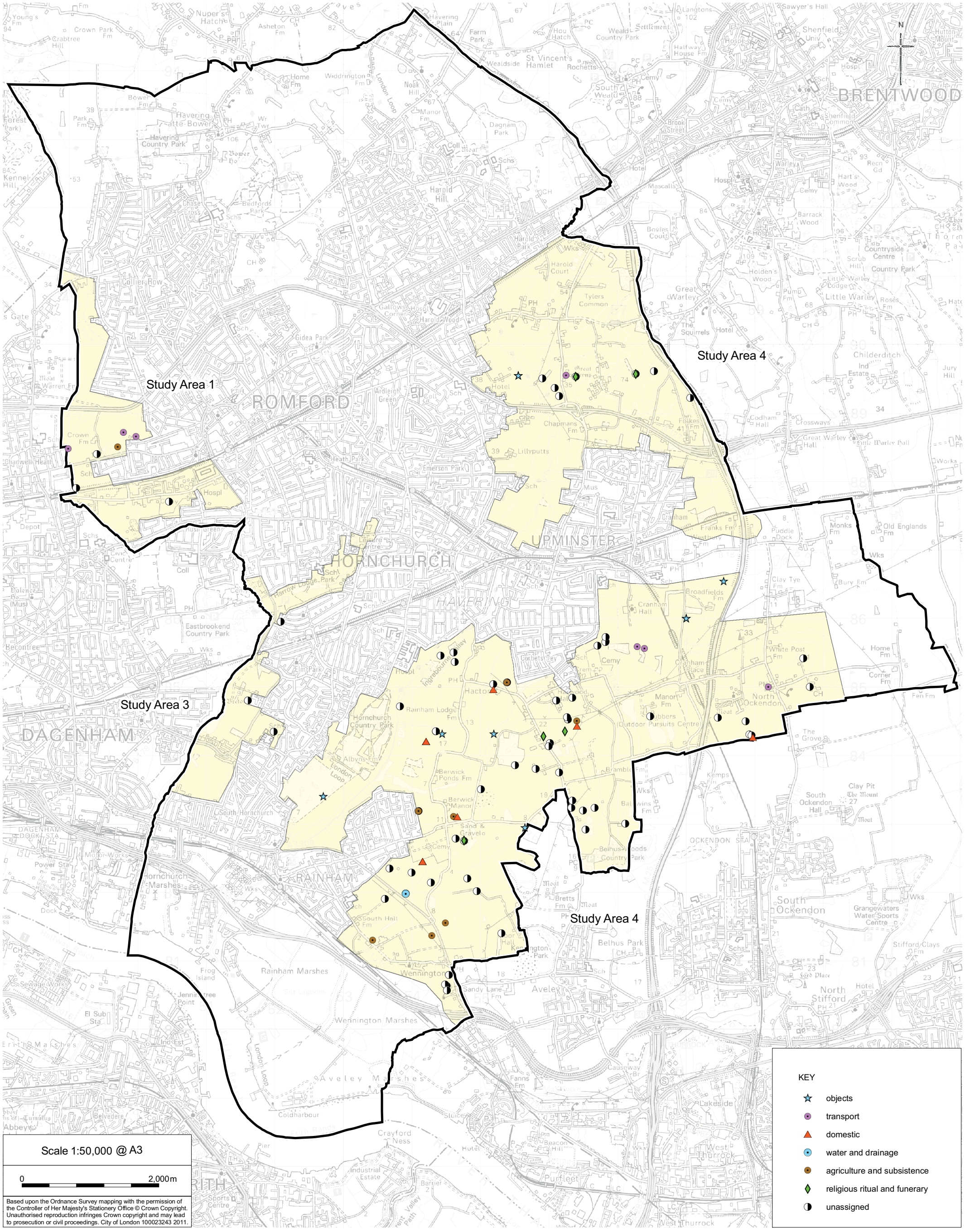

Fig 17 Undated assets