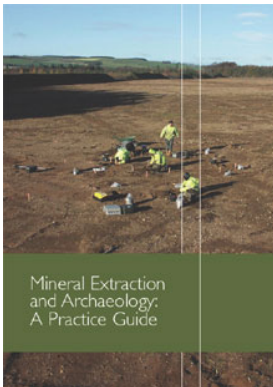




Historic England

## Mineral Extraction and Archaeology: A Practice Guide



On 1st April 2015 the Historic Buildings and Monuments Commission for England changed its common name from English Heritage to Historic England. We are now re-branding all our documents.

Although this document refers to English Heritage, it is still the Commission's current advice and guidance and will in due course be re-branded as Historic England.

[Please see our website](#) for up to date contact information, and further advice.

We welcome feedback to help improve this document, which will be periodically revised. Please email comments to [guidance@HistoricEngland.org.uk](mailto:guidance@HistoricEngland.org.uk)

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# Mineral Extraction and Archaeology: A Practice Guide

**REVISION NOTE**

**June 2012**

On 27 March 2012, the Government published the [National Planning Policy Framework](#) (NPPF). The NPPF supersedes [Planning Policy Statement 5: Planning for the Historic Environment](#) (PPS5) (which replaced [Planning Policy Guidance 15: Planning and the Historic Environment](#) (PPG15) and [Planning Policy Guidance 16: Archaeology and Planning](#) (PPG16) in 2010); and [Planning Policy Statement 1: Delivering Sustainable Development](#), (PPS1) as Government Policy on the management of change to the Historic Environment in England.

The NPPF also supersedes [Minerals Policy Statement 1: Planning and Minerals](#) (MPS1); [Minerals Policy Statement 2: Controlling and Mitigating the Environmental Effects of Minerals Extraction in England](#) (MPS2); [Minerals Planning Guidance 2: Applications, permissions and conditions](#) (MPG2); [Minerals Planning Guidance 3: Coal Mining and Colliery Spoil Disposal](#) (MPG3); [Minerals Planning Guidance 5: Stability in surface mineral workings and tips](#) (MPG5); [Minerals Planning Guidance 7: Reclamation of minerals workings](#) (MPG7); [Minerals Planning Guidance 10: Provisions of raw material for the cement industry](#) (MPG10); [Minerals Planning Guidance 13: Guidance for peat provision in England](#) (MPG13); and [Minerals Planning Guidance 15: Provision of silica sand in England](#) (MPG15) as Government Policy on Facilitating the Sustainable Use of Minerals.

**Whilst some of the references in this document may now be out-of-date, English Heritage believes that it does still contain useful advice, guidance and case studies.**

For further enquiries, please email [policy@english-heritage.org.uk](mailto:policy@english-heritage.org.uk)

[www.english-heritage.org.uk](http://www.english-heritage.org.uk)



# Mineral Extraction and Archaeology: A Practice Guide



This document has been prepared by the Minerals and Historic Environment Forum as an aid to planning authorities, mineral planners, mineral operators, archaeologists and consultants. It provides guidance specifically for dealing with archaeological remains as part of mineral development through the planning process. The principal purpose of this Practice Guide is to provide clear and practical guidance on the archaeological evaluation of mineral development sites, particularly for the determination of individual planning applications for minerals development. It should ensure that adequate information is acquired in a cost-effective way so that an informed planning decision can be made. The guide also provides some information on the mitigation techniques that could be employed.

Government planning policy relating to archaeology and mineral extraction is set out in Mineral Policy Statement 1 (DCLG 2006a) and *Planning Policy Guidance Note 16* (DoE 1990). English Heritage's policy towards mineral extraction can be found in *Mineral Extraction and the Historic Environment* (2008a). This Practice Guide builds on the *CBI Archaeological Investigations Code of Practice* (1991) with the aim of ensuring that planning decisions are informed by investigations that are proportionate to the archaeological potential of a site, and reasonable in all other respects.

This Practice Guide deals specifically with land-based mineral extraction in England. It is confined to archaeological considerations and does not cover standing buildings for which other guidance exists. Good practice for mineral extraction and archaeology in the marine environment is dealt with elsewhere (BMAPA/EH 2003), as is a strategy for dealing with archaeology in relation to peat extraction (English Heritage 2002c).

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The guide was authored by Clive Waddington of Archaeological Research Services Ltd on behalf of the Minerals and Historic Environment Forum that includes:

Association of Local Government Archaeological Officers: England

British Aggregates Association

Confederation of British Industry Minerals Group

English Heritage

Institute of Field Archaeologists

Mining Association of the UK

Planning Officers Society

Quarry Products Association

Standing Committee of Archaeological Unit Managers

The Practice Guide carries the endorsement of all the organisations represented on the Forum and each is committed to promoting the practices it contains. The Forum continues to meet to discuss issues relating to archaeological practice and mineral extraction and promote good practice. It can be contacted by writing to the address below.

The Minerals and Historic Environment Forum  
c/o The Executive Secretary  
CBI Minerals Group  
Centre Point  
103 New Oxford Street  
London  
WC1A 1DU

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## INTRODUCTION

**1** The primary aim of this Practice Guide is to assist local planning authorities, mineral planning authorities, mineral planners, mineral operators, archaeologists and consultants in delivering a consistent, proportionate, evidence-based approach to archaeological investigation and mitigation by providing technical information and the basis for structured dialogue. It will assist in identifying and applying the most appropriate techniques to gather the information necessary for the discharge of the various stakeholder roles within the land-use planning system.

**2** For the purposes of this Practice Guide the term 'archaeological remains' encompasses those elements of the historic environment that include buried and above-ground remains, including anything which provides evidence of the impact of past human activity upon landscapes.

**3** There is already a strong and well-tested policy basis for this document in *Planning Policy Guidance Note 16 (PPG 16, DoE 1990)* and the range of legislation and guidance that covers the Environmental Impact Assessment process. This is supported by the CBI Archaeological Investigations Code of Practice for Mineral Operators. There has been significant development in archaeological methodology since the publication of the revised code in 1991 (CBI 1991). This new Practice Guide therefore seeks to ensure that:

- the best-informed decisions are made regarding the level of archaeological knowledge needed at each stage of the planning process
- the use of the full range of up to date and appropriate investigative techniques is considered
- there is consistency in planning authority responses, proportionate to the archaeological potential of the site and reasonable in all other respects.

**4** This document provides advice on good practice for all stakeholders, from the strategic considerations required in development frameworks, through the detailed matters involved in the development, submission and determination of individual planning applications, to the measures that are used when development takes place. Five principles set out in the following section were agreed as the basis for producing this guidance.

**1** The Goverseth china clay refinery, Cornwall. The pits and waste dumps are accompanied by substantial processing infrastructure. The startling turquoise colour is the mica in the settling tanks. © Cornwall County Council

**2** Large plant is required for mineral extraction and this makes health and safety an important

priority for archaeologists carrying out work at extraction sites.

© Aggregate Industries

**3** This Mammoth tusk, dating from the last Ice Age, was discovered in sand and gravel at Girton Quarry, Nottinghamshire, and can be seen at Nottingham Natural History Museum. © Tarmac Ltd



## AGREED BASIS FOR THE GUIDE

5 The Forum agrees that:

- A steady, adequate and sustainable supply of minerals is essential to the nation's prosperity, infrastructure and quality of life.
- Minerals are finite and irreplaceable resources that can only be worked where they occur. Proposals for the extraction of those resources will only proceed if the minerals operator considers the commercial risk acceptable.
- Archaeological remains are a finite and irreplaceable resource that may occur anywhere. In many cases they are highly fragile and vulnerable to damage and destruction.
- Archaeological resources are not all equal in value; those of international or national importance require the highest level of protection from competing development. Equally, few archaeological resources are without value and this can sometimes only be established by investigation.
- It is the role of the planning system to reconcile the needs of the historic environment and minerals development in the context of sustainable development.

These points are explained more fully below.

### ***A steady, adequate and sustainable supply of minerals is essential***

6 'Minerals are essential to the nation's prosperity and quality of life, not least in helping to create and develop sustainable communities. It is essential that there is an adequate and steady supply of material to provide the infrastructure, buildings and goods that society, industry and the economy needs but that this provision is made in accordance with the principles of sustainable development', *Minerals Policy Statement 1*, paragraph 1 (MPS1, DCLG 2006a).

### ***Minerals are finite and irreplaceable resources***

7 Mineral extraction can only occur where viable minerals are found. In that respect it is different from most other forms of development in that the scope for

considering alternative locations is limited by geology. This is especially true in the case of less abundant minerals such as coal, industrial minerals, silica sand and distinctive building stone which themselves may be locally, regionally or nationally important. What is often forgotten is that although recyclable, primary minerals are finite and irreplaceable; in the context of sustainability, it is essential to secure their prudent and efficient use and to prevent needless sterilisation of mineral resources.

### ***Archaeological remains are a finite and irreplaceable resource***

8 The removal of archaeological remains is an irreversible process; once they have been removed they can never be replaced. Humans have occupied England from as far back as 700,000 years ago, and continuously since the last Ice Age around 13,000 years ago. Evidence of human activity can be recognised in different forms and at different scales, ranging from the very local to whole landscapes. Between areas, however, there can be large variations in the number and type of archaeological remains. There is also likely to be a relationship between the origin and age of a landform, the history of its subsequent use by people, the likely characteristics of any archaeological remains and the probability of them surviving.

9 For example, remains are often abundant on sand and gravel terraces. This is because these areas are typically free-draining and fertile, and were consequently favoured as locations for Neolithic monuments, later prehistoric and Roman settlements and field systems and Anglo-Saxon settlements. In hard-rock areas with little or no drift cover, the archaeological associations may be different, typically comprising upstanding stone cairns, standing stones, house platforms, field systems, prehistoric rock art, rock shelters, cave sites and artefact scatters. Another important relationship between a landform and its archaeological potential is the occurrence of Palaeolithic material – typically flint tools and faunal remains, such as mammoth bones – within sand and gravel deposits themselves. The likelihood of encountering such remains depends on both the age of the landform unit and the circumstances of its deposition. In some cases monitoring of archaeologically sensitive deposits may form an important part of a mitigation strategy, although the *in situ* preservation of such Palaeolithic remains will rarely be practical or justified.

**10** The planning system relies on the overview and insight of local authority archaeological curators to guide the archaeological aspects of the Local Development Framework (see below) as well as all subsequent stages in the planning process. The curator responsible for providing advice to local and mineral planning authorities can be expected to have an in-depth knowledge of the area – which means that delivery of that advice needs to be appropriately resourced. Both the planning authority and developers should look to the curator to identify those areas that have archaeological potential, and in turn to recommend how that potential should be assessed. This is best achieved if all the parties agree to enter into a structured dialogue from the earliest stages of an application. The local authority archaeological curator should be regarded as the focal point in all arrangements for archaeological work on individual development sites. In submitting a planning application the developer must satisfy the planning authority that the impact and mitigation of the development on any potential archaeological remains have been properly considered. The application must define the character and extent of any such remains to indicate the weight that should be given to determining whether or not they should be preserved (see *PPG 16* paragraphs 21-22).

**11** Provided that sufficient archaeological, landscape, geological and geomorphological information is available, it should be possible to identify the type of archaeological remains that are likely to be present and the particular approaches that should be most applicable for investigating and managing them.

#### ***Archaeological resources are not all equal in value***

**12** In addition to predicting the types of archaeological remains that are likely to be encountered, it is equally important to take into account their likely importance when assessing the archaeological potential of sites and areas.

**13** Where sites are internationally recognised or ‘scheduled’ under Ancient Monuments legislation, their importance will be clear. *PPG 16* (DoE 1990) includes a presumption in favour of the preservation *in situ* of nationally important remains and their settings, whether scheduled or not. It is important to bear in mind that sites do not have to be formally scheduled to be of national importance. A set of criteria that may be used to assess national importance is contained within Annex 4 of *PPG 16*, although these should not be regarded as definitive. Rather, they are indicators that contribute

to a wider judgment based on the individual circumstances of a case consistent with the content of *Minerals Policy Statement 1* (DCLG 2006a).

**14** In areas where remains are relatively abundant and well understood, a new find of a similar nature may or may not add significantly to overall knowledge. However, something unique or special to that particular environment could be of much greater value. An assessment of importance will always have to be based on the merits of the particular site or landscape in question. Regional archaeological research frameworks for the historic environment, most of which are now available in published form or via the archaeological curator, set out the key research priorities for each English region in addition to existing national period research frameworks and regional reviews of environmental archaeology. Assessments of importance should relate back to these and any other current national, sub-regional or local research strategies or policies.

#### ***It is the role of the planning system to reconcile the needs of the historic environment and minerals development***

**15** Government planning policy (eg *Minerals Policy Statement 1* (DCLG 2006a) and *Mineral Planning Guidance Notes* for coal, cement, peat and restoration (ODPM 1999 b-e) and planning guidance (*PPG 16*, DoE 1990), the latter underpinned by the voluntary agreement embodied in the *CBI Code of Practice for Mineral Operators* (CBI 1991), provide an ordered framework, based on a phased approach, for considering archaeological issues in relation to mineral working.

**16** It is the government view that the key to the future of the great majority of archaeological sites and landscapes lies with local authorities, acting within the framework set by central government in their role as planning and mineral planning authorities.

**17** Local planning authorities are required to produce Local Development Frameworks (LDFs) to provide strategic ‘spatial plans’ for their areas and to guide decisions about individual planning applications. Where these relate specifically to planning for minerals, they are often referred to as Minerals Development Frameworks (MDFs). An area should not be allocated for mineral development in a LDF unless the mineral planning authority is satisfied in principle that mineral working could occur. The LDF should provide general guidance about the information needed to support a planning

**4** Dix Quarry, Stanton Harcourt, Oxfordshire: archaeologists excavate remains of mammoths and stone tools dating back to a previously unknown warm interglacial episode 200,000 years ago. © Hanson Aggregates



**5**



**5** Excavation of a prehistoric pit alignment at Barrow upon Trent, Derbyshire. © Trent & Peak Archaeology

application. Whenever possible, it should also alert prospective developers to any archaeological issues that will need to be addressed in respect of allocated sites. Areas of higher and lower archaeological potential should normally be defined within the LDF to ensure that planning authorities give appropriate consideration to archaeology when identifying future working areas. The better the quality of the information available, the greater the certainty with which those locations may be identified and the lower the potential risks to all parties and to the archaeological resource. Planning authorities should consult local authority archaeological curators to ensure they are provided with the information and advice needed to inform and underpin the LDF. Further advice on the archaeological input to LDFs is included in the relevant section below (paras 24–29).

**18** Early identification of the potential impacts of a proposed development is a key element in working towards the goal of achieving sustainable minerals development and appropriate treatment of archaeological remains. Applicants are strongly recommended to engage in pre-application discussions as a way of helping them to formulate their proposals. Applications that are not supported by adequate information can take longer to determine, because further information will need to be provided.

**19** Sometimes the planning authority will decide that a pre-determination archaeological evaluation is needed before an informed and reasonable decision can be taken on an application. This evaluation should draw on field techniques appropriate to the landforms and types of archaeology expected. In addition, it should use Historic Landscape Character data, available from some HERs, to contextualize the site more widely into the landscape. The brief for a pre-determination programme of work should be developed by the local authority archaeological curator in discussion with the consultant or contractor acting on behalf of the developer, in accordance with the detail in paragraphs 32–37 of this Practice Guide. The programme should be consistent with best practice across the country, proportionate to the archaeological potential of the site and reasonable in all other respects. *PPG 16*, paragraph 21, states that pre-determination evaluation is ‘normally a rapid and inexpensive operation’ (relative to the overall scale of the operation) which helps to define the character and extent of the archaeological remains that exist in the area of a proposed development. The availability of this information early in the process is an important risk management tool that will give the

developer and the curator a clearer indication of the archaeological potential of the site and thereby minimise the possibility of the unexpected. In most instances, evaluations are also the key to identifying the order of costs involved in dealing with any remains. If a site is to be developed in phases over a long period of time there is merit in the developer producing a site strategy or masterplan, particularly if a number of different archaeological contractors become involved over the life of the site.

**20** An archaeological assessment of the proposed development, including the findings of any initial investigations, should be incorporated within any Environmental Impact Assessment (EIA, see paras 32–5) accompanying the planning application. Further information on the EIA process and content can be found on the websites of Planarch and the EIA Centre. The developer should be prepared for the planning authority to ask for additional investigation in the light of information gathered by the initial work. This is entirely reasonable, provided that it is consistent with the requirements set out in paragraph 19 above and PPG 16 paragraph 21.

**21** If planning permission is granted, this may be subject to further archaeological work being undertaken or a requirement to preserve *in situ* remains identified during pre-determination evaluation. Further details of measures that can be specified through planning conditions and other obligations are contained in the section on Post-Permission Mitigation Measures (paras 38–44).

**6** Hunterhugh Craggs, Northumberland: after quarrying of rock outcrops in the early Bronze Age this carving was made on the new surface. © Archaeological Research Services Ltd

**7** Cheviot Quarry, Northumberland: archaeologists excavating the interior of a

Bronze Age roundhouse that was accurately dated to the 10th century BC. © Archaeological Research Services Ltd

**8** View towards the visitor centre and wetlands at Attenborough Quarry, Beeston, Nottinghamshire, where much of the site has been restored and is actively used by community groups. © Tim Cooper, Arcus



## THE PLANNING PROCESS

### Overview

**22** The policies and proposals that are the basis of the Development Plan are contained in the Regional Spatial Strategy and Local Development Frameworks appropriate to that area (which may, in the case of those documents specific to minerals, be referred to as Mineral Development Frameworks or MDFs). All planning applications must be determined in accordance with the Development Plan unless material considerations indicate otherwise. Consequently it is essential that the best available archaeological information is used when the LDFs are being drafted and consulted upon. In particular, at the LDF stage the planning authority should seek archaeological input from local authority archaeological curators that will assist in identifying areas of potential archaeological sensitivity. If appropriate policy provision is not made when a LDF is drafted it makes protection of archaeological interests much more difficult later, when individual planning applications are considered. The development of the archaeological components of LDFs is primarily a role for local authorities to undertake, although mineral operators may assist.

**23** At all phases, provision for archaeological work should follow a question-led approach in which clear research goals are linked, wherever possible, to local, regional and national research agendas. At the pre-determination stage, however, questions may initially relate to more basic concerns such as the character, date and extent of archaeological remains to provide information on their relative importance. Later on it is particularly important that any programme of work is linked to regional research frameworks for the historic environment, and any other local research strategies or policies. The responsibility for this is shared between the archaeological curator, consultant and contractor. Any programme of archaeological work will need to be agreed by the local authority archaeological curator and approved by the mineral planning authority in advance of commencement.

### Local Development Frameworks

**24** A new system for producing development plans was introduced in 2004. The principal policies against which minerals planning applications are considered are now contained in the LDF (or MDF) in place of the old Minerals Local Plans. LDFs and MDFs are in turn made up of a series of Local Development Documents (LDDs) that address specific aspects of land use planning

for their area. Further detail on LDDs can be found in PPS12 and the accompanying Practice Guide (ODPM 2004).

**25** An important part of the new system is improved stakeholder and public engagement in development plan preparation. Archaeological curators as key stakeholders should seek to ensure that they are involved in the preparation of LDDs so that archaeological interests are addressed. The planning authority should take account of the advice provided by curators in drafting policies and proposals for the LDD. Ideally, areas of known archaeological potential should be flagged and considered in the LDD and, if possible, mapped, drawing on the best possible data available at the time. Paragraph 15 of *PPG 16* (DoE 1990) states that 'development plans should include policies for the protection, enhancement and preservation of sites of archaeological interest and of their settings. The proposals map should define the areas and sites to which the policies and proposals apply'. However, it must be recognised that archaeological knowledge of an area may not be comprehensive. By identifying areas of known potential at the earliest opportunity the risks to archaeological assets, mineral operators and planning authorities are reduced. To ensure effective consideration of archaeological interests in the LDDs, it is important that archaeological curators have an in-depth knowledge and understanding of the local and regional archaeology and are appropriately resourced and supported to deliver archaeological advice.

**26** Table 1 summarises the input to the LDDs required of archaeological curators. Flagging of archaeologically sensitive areas within LDDs is vital to protecting archaeological interests and safeguarding developers from proceeding with expensive applications for sites that later present significant risks in relation to archaeological interests. Mapping at the LDD stage can often be broad-brush, however, and the developer should therefore seek early advice from the archaeological curator.

**27** A useful way of providing high quality data to underpin archaeological provision within a LDD is to map landform units and then overlay them with archaeological data sets derived from such sources as aerial photographs and geophysical survey. Sometimes referred to as a 'resource assessment exercise', this approach, digitally integrated into an Historic Environment Record (HER, also known as the Sites and Monuments Record or SMR), allows areas of

PHASE	ACTIONS FOR ARCHAEOLOGICAL CURATORS
<b>I</b> Issues and Options	Seek to ensure all issues associated with archaeology are brought to the attention of the Mineral Planning Authority (MPA) through early dialogue. The MPA should ensure that no proposals are put forward that would have an unacceptable impact on archaeological interests.
<b>2</b> Preferred Options	Respond to the MPA's consultation making it clear which proposals would have an impact upon archaeological interests that would be contrary to national or regional or local policy. Where possible, put forward suggestions/alternatives for consideration which would remedy the situation.
<b>3</b> Submission	Respond to the consultation noting if any of the submitted proposals are 'unsound', ie that they do not pass one or more of the 'tests of soundness' set out in PPS12. Where possible, put forward suggestions that would make the policy or proposal sound from an archaeological perspective.
<b>4</b> Sustainability Appraisal (integral to each of the phases set out above)	The MPA should ensure that it seeks the archaeological curator's advice to ensure the appraisal has parameters that include the historic environment.

**Table 1:** Archaeological input to the Local Development Documents.

archaeological potential as well as the age of different landforms to be explicitly identified in well-surveyed areas and to be inferred in others. Given that aerial photography works better over some soils and types of geology than others, additional data from techniques such as geophysical survey and fieldwalking can be added to such digital maps. Research has shown that there is a direct link between certain types of landform and kinds

**9** Aggregate extraction occurs in different ways. For example, here blast-hole drilling is taking place at Tunstead limestone quarry, Derbyshire. © Tarmac Ltd

**10** A restored whinstone quarry that will be brought into public access at Howick, Northumberland. © Archaeological Research Services Ltd

**11** The screening and scoping phases provide an opportunity to flag the potential archaeological impacts of a mineral development at the earliest stages of its planning. © Archaeological Research Services Ltd



**12** St Keverne, Cornwall: this road-stone and aggregate quarry dug into the cliffs on the Lizard peninsula has its own jetty and road access. The surrounding field boundaries are prehistoric in origin. © Cornwall County Council

**13** This late 19th-century granite quarry on Bodmin Moor is an historic monument in its own right.

In reworking the quarry, care needs to be taken to conserve the shape and character of the 'finger' dumps that are typical of the contemporary tramming of waste. © Cornwall County Council

**14** View over Dowlow and Hindlow quarries, Derbyshire, on the Carboniferous Limestone plateau. © English Heritage.NMR



of archaeological and environmental remains (eg Bishop 1994, Passmore *et al* 2002, Knight and Howard 2004, Waddington and Passmore 2006). In some instances landforms, such as alluvial terraces, may overlie older sediments that contain earlier remains. Different landforms present different opportunities for the preservation and evaluation of archaeological and palaeoenvironmental remains. Understanding these differences can enable identification of areas of higher and lower sensitivity, which means in turn that the response to proposed developments can take this into account. Another useful predictive tool is the Historic Landscape Characterisation (HLC) data maintained by some HERs, although its value will depend on the scale at which the HLC data has been mapped.

**28** Easily accessible high quality map-based data allows all stakeholders involved in mineral extraction to base their decision-making, strategic planning and mitigation strategies on the same set of information. However, this kind of mapped evidence requires informed interpretation by the archaeological curator before areas of archaeological potential can be securely linked to relevant policies within the LDD. For that reason it is essential to consult the local authority archaeological curator before any development proposals are drawn up.

### Planning applications

**29** Table 2 summarises the archaeological input required during each phase of the planning application process. Any programme of work needs to be agreed in advance with the archaeological curator.

### Screening

**30** Seeking a 'screening opinion' from the local Mineral Planning Authority (MPA) is optional for the prospective developer, but nevertheless forms part of the statutory process. If one is sought then the local authority must provide a response. It is important, therefore, that the local authority has sufficient information available to give one within the prescribed time limit. It is advantageous for the MPA to consult the archaeological curator at this stage, if not before, to ensure that any issues of concern are raised before a screening opinion is issued. Certain types and scales of mineral development will require an Environmental Impact Assessment (EIA), together with an Environmental Statement (ES) that details its results (for further definitions of the EIA and ES see paragraph 32 below). The Town and Country Planning Regulations (DETR 1999f) and Circular 02/99 (DETR 1999a) set out the circumstances when planning applications require an EIA. The information contained in an ES will be taken

PLANNING PHASE	ARCHAEOLOGICAL INPUTS
<b>1</b> Screening	Screening is a formal process which determines whether or not a planning application should be accompanied by an EIA (in most cases minerals extraction applicants will submit one). A 'screening opinion' must be provided by the planning authority if this is requested by the applicant. It is advantageous for the MPA to consult archaeological curators as part of this phase.
<b>2</b> Scoping	This is the process of determining what should be included in the EIA. Scoping will invariably identify: the need for an environmental statement on the historic environment, the elements which need to be considered (eg buried remains, earthworks, palaeoenvironmental remains, historic landscape character etc), appropriate methods for assessing the potential impacts of development, and the proposed mitigation measures. Archaeological curators should be consulted by the MPA and the mineral developer.
<b>3</b> Pre-determination and EIA	The EIA process must be completed before submission of the planning application. During this phase a range of techniques should be used to collect sufficient data to identify the significant archaeological effects of the development, as well any consequent mitigation measures that may need to be designed. The starting point for the historic environment component of the EIA is typically a desk-based assessment, from which other pre-determination measures may follow.

	The chosen investigative techniques should meet clearly defined archaeological objectives and be suited to the nature of the landform and the type of archaeology anticipated. Archaeological curators should be consulted by the MPA and the mineral developer.
<b>4</b> Determination	At this stage a decision is taken on whether the development is to be approved, and what planning conditions or obligations in relation to the historic environment should be attached. The MPA should obtain advice from the archaeological curator before coming to a decision.
<b>5</b> Post-determination measures	The measures taken at this stage could range from no further work being required, through excavation and recording (including specialist analysis, publication and archiving), to preservation <i>in situ</i> of archaeological remains. The archaeological curator has the role of monitoring any archaeological mitigation works.

**Table 2:** Archaeological input to the planning application process.

into account in determining the proposal. If applicants consider that their proposals are likely to require an EIA they should seek guidance at the screening stage on the need for an EIA (ie a 'screening opinion'). All submitted planning applications will be screened and applicants advised if an ES is required, if not already submitted.

### Scoping

**31** Before making a planning application, a developer may ask the planning authority for its formal opinion on the information to be supplied in the Environmental Statement (a 'scoping opinion'). This allows the developer to be clear about what the planning authority considers the main effects of the development are likely to be and therefore the topics on which the ES should focus. The planning authority should consult its archaeological curator at this stage to ensure that any issues of concern are raised at the earliest opportunity. Even if consultation

**15** An effective mitigation programme will ensure that archaeological remains are properly recorded so that the resulting information can enhance our understanding of the past, as in the case of the Neolithic material discovered here at Cheviot Quarry, Northumberland. © *Tarmac Ltd*

**16** Excavation of a Roman corn-drying kiln at Denham, Buckinghamshire. © *Buckinghamshire County Council*



of the HER shows that no archaeological remains are known from the application site, this does not necessarily mean that it is without significant archaeological potential. English Heritage may be a statutory consultee in certain circumstances. *PPG 16* (DoE 1990) states that early consultation with historic environment curators is highly desirable as a means of agreeing the methods to be used in all archaeological work beyond the scoping stage. The key questions that should be asked at this stage are what are the likely archaeological impacts and how can these be mitigated?

### **Environmental Impact Assessment and pre-determination measures**

**32** If the scoping process has identified archaeological issues, archaeological investigation should be included as part of an Environmental Impact Assessment (EIA) in order to assess what impacts need to be addressed and how they can be mitigated. The historic environment is an important consideration in any EIA. The basic structure of the EIA process as defined by the European Union Directive (85/337/EC updated 1997) has been incorporated very closely into UK legislation through a series of regulations or 'statutory instruments'. Environmental Impact Assessment (EIA) is a procedure that ensures that the environmental consequences of certain projects are identified and assessed before any authorisation, such as a planning permission, is given. Proposals that must be subject to EIA are those which are likely to have significant effects on the environment by virtue of their nature, size or location. In practice most planning applications for mineral extraction will require an EIA. The term 'Environmental Statement' (ES) is often used to refer to the key document that results from the EIA information-gathering process. The preparation of the ES is often the point at which the pre-determination stage is formalised and this is where a mineral developer's responsibilities formally commence.

**33** A useful set of guiding principles is set out in PLANARCH 2. PLANARCH is a partnership established to further the integration of archaeology within the planning process in North West Europe. PLANARCH 2 identified good archaeological practice based on experience of EIA implementation across parts of the EU. The operational principles are intended to provide a rigorous, robust and reasonable framework for ensuring that the historic environment is appropriately treated in the EIA process. They have been arrived at following a review of current practice across parts of England and North West Europe as part of the PLANARCH project.

TECHNIQUE	LOCAL DEVELOPMENT FRAMEWORK	PRE-DETERMINATION	POST-DETERMINATION	POST-EXCAVATION AND DISSEMINATION
Aerial photograph transcription	•••••	•••		
Archaeological survey		•••	••••	
Desk-based assessment		•••••		
Evaluation trenching		•••••	••	
Excavation		•	••••	
Fieldwalking		•••	••	
Geomorphological mapping	••••	•••••		
Geophysical survey		••		
Palaeoenvironmental analysis		•	•••	
Post-excavation, archive and dissemination				•••••
Sediment coring		••	•••	
Strip, map and sample			•••••	
Test pits		••	••	
Watching brief			••••	

**Table 3:** Relative frequency with which archaeological techniques are used at different phases of the planning process.

**34** No single technique exists that can identify all archaeological remains. There is a range of established techniques that is used to evaluate and record archaeological and palaeoenvironmental deposits (see Techniques section below). Some of these allow the detection of sites (eg aerial photography, fieldwalking, geophysics) while others are used to make a more detailed record of structures and deposits (eg surveying and test pits). Evaluating an area deemed to be archaeologically sensitive usually requires a combination of techniques appropriate to the type of landform and potential archaeology that may be encountered. For example, linear evaluation trenches are generally effective for finding continuous features such as field systems, enclosures, forts or large ring ditches (Hey and Lacey 2001, 59). Conversely, they are poorly suited to finding dispersed, small or non-continuous remains such as post-built buildings, pits or hearths. The quality of pre-determination archaeological information required for proposed mineral developments is a significant consideration for developers and curators because there is usually limited potential for amending permissions to take account of nationally important archaeological remains should these be found post-determination.

**35** Evaluation of the historic environment component of a proposed development site is undertaken incrementally using an appropriate selection of the techniques set out in Table 3 and based on effective dialogue between the developer and curator. The first piece of pre-determination work is usually the desk-based assessment. This is a crucial task and it is in the interests of the mineral operator and local authority that it is undertaken by an appropriately qualified and experienced archaeologist. A good desk-based assessment is a cost-effective investment that will reduce risk, whereas a poor assessment can lead to unexpected costs and delay. For certain types of mineral workings it is also important to consider the impact of any enabling works (eg access roads, processing plants etc), the potential for subterranean remains (eg old mine workings) as well as potential Palaeolithic remains within the mineral body itself. Any programme of pre-determination archaeological works should be agreed with the archaeological curator and approved by the mineral planning authority in advance of commencement.

KEY PRE-DETERMINATION TECHNIQUES	WHAT CAN IT DELIVER?
Aerial photograph transcription	Useful for discovering large sites.
Archaeological survey	This may take the form of a topographic survey of upstanding features, a contour survey or rapid walkover survey to identify any surviving upstanding features.
Desk-based assessment	In-depth synthesis of existing data and prediction of the type of archaeological remains that could be expected to occur, or be impacted upon.
Evaluation trenching	Invasive technique that allows the extent and character of sub-surface remains to be identified and assessed.
Fieldwalking	Rapid coverage over large ploughed areas virtually the only technique that provides a record of remains within the overburden of a site.
Geomorphological mapping	Establishes the nature and extent of landforms and the associations they may have with particular types of archaeological remains.
Geophysical survey	Rapid coverage over large areas noting the potential presence of buried archaeological remains.
Sediment coring	Rapid assessment of the existence of buried sites, buried land surfaces and organic deposits that may hold palaeoenvironmental information.
Test pits	As evaluation trenching but on smaller scale. Can also link field-walking data with buried features and record archaeological remains surviving in the overburden.

**Table 4:** Contributions of the archaeological techniques typically used at the pre-determination stage to establish the importance of archaeological remains.

## Determination

**36** Following one or more stages of pre-determination works, an informed decision is made by the planning authority to grant or refuse planning permission. If permission is granted, appropriate planning conditions or obligations, such as Section 106 agreements, will be applied. Permission may be granted subject to a range of conditions. Examples could include further evaluation work, full archaeological recording or, on some occasions, the preservation *in situ* of nationally important remains identified during the pre-determination evaluation stage. On occasions no further action may be required other than the analysis and dissemination of results to date (for an example of model conditions see *PPG 16* paragraph 30 (DoE 1990) and DoE Circular 11/95). It is a key principle of *PPG 16* that there should be a presumption in favour of preservation *in situ* of nationally important remains and their settings, whether scheduled or not. In addressing the latter consideration the developer and curator also need to give consideration to the character of the surrounding historic landscape. In some cases preservation *in situ* may be beneficial for both the protection of the archaeology and the developer, as the latter does not have to bear the cost of full excavation. Preservation *in situ* may be appropriate for other remains that are considered to be of sufficient importance.

**37** The criteria for assessing whether archaeological remains are of national importance are set out in Annex 4 of *PPG 16* (DoE 1990) together with an additional criterion identified by English Heritage as 'amenity value'. The amenity value of a monument is assessed in terms of its visibility and its physical and intellectual accessibility. These criteria are currently under review and further guidance can be expected. Other factors that should be considered are the state of preservation of the archaeological remains and the potential for survival beneath the surface. Because all sites are unique, weighing up the significance of archaeological remains requires professional judgement.

## Post-permission mitigation measures

**38** Official guidance states that planning conditions, including those for post-permission archaeological measures, should only be imposed where they satisfy all of the following tests. In brief, all archaeological conditions at any stage in the planning process should be:

KEY POST-DETERMINATION TECHNIQUES	WHAT CAN IT DELIVER?
Archaeological survey	This may take the form of a topographic survey of upstanding features, a contour survey or rapid walkover survey to identify any surviving features with surface expression.
Excavation	Full recording and/or sampling of archaeological remains over large or small areas before removal.
Monitoring	This may include an archaeologist visiting an extraction site on a regular basis when extraction is taking place to monitor sediment or rock sections in order to identify and record archaeological features that may be revealed.
Palaeo-environmental analysis	Reconstructs past human use of the environment through a variety of methods that include sampling organic sediments for pollen, seeds, charred or waterlogged wood, and indicator species such as beetles, snails or other organisms.
Strip, map and sample	Stripping the site to reveal the entire archaeological remains within a development area, planning them and then selectively sampling to provide information sufficient to interpret the site adequately.
Watching brief	Ensures archaeological monitoring (and recording if necessary) over a given area as it is stripped back under close archaeological supervision.

- necessary
- relevant to planning
- relevant to the development to be permitted
- enforceable
- precise
- reasonable in all other respects

Any programme of post-permission archaeological works should be discussed and agreed with the archaeological curator in advance of commencement. Such a requirement usually appears as part of an archaeological condition.

**39** Archaeological mitigation measures range from no further work, through full excavation to preservation *in situ* of archaeological remains. Typically they lie somewhere between two ends of the spectrum and involve a combination of preservation, excavation (ie recording) and perhaps long-term monitoring (see Table 5). Because the choice of mitigation measures requires a long-term perspective, due consideration should be given to ensuring that mitigation solutions are sustainable over the long term. In some cases this means that archaeological remains will be protected through 'preservation by design'. For example, if ground water levels need to be altered, this work will be designed in a way that prevents any waterlogged archaeological remains from drying out and thus being destroyed. Where remains are preserved *in situ* there may be a need for long-term monitoring, and possible provision for further mitigation if preservation conditions deteriorate.

**40** A key part of post-permission mitigation is the assessment, analysis, archiving and dissemination of information – sometimes referred to as the 'post-excavation stage' (Table 6). It is not only essential that such work is factored into the cost of post-permission mitigation but also that its level and scope is agreed with the archaeological curator shortly after the fieldwork is complete. Later on there may be significant opportunities for developers to use interpretative, educational and outreach initiatives to engage with the wider community and gain recognition for their investment in the archaeological heritage.

**Table 5:** Contributions of the archaeological techniques that are most typically used in the post-determination stage.

TYPICAL POST-EXCAVATION WORK	WHAT CAN IT DELIVER?
Primary archive	This includes a stratigraphy report detailing all archaeological features and contexts and relating them to their stratigraphic sequence and any relationships between features as well as illustrations, photographs of the small finds and environmental samples and their accompanying registers.
Assessment	After the primary or site archive is compiled certain categories of material that may provide further information are rapidly assessed to see whether they merit a full analysis. For example, common finds that are assessed are pottery, flint tools, metalwork, skeletal remains, environmental samples and material that could be radiocarbon dated. Selected samples may be dated to provide spot-dates on key deposits.
Analysis	If, after assessment, any material is considered appropriate for further analysis then a more-thorough analysis of the material takes place. This could include, for example, the acquisition of radiocarbon dates, a report on the pottery assemblage or report on the environmental remains from a site.
Report Production	Once the primary archive has been assembled and any assessments and analyses are complete a final integrated report is produced that should synthesise and interpret the archaeological remains.

Archive	This includes the archiving and mounting of photographs and transparencies, the conservation and appropriate storage of small finds and the paper site archive. These should then be deposited with an appropriate institution. The digital archive is normally submitted to the on-line database of archaeological sites (OASIS).
Dissemination	This may take a range of forms from a published academic paper or monograph to newspaper and magazine articles, public talks, television and radio programmes, other media coverage, information panels, open days, school visits or school packs, leaflets, guided walks and so forth.

**Table 6:** Contributions of the key components of the post-excavation, archive and dissemination phase.

**41** Restoration is a key element of mineral extraction and one that has been carried out to good effect on many sites, thereby improving the landscape and the quality of life of local communities. It is important that plans for quarry restoration are in keeping with the historic landscape character of the site's surroundings. In practice this has to be reconciled with a wider range of interests that may also include biodiversity, geodiversity and recreation.

## TECHNIQUES

**42** The range of archaeological techniques described below is not exhaustive, but simply provides an overview of the more-commonly employed methods. For convenience they are described in alphabetical order rather than in the sequence in which they will typically be employed in the planning process. The effectiveness of different archaeological techniques depends on the type of landform on which they are being used, the type and period of archaeology they are trying to locate or record, and in some cases even the time of year they are used. No single technique can provide all the information and it is therefore in the interests of both the developer and the local authority archaeological curator to agree a suite of techniques suited to the particular needs of the site under investigation.

**43** The post-excavation stage of any programme of work is an important consideration and should include provision for the assessment, analysis, archiving and dissemination of the results including, where possible, to the general public. The contribution by the developer should be accorded due recognition wherever appropriate. A section on the post-excavation phase is included below.

**44** When employing any archaeological technique, appropriate technical standards and guidance must be followed, including those set out by the Institute of Field Archaeologists (IFA) and English Heritage as well as other guidance specific to the region or technique.

**45** In the following overviews reference is made to the relative costs of each technique. These comments are intended only as a guide to help provide a broad indication of the cost of the various techniques relative to each other. It must be borne in mind, however, that this will always be proportionate to the scale and complexity of the site in question. In terms of risk management more expensive techniques that provide good quality information can sometimes be more cost effective in the long run than cheaper but less reliable ones that introduce a higher element of risk.

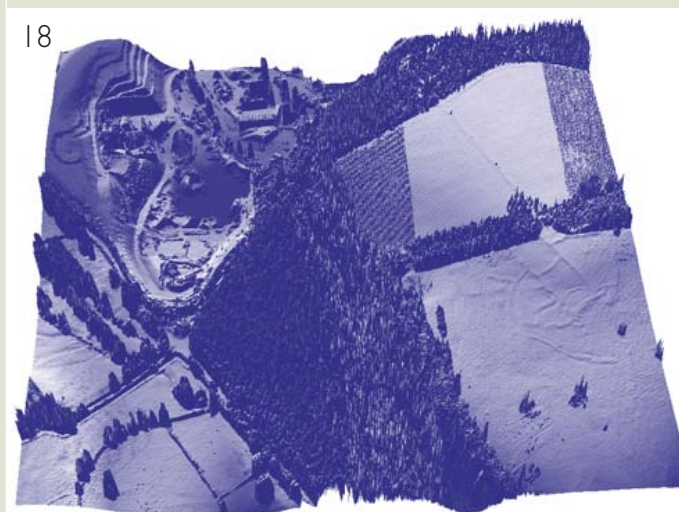
### Aerial photography

**46** Over the past hundred years, aerial photography has proved to be a very effective tool for discovering archaeological sites, although its effectiveness depends on the local geology, soil and land-use regime. Large collections of aerial photographs, taken both for archaeological and non-archaeological purposes, are available for study and provide a rich source of valuable information.

**17** Cropmarks of ring ditches belonging to previously upstanding Bronze Age barrows in a field adjacent to flooded gravel pits near West Deeping, Cambridgeshire. © English Heritage.NMR



**18** A LiDAR image showing part of a Romano-British field system (right) near Halecombe Quarry, Somerset. Cambridge University Unit for Landscape Modelling. © English Heritage



**19** Surveying of the principal crushing mill at Hilton and Murton lead mines, Scordale, Cumbria. © English Heritage



**47** Aerial photography can reveal archaeological sites that survive as upstanding remains or earthworks, including those that are slight and difficult to observe at ground level. Sites no longer visible at the surface may be identified, under certain conditions, through differences in the growth of plants and crops. These crop marks and parch marks are usually only recognised from the air and are particularly common in drought conditions. Sites can also be recognised through soil marks, when ploughing brings parts of archaeological deposits to the surface of the field.

**48** Analysis of aerial photographs from all readily available collections should be a normal part of any desk-based assessment. The work should be undertaken by a specialist archaeological air photo interpreter who will be able to provide accurate mapping and guidance on the types of features visible and the limitations of the results. The collections of aerial photographs held by the National Monuments Record (Swindon) and the Unit for Landscape Modelling (Cambridge University) should always be consulted, as well as those available through the local planning authority. The results should be compared with available geomorphological data to identify whether apparently blank areas may be due to archaeological remains being more deeply buried and so less likely to be visible.

**49** English Heritage is undertaking a National Mapping Programme (NMP) to provide a synthetic analysis of archaeological features recorded from the air. The results from this can inform the Local Development Framework or be used in the pre-determination phase of the planning application. In the areas already completed this can provide a useful guide for planning purposes. Nevertheless it is still necessary to check whether new air photo information is available and whether more-detailed work is needed for mitigation purposes. Several aggregate resource assessment surveys have also used the NMP methodology to help strategic planning and enhance the respective HERs.

**50** Aerial photography can only partially reveal the extent and character of archaeological remains. New techniques such as airborne laser scanning (LiDAR) and multi-spectral imaging can be useful additional tools. Like geophysical survey, however, they should be treated as complementary techniques rather than be used in isolation.

**51** Aerial photography is a mid-range expense, but highly cost-effective in terms of the return that can be expected from analysis and transcription. For potential large-scale, long-term developments consideration should be given to commissioning archaeological flying at specific times of the year when the soil moisture deficit is at its maximum.

### **Archaeological survey**

**52** Traditional archaeological survey is a non-intrusive method for recording upstanding archaeological remains. It is particularly useful for understanding constructional relationships and is used on earthwork sites and those with standing buildings or masonry. Surveys can take a variety of forms: the recording of upstanding features, landscape topography and contour surveys. If upstanding remains are to be excavated it is standard practice to accurately survey the site in advance of excavation. In addition, if landscape character or the setting of a site may be disturbed by a development, then a survey of the surrounding area may be required.

**53** Surveys can often be enhanced by reference to aerial photographs that help show large features more clearly, as well as the presence of buried features. Field surveys may also be enhanced by the use of LiDAR data; depending on its resolution, this can very rapidly provide detailed contour information that can assist in picking out subtle as well as more-clearly defined features. It can be particularly useful in relation to the rapid survey of complex earthworks such as ridge and furrow ploughing, deserted medieval villages, areas of woodland and features associated with previous mineral extraction or 20th-century military installations.

**54** Walkover survey is a rapid means of assessing the upstanding archaeology and built structures of large or inaccessible areas, such as woodland. It comprises systematically walking over a given area in order to plot all features onto a base map, usually with the aid of a hand-held global positioning system (GPS).

**55** Survey is a recording technique that can be employed either pre or post-determination. It is a medium-expense technique that requires time in the field by a team of usually two or more people depending on the size of the site. It can involve the use of specialist survey equipment, GPS instruments, surveying software and drawing packages to produce scale drawings from digital output.

## Desk-based assessment

**56** A desk-based assessment (DBA) is defined by the Institute of Field Archaeologists (IFA 2001b) as 'a programme of assessment of the known or potential archaeological resource within a specified area or site'. This involves a detailed and comprehensive assessment of all the documentary evidence that can be accessed for the development site and its immediate environs. Its purpose is to allow a well-informed judgment to be made about the archaeological potential of the site and the importance of any known remains.

**57** A DBA is frequently submitted to the planning authority by the applicant in order to assist in determining the need for further archaeological investigation. Archaeological curators should be consulted at the outset as to what is required in the DBA and will advise on the specification for the work. The archaeological importance of a site is assessed against other comparable examples and is guided principally by the criteria set out in *PPG 16*.

**58** A DBA is used to 'identify the likely character, extent, quality and worth of the known or potential archaeological resource' (IFA 2001b). In doing this, the DBA will need to provide a statement of archaeological potential, which if necessary can be tested and refined by further assessment. The DBA will typically include and analyse information from a range of sources, including in the first instance the HER, together with modern and historical maps and plans of the area, the National Monuments Record (NMR), Historic Landscape Characterisation (HLC) data, aerial photograph evidence, published literature and unpublished reports, geological information, place-name evidence and any literature relating to previous investigations on or near the site.

**59** Historic Landscape Characterisation (HLC) is a technique for mapping and classifying the historic character of the landscape. Around 89 per cent of England's countryside has been characterised at a macro level by an English Heritage supported programme, although HLC may also be undertaken at a detailed level in order to address the specific requirements of the planning process. It makes use of the sources typically consulted in DBAs, but adds an historical interpretation of past and present landscape patterns. HLC is expressed via digital mapping as part of a GIS, normally supported by associated texts and databases. As well as documenting what has already been identified HLC can allow the prediction of hitherto unrecorded components

of the historic landscape, including above-ground and buried archaeological remains.

**60** Desk-based assessments are relatively inexpensive as they do not include any fieldwork other than a mandatory site visit and walkover survey (see IFA 2001b). They are undertaken during the pre-determination phase of the planning application. Because their information is crucial to the decision-making process the commissioning of a good DBA will invariably be a sound investment.

## Evaluation trenching

**61** Evaluation is a 'limited programme of non-intrusive or intrusive fieldwork which determines the presence or absence of archaeological features, structures, deposits, artefacts or ecofacts within a specified area or site' (IFA 2001d). It involves machine-stripping the overburden from trenches spaced across the development area or in targeted areas to define the nature, extent and importance of any archaeological remains. Evaluation trenching must comply with the IFA's *Standard and Guidance for Archaeological Field Evaluation* (2001d).

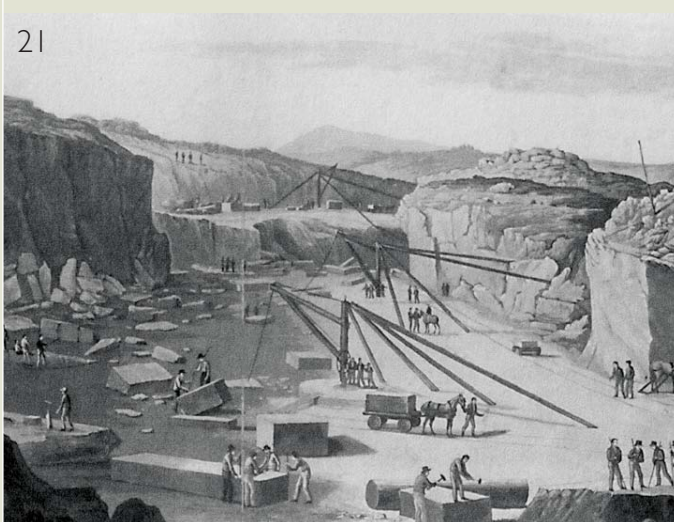
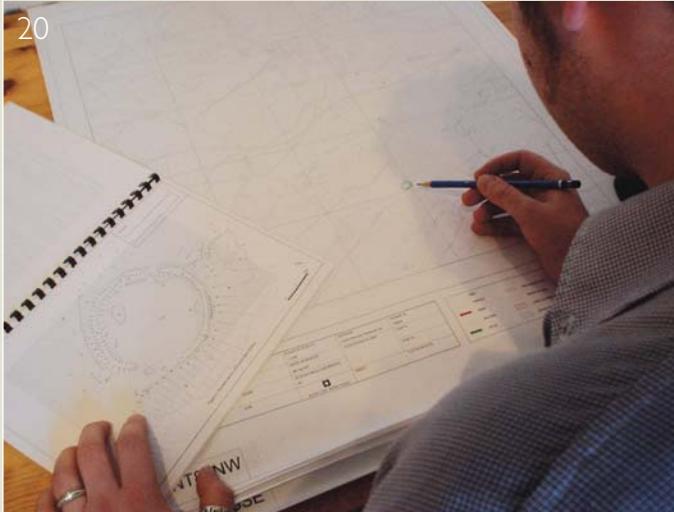
**62** Each site should be considered on its specific merits and the design of trenching should follow a question-led approach that draws on expectations of the type of archaeology that may reasonably be encountered and of its likely location. The planning authority may request a sample of the site's area and the importance of the archaeological remains within it, to be evaluated. The sample size should be reasonable and appropriate (see CBI 1991 and commentary in Hey and Lacey 2001). This is because the purpose of evaluation trenching is to identify the potential of an area and the importance of the archaeological remains within it, and not to sample excavate the site. Responsibility for ensuring appropriate levels of evaluation trenching should be shared between curators, developers, consultants and contractors. Before planning permission is granted the mineral planning authority should be able to demonstrate that all reasonable steps have been taken to ascertain that no remains worthy of *in situ* preservation will be, or are likely to be, disturbed by the proposed development.

**20** The study of previous archaeological work and the examination of old maps are classic components of a desk-based assessment. © Archaeological Research Services Ltd

**21** Information can also be acquired from examination of historic drawings such as this 1827 example showing granite

quarrying at Haytor, Devon. Devon Library Service (Westcountry Studies Library)

**22** These evaluation trenches at Broadoak Quarry, near Ebchester; County Durham, were positioned following a programme of intensive fieldwalking across the site. © Archaeological Research Services Ltd



**63** Although evaluation trenching has become a very common technique it can be more effective at finding certain types of archaeological remains than others. Depending on the results of an evaluation, the archaeological curator may decide that further investigation is necessary. Trenching will frequently be positioned to investigate known or potential remains identified using other evaluation techniques. Trenching is particularly effective at finding large structures, or linear features such as ditches, pit alignments, enclosed sites, field systems and Roman roads. It can also result in the discovery of smaller and more discrete features such as pit clusters, small post-built buildings and burials. If these latter types of archaeological remains are expected then other techniques should also be considered. Alternatively they could be dealt with through post-permission conditions. Interpreting the results from evaluation trenching is of key importance. An arc of three small post-holes in a trench may, for example, indicate the presence of a substantial settlement. It is typical for evaluation programmes to include a contingency requirement for additional or extended trenching to provide a better understanding of any remains that are identified. Combined with other evaluation techniques evaluation trenching can offer an accurate, speedy and cost-effective means of finding remains that merit preservation *in situ* and identifying other necessary mitigation measures.

**64** Trenching is a medium to high expense technique that can be very effective for locating and evaluating large sites, linear features or sites where certain types of buried archaeological remains are anticipated. It requires a combination of mechanical excavation and limited archaeological investigation followed by assessment of any archaeological and environmental remains that are revealed. It is used as part of the pre-determination phase of the planning application.

## Excavation

**65** An excavation is defined by the IFA as 'a programme of controlled, intrusive fieldwork with defined research objectives which examines, records and interprets archaeological deposits, features and structures and, as appropriate, retrieves artefacts, ecofacts and other remains within a specified area or site (IFA 2001c). All excavation must comply with the IFA's *Standard and Guidance for Archaeological Excavation* (2001c).

**66** Full archaeological excavation of a site allows for preservation by record. Although physically destructive, excavation is almost invariably the most informative field technique and is imperative when archaeological remains would otherwise be destroyed. As well as allowing a site to be recorded and understood in its entirety, excavation tends to be the most effective technique for generating positive publicity and public interest in a site.

**67** The excavation process follows a typical sequence:

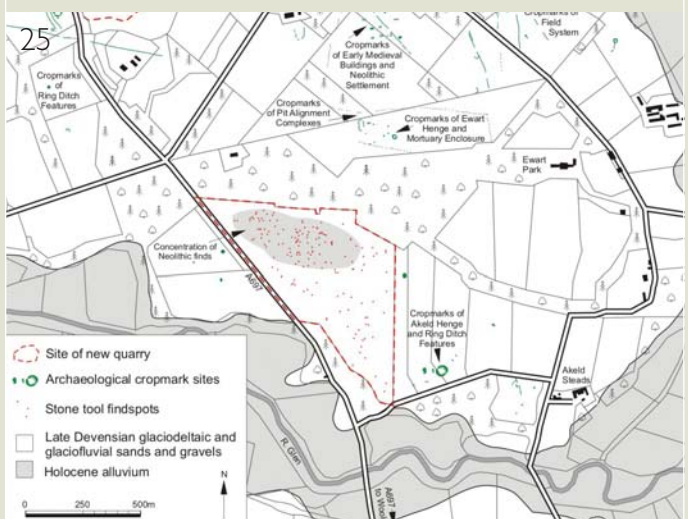
- Once the overburden has been stripped, all features are hand-cleaned and surveyed. This can include extant features such as pits, post-holes, hearths and ditches, or spreads of artefacts within sediment horizons, such as scatters of stone tools, animal bones or even log boats.
- Each archaeological deposit and feature is usually fully excavated or sampled, drawn, levelled, photographed and surveyed. The fill of a feature is often sampled to recover smaller artefacts as well as botanical remains such as charred plant remains (for guidelines see English Heritage 2002). A record sheet for each feature and deposit is completed together with registers of finds, samples, photographs and drawings.
- Once excavation is complete the primary or site archive is moved to the office and any fragile finds are placed in a stable environment. Finds, samples, photographs, written and drawn records are then collated ready for the Post-excavation stage (see section below).

**68** Large scale excavation work should follow established practice through the use of English Heritage's MoRPHE (Management of Research Projects in the Historic Environment, English Heritage 2006, the recent replacement for MAP2) process and the IFA *Standard and Guidance for Archaeological Excavation* (2001c).

**23** A large multi-phase Iron Age roundhouse under excavation at Hoveringham Quarry, Gonaladston, Nottinghamshire. © L Elliot

**24** Fieldwalking at Lanton Quarry, Northumberland, revealed a discrete focus of Neolithic occupation on part of the site. © Archaeological Research Services Ltd

**25** Map showing the distribution of archaeological remains in relation to different geomorphological units at the Lanton Quarry site, Northumberland. © Archaeological Research Services Ltd



**69** Excavation is usually employed as part of the post-determination phase of the planning process. Because it is labour-intensive and generates more post-fieldwork analysis than other techniques, excavation tends to be the most expensive type of archaeological work. Once the site has been stripped and the full extent of archaeological features has been established excavation costs and time frames can normally be fixed so as to limit further financial risk to the developer.

### Fieldwalking

**70** This is an important technique that should be considered for all potential quarry sites where removal of topsoil will occur. This is because fieldwalking allows two processes to be undertaken at the same time. Firstly, by collecting a sample of the surviving artefacts from the topsoil a record is created of the archaeological resource in the topsoil. For some periods such as the Late Upper Palaeolithic, Mesolithic, Neolithic and Early Bronze Age this may be all that is left of past human activity at the site. Secondly, spatial plotting of artefacts found on the surface can allow the location of potential sub-surface remains. Although this method is relatively inexpensive it can yield good informative data. For best results it is sometimes worth having an area of land specially ploughed or harrowed, provided it has been ploughed in the past and there is no risk to upstanding or buried archaeological remains. Fieldwalking usually needs to be supported by other more invasive techniques, such as test pitting or evaluation trenching, in order to further define and characterise any surviving sub-surface deposits and the evidence for archaeological remains in the overburden.

**71** Fieldwalking involves archaeologists systematically walking across ploughed fields searching the ground for artefacts. The closer together the walkers are placed the more accurate the survey will be and the greater the potential to identify sites and assess potential risk. In northern England intervals of 2–5 metres have been found to be most effective whereas in other areas, where flint is more common, spacings of perhaps 10m may be more appropriate. Finds are bagged, numbered and plotted in so that each find can be accurately located on a map.

**72** The most common finds are stone tools and pottery. Fieldwalking is therefore particularly useful for identifying Stone Age (Palaeolithic, Mesolithic, Neolithic) and Early to Middle Bronze Age sites, as well as Iron Age, Roman, medieval and post-medieval sites that sometimes produce large quantities of well-fired pottery. Poorly fired

prehistoric and early medieval pottery is rarely found using this technique. Where sites are identified by aerial photography or geophysics, fieldwalking can be used to assess their date as well as to retrieve important artefactual evidence that may not survive in the buried deposits. It is sometimes worth considering including a formal programme of metal detecting (for standards on metal detecting see Gurney 2003) across a field if it is considered there is potential for metalwork to survive.

**73** Fieldwalking is a relatively inexpensive technique that allows for broad-brush archaeological prospection and characterisation of Stone Age and later land use over large areas based on the patterning of stone tool distributions. However, if significant quantities of finds are retrieved there may be additional costs for specialist analysis of lithics (stone tools), ceramics and, more rarely, metalwork and coarse stone tools. Fieldwalking is most commonly employed in the pre-determination phase of the planning application but the results from earlier surveys can usefully feed into the LDD. It is particularly effective for locating Stone Age archaeology when undertaken at closely spaced intervals.

### Geomorphological mapping

**74** Geomorphological mapping can assist in the design of an evaluation programme. Detailed maps of landform units can be used to identify potential palaeoenvironmental remains, assess sediment units, as well as to produce superficial and buried-terrain models that can inform predictive models of sites and their wider landscape setting. Such work can reveal how the landscape was formed and how it has been modified through time. This in turn allows prediction of the survival of remains of different periods at different depths, alongside an assessment of their likely state of preservation and the type of techniques appropriate for their evaluation.

**75** Geomorphological mapping usually requires a programme of fieldwork and survey by appropriate specialists, supported by desk-based analysis of Ordnance Survey maps, geological maps, aerial photographs and data from remote-sensing techniques such as LiDAR. Mineral operators frequently conduct their own geotechnical bore-hole testing and where possible this should be used to assist and complement the geomorphological analysis for archaeological purposes. Geomorphological maps can be used as the basis for landform classification and these can inform archaeological expectations for an area and subsequent decision-making.

**76** A typical application of geomorphological mapping might involve augering across the development area to map the depth and extent of a buried land surface or to identify waterlogged sediment traps and other organic horizons. The technique can also be used to determine the location and depth of hillwash deposits and then follow up such identifications with evaluation trenching to assess their archaeological potential.

**77** Field-based geomorphological mapping is a rapid, cost-effective and relatively inexpensive means of analysing environmental change and landform evolution, as well as providing a platform for other evaluation work. To maximise cost effectiveness, industry-required geotechnical assessments and archaeological geomorphological mapping should ideally be integrated. Together they can provide important information on past landscape development and land-use by human populations as well as generate data on earlier farming practices. Detailed mapping of extensive areas can be greatly facilitated by high-resolution remote sensing techniques such as LiDAR, although these may add to the cost of survey. Geomorphological mapping is typically employed as part of the pre-determination phase of the planning application although prior work can provide important information to the LDD.

### **Geophysical survey and remote sensing**

**78** Geophysical survey consists of a suite of non-invasive ground-based remote-sensing techniques that can aid the discovery of buried archaeological remains by measuring different physical properties of the subsurface. The preferred methods for mapping shallow remains are magnetometer and earth resistance survey, although ground-penetrating radar (GPR) is sometimes used. English Heritage has prepared detailed guidance for the deployment of these techniques (English Heritage, 2008b). The archaeological curator and consultants will usually be able to use their local knowledge to comment on the likely effectiveness of the techniques in a given area and thus on whether or not they should be employed. There may also be opportunities for integrating archaeological prospection with broader minerals-based geophysical survey.

**79** Geophysical survey can offer a relatively inexpensive and cost-effective means of testing large areas for the presence of sub-surface remains. However, its ability to successfully detect archaeological deposits is influenced by local site conditions such as geology, soil properties, the depth of the overburden and variations in soil-moisture content. Because geophysical techniques

depend on a physical contrast between buried archaeological features and the surrounding medium, it is not always possible to detect features with fills similar to their host soils and geology. Modern disturbance from pipes and other services can also mask more subtle responses to archaeological features. Even when circumstances are favourable, small discrete features such as post-holes may not be identified, although surveying with higher than normal sample densities can increase the chances of detection. Alluvial and other types of superficial deposits, particularly at depths in excess of a metre, present serious difficulties for geophysical prospecting.

**80** Because the responsiveness of geophysical techniques is conditioned by local ground conditions, a pilot survey linked with coring or test pitting can help with the development of a reliable and efficient evaluation strategy. Different geophysical methods are often complementary in the information they provide about buried remains. Because of its speed, magnetometer survey will often be the preferred initial technique, followed up by more closely targeted investigations using other methods. Geophysical survey is typically a medium-expense technique; it is not labour intensive but does require the use of specialist personnel and equipment. It is typically employed as part of the pre-determination phase of the planning application.

**81** In recent years an airborne remote sensing technique known as LiDAR (Light Detection and Ranging) has been used to create highly detailed models of the land surface at sub-metre resolution. As the LiDAR survey aircraft flies over the target area a pulsed laser beam is scanned from side to side, measuring between 20,000 to 100,000 points per second to build an accurate, high resolution model of the ground and the features upon it. This information can assist aerial photographic interpretation of upstanding archaeological features as well as slight natural features such as palaeochannels. In England the Environment Agency has for several years used LiDAR for the production of terrain maps for assessing flood risk. They hold data for large areas of the country, concentrating on the coasts and river valleys, and this can be made available in .jpg format to legitimate researchers subject to strict licensing agreements.

**26** Magnetometer survey for Trent & Peak Archaeology showing the arc of a Romano-British enclosure with overlying ridge-and-furrow cultivation at Captain's Pingle, Barrow upon Trent, Derbyshire.  
© University of Leicester Archaeological Services and Lafarge Aggregates Ltd

Quarry, Northumberland.  
© Archaeological Research Services Ltd

**28** Microscopes are used to identify ancient botanical remains identified after the expertly prepared sample has been mounted on a slide.  
© Archaeological Research Services Ltd

**27** Environmental sampling of an alluvial sediment unit near Cheviot

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## Palaeoenvironmental analysis

**82** Palaeoenvironmental remains are those that shed light on past landscapes and how they have been impacted upon by human activity. They may include organic evidence. At the pre-determination stage this analysis, where it is deemed appropriate, should be limited to assessment of whether or not deposits of high palaeoenvironmental value are likely to be removed during minerals extraction.

**83** If it is known that development will remove deposits of high palaeoenvironmental potential, planning conditions or obligations will require the analysis of those sediments. To ensure the most cost-effective information gain, sampling strategies for palaeoenvironmental analysis should be implemented by specialists in this field working closely with the mineral operator.

**84** Finer-grained sediments accumulating in natural fluvial deposits, ox-bow lakes and peat bogs can trap and preserve pollen grains, fragments of plants and insects as well as large pieces of wood and even contemporary timber structures. These fossil remains can be extracted from sediments and analysed in the laboratory together with material from archaeological deposits such as land snails, faunal remains and other organic material. Combined with radiocarbon dates from their associated sediments (or the fossils themselves) these records help to build a picture of the plant and insect communities of past landscapes as well as the human use and exploitation of organic materials. This information allows archaeologists to build up a detailed picture of how landscapes looked and how they were used by earlier human populations. Often, this kind of contextual information cannot be acquired through archaeological excavation alone. Palaeoenvironmental information also can sometimes be acquired from the fills of archaeological features, particularly when these contain waterlogged or charred remains or where the surrounding geology is sufficiently alkaline to preserve unburnt organic material.

**85** The palaeoenvironmental record may yield evidence for human activity such as deforestation, woodland management, pastoralism, cereal cultivation, mining and even climate change. It therefore constitutes an important part of the archaeological record. Furthermore, in areas where the latter is disturbed or absent, palaeoecological techniques offer the only means of evaluating the presence and activities of past human groups.

**86** Palaeoenvironmental analysis is a medium-cost technique, depending on the scale of the work, that requires the use of specialist facilities and staff. Palaeoenvironmental analysis can often provide information about the past at a different geographic scale to that usually acquired from archaeological excavation. It can also be used to assess the environmental impact and sustainability of past human activities.

### Post-excavation, archive and dissemination

**87** Once archaeological fieldwork of any sort has taken place there follows a post-fieldwork phase during which remains are processed and analysed and a report produced. The shorthand term for this phase is 'post-excavation'.

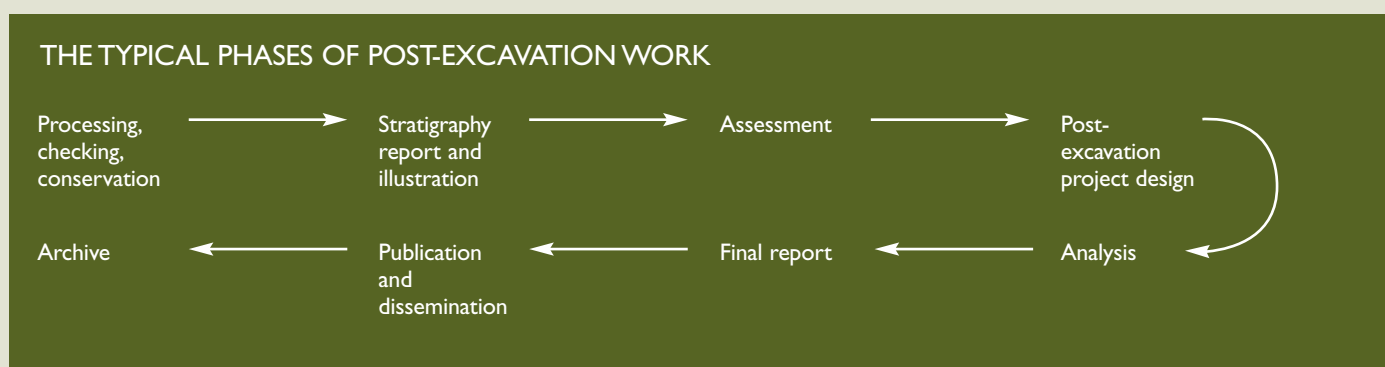
**88** Post-excavation work follows an established routine and set of standards which have been set out in MORPHE (English Heritage 2006), the IFA's various standard and guidance documents (IFA 2001a–e) and those published as English Heritage's 'Centre for Archaeology Guidelines' (English Heritage 2001a–b; 2002 a–b, 2003, 2004, 2008b).

**89** During the post-excavation phase the remains recovered from excavation are assessed to identify whether the material is worth further analysis in terms of the information it could yield. The most frequent analyses are those of stratigraphic association, small finds (eg stone tools, ceramics, metalwork, bone objects, leather, textiles and glass), human skeletal remains, botanical and environmental remains (eg plants, wood, seeds, beetles, invertebrates, pollen), faunal remains (eg animal bones), scientific dating (eg radiocarbon dating, thermoluminescence and dendrochronology) and residue analysis (eg from residues surviving on pot surfaces) but this list is by no means exhaustive. If remains need to be specially conserved then this

is carried out on the basis of expert advice, sought in the first instance from the English Heritage Regional Scientific Advisor.

**90** Once the results of analysis are available a synthesis draws together all the archaeological work and interprets it. Depending on the quantity and significance of the results an appropriate level of publication will be required. This could range from a note in a local archaeological journal through to an academically refereed paper or standalone monograph. However, dissemination does not need to be confined to publication. It can also provide mineral developers with a huge range of opportunities to engage with the public and to gain recognition for their investment in archaeological work. Other forms of dissemination can include open days, site tours, opportunities to take part in archaeological fieldwork, public lectures, walks, school activities, information panels, reconstructions, leaflets, TV, radio and other media coverage.

**91** The permanent record of archaeological work includes the primary or site archive (field notes, registers, drawings and recording sheets), the digital archive (all digital files associated with the work) and the physical archive (finds, samples, photographs etc). The primary and physical archive is deposited in an appropriate museum together with a copy of the digital archive on disc. A copy of the digital archive may also be deposited with the Archaeological Data Service (ADS) who will curate the files in future years to ensure they remain compatible with upgrades in software technology. Most local authorities also require a copy of the final report to be uploaded on to the Online Access to the Index of Archaeological Investigations (OASIS) web site (maintained by the ADS) where a project summary and copy of the report is available for public viewing via the internet.



**29** Coring for organic sediments in a filled-in kettle hole close to an aggregate quarry at Wooperton, Northumberland. © Archaeological Research Services Ltd

**30** A mechanically stripped surface being cleaned at Barrow upon Trent, Derbyshire. © Trent & Peak Archaeology



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**31** Test-pitting on a sand and gravel terrace where large quantities of Mesolithic flint tools had previously been discovered. © Archaeological Research Services Ltd

**92** Post-excavation work through to dissemination and archive can be a low, medium or high- expense depending on the complexity and scale of the work. If additional work is carried out to produce wider public benefits, such as interpretive, educational and outreach initiatives, the small extra cost involved is usually outweighed by significant gains for the mineral operator and the public.

### Sediment analysis

**93** Analysis of the depth, nature and age of sediments lying beneath the surface is an important means of understanding land-forming processes and environmental history. It should complement geomorphological mapping in palaeoenvironmental investigations. Sedimentary sequences may be well exposed in eroding river banks, aggregate quarries and drainage ditches. However, these sections may only expose the upper part of sediment bodies and in these cases, as well as in areas that lack any such exposure, it is usually necessary to extract sediment cores using hand-operated or powered augers. Mineral operators frequently commission geotechnical boreholes of their own and these can provide very useful information for archaeologists. In some cases it may be appropriate for a borehole to be monitored by a geoarchaeological specialist who can identify any potential archaeological or palaeoenvironmental material recovered from the borehole.

**94** Of particular interest to low-lying sand and gravel sites are palaeochannels that reflect changes in the course of past river channels. These former ox-bow lakes and floodplain wetlands are the most-likely areas for deposition of peat and organic-rich sediments that are suitable for radiocarbon dating and the preservation of pollen, plant and insect remains. These organic materials can reveal much about former environments, human land-use and change over time. It is not unusual for palaeochannels to contain evidence that directly relates to human activity, such as fish weirs, flax retting, boats and so forth.

**95** Sediment coring and analysis is an inexpensive to medium-expense technique which, in association with geomorphological mapping, provides the basis for analysis of environmental change and a means of accessing material for radiocarbon and palaeoecological analysis. It requires the use of specialist equipment and staff and can be employed as part of the pre-determination phase of the planning application or as a post-permission measure.

## Strip, map and sample

**96** The 'strip, map and sample' method, sometimes referred to as 'strip and record', is different to full excavation as it is primarily aimed at large open-area excavation where the intention is not to excavate all the archaeological remains exposed, but rather to plan them in full and selectively sample them to answer specific questions. It is important that the sampling strategy is rigorous and flexible and is kept under constant review as recording progresses, for example to record archaeological remains in the overburden. This technique is particularly well suited to large rural sites but less appropriate for small but complex sites, and particularly those with deep stratigraphy. The technique involves the overburden being systematically stripped by machine to expose the top of the archaeological horizon. Archaeological remains within the stripped area are then cleaned, photographed and mapped. Following on from this a process of systematic excavation of deposits is undertaken, the intensity of which is usually decided once it has been established what archaeological remains exist. The features or areas selected for excavation are usually sampled for artefacts and botanical remains.

**97** In certain circumstances this approach has considerable appeal. Firstly, it allows for all archaeological remains to be recorded in plan. This allows for a much fuller understanding of site layout and organisation and the relationship between groups of features and their wider setting, as well as the preservation by record of all remains that will eventually be removed. Secondly, the adoption of this approach may mean that less costly work is required in the pre-determination stage as its adoption as a post-determination measure should ensure that all archaeological remains revealed on a site are recorded in plan at that stage. Thirdly, resources can be targeted to maximise the information gain rather than excavation of all deposits. This also encourages a question-led, research-focused, approach, which helps archaeologists to think through what the site can tell us.

**98** Some of the most important gains in archaeological knowledge in recent years have occurred through the use of the strip and record approach. These have included the discovery of sites that are difficult to prospect for, such as Neolithic buildings, Bronze Age roundhouses in lowland settings and Post-Roman post-built houses. Similarly, poorly surviving remains that are difficult to recognise for example during evaluation trenching, have come to light unexpectedly as a result of this approach and these can add significantly to our understanding of the past.

**32** A watching brief under way at Cheviot Quarry, Northumberland.  
© Archaeological Research Services

**33** Following the discovery of 5th-century AD timber buildings at Cheviot Quarry, Northumberland, this reconstruction was built at the neighbouring heritage trail, where it can be visited by the public. © Archaeological Research Services Ltd



**99** Strip, map and sample can be medium to high expense but it can be more cost-effective and less expensive than full excavation. The drawback is that the costs are not known until the area has been stripped, cleaned and mapped. However, as subsequent excavation is targeted this does mean that resources can be allocated to best effect. The subsequent sampling strategy that is adopted after a site is stripped should be rigorous and flexible and kept under review so that deposits of a particular type or value can be dealt with appropriately. For further information about this technique and its implications within the context of the planning process see Hey and Lacey (2001).

### Test pits

**100** Test pits are different to evaluation trenches as test pits are usually hand dug and are much smaller. If test pits produce evidence for the survival of archaeological remains this can be very useful. Given their small size, however, a lack of positive results does not necessarily mean that there are no archaeological remains in the vicinity.

**101** Test pitting is often used in conjunction with other forms of archaeological investigation to test for the presence of buried remains. In areas where it is not possible to fieldwalk – such as fields under permanent pasture or in areas of woodland – regularly spaced test pits allow the soil to be sampled for the presence or absence of artefacts, while also allowing for the identification of buried deposits. Test pits also provide information on the nature and depth of the overburden and this can assist in deciding the most appropriate archaeological evaluation techniques to employ on a potential development site.

**102** Test pits can vary in size from 1m and 2m squares to 5m squares. They are often excavated in a grid pattern and the contents of each pit are usually sieved by spit to maximise the recovery of finds. Because of their small size test pits are not well suited to the evaluation of large areas. However, they provide a suitable means of supporting other techniques that target their location, such as fieldwalking, geophysics and aerial photographic analysis.

**103** Test-pitting provides a way of sampling non-ploughed areas, such as pasture or woodland as well as testing data from fieldwalking, geophysical survey and aerial photographic analysis for the presence of sub-surface remains. It is generally an inexpensive to medium-expense technique that demands a significant

investment of labour depending on the size of the area being investigated and the sample interval required. Test pits also provide a section through sediments and this additional information can be helpful in understanding whether or not remains will survive in the area, as well as how the landform and soil cover has formed and developed. They are typically employed as part of the pre-determination phase of the planning application.

### Watching brief

**104** A 'watching brief' – sometimes referred to as 'archaeological control and supervision' or 'recording brief' – is defined by the IFA as 'a formal programme of observation and investigation conducted during any operation carried out for non-archaeological reasons' (IFA 2001a). All watching briefs must comply with the IFA's Standard and Guidance for an Archaeological Watching Brief (2001a).

**105** Watching briefs are employed when other evaluation techniques have not detected significant archaeological or palaeoenvironmental remains but there is still considered to be some potential for them to survive, or where the presence and nature of remains could not be accurately established in advance of development.

**106** A watching brief involves the presence of archaeologists and/or palaeoenvironmental specialists on site who supervise, observe and record any remains exposed during groundworks. A planning authority usually specifies a watching brief as part of a planning condition in order to record any archaeological remains under a controlled programme of soil stripping.

**107** A watching brief can range from being an inexpensive to expensive technique. In straightforward cases it requires few people to be on site, and if little is identified the results will justify only a brief published report. However, if archaeological remains are found then developers are usually expected to pay for full excavation and recording of the deposits, which could not only make this an expensive process but one that delays the development. Furthermore, a watching brief should include stripping back of the overlying soils in a controlled way that avoids machinery tracking over cleared areas; this may slow down the stripping of a site and add to the cost of keeping plant on site. For this reason archaeologists usually advise developers to budget for a contingency sum and build additional time into the programme of works if a watching brief is employed, in case archaeological or palaeoenvironmental remains are found.

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## USEFUL SOURCES OF INFORMATION AND ADVICE

Aggregates Levy Sustainability Fund (Information about a host of research projects that have generated better understanding of sustainability within the minerals industry)

[www.sustainableaggregates.com](http://www.sustainableaggregates.com)

Association of Local Government Archaeological Officers UK (ALGAO: UK)

[www.algao.org.uk](http://www.algao.org.uk)

British Aggregates Association

[www.british-aggregates.co.uk](http://www.british-aggregates.co.uk)

British Geological Survey:  
Centre for Sustainable Mineral Development

[www.bgs.ac.uk/mineralsuk](http://www.bgs.ac.uk/mineralsuk)

English Heritage

[www.english-heritage.org.uk](http://www.english-heritage.org.uk)

Goodquarry (Resource guide created by the Mineral Industry Research Organisation)

[www.goodquarry.com](http://www.goodquarry.com)

HELM (Historic Environment Local Management information site maintained by EH)

[www.helm.org.uk](http://www.helm.org.uk)

Heritage Gateway (Information on archaeological sites and contact details for local HERs)

[www.heritagegateway.org.uk](http://www.heritagegateway.org.uk)

Institute of Field Archaeologists (IFA)

[www.archaeologists.net](http://www.archaeologists.net)

MAGIC (Web-based map of environmental schemes and land designations in England)

[www.magic.gov.uk](http://www.magic.gov.uk)

National Mapping Programme (Information on English Heritage's national aerial photographic survey)

[www.english-heritage.org.uk/server/show/nav.1186](http://www.english-heritage.org.uk/server/show/nav.1186)

National Monuments Record (English Heritage's public archive of 10 million archaeological and architectural records and photographs)

[www.english-heritage.org.uk/server/show/nav.1530](http://www.english-heritage.org.uk/server/show/nav.1530)

OASIS (Index to archaeological literature resulting from developer-funded fieldwork)

<http://ads.ahds.ac.uk/project/oasis>

Planarch (Partnership promoting integration of archaeology within the planning process)

[www.planarch.org](http://www.planarch.org)

Quarry Products Association (QPA)

[www.qpa.org.uk](http://www.qpa.org.uk)



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